Environmental Investigation Plan

Johnsonville Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Johnsonville Fossil Plant
New Johnsonville, Tennessee

December 10, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	July 24, 2017
1	Issued for TDEC Review – Addresses Revision 0 TDEC Review Comments	January 12, 2018
2	Addresses March 9, 2018 TDEC Review Comments and Issued for TDEC Review	May 11, 2018
3	Addresses June 11, 2018 TDEC Review Comments and Issued for TDEC Review	July 20, 2018
4	Addresses comments and revisions from other EIPs and issued for TDEC review.	December 10, 2018

ENVIRONMENTAL INVESTIGATION PLAN
JOHNSONVILLE FOSSIL PLANT

TITLE AND APPROVAL PAGE

Title of Plan: Environmental Investigation Plan
Johnsonville Fossil Plant
Tennessee Valley Authority
New Johnsonville, Tennessee

Prepared By: Tennessee Valley Authority

Effective Date: December 10, 2018 Revision 4, Final

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Abbreviations

BTV	Background Threshold Value
CARA	Corrective Action/Risk Assessment
CCR	Coal Combustion Residuals
CCR Rule	EPA Final Rule on Disposal of Coal Combustion Residuals from Electric Utilities
CL	Lean Clay
DPT	Direct Push Technology
EAR	Environmental Assessment Report (Report)
EIP	Environmental Investigation Plan
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
GPS	Global Positioning System
JOF	Johnsonville Fossil Plant
MCLs	Maximum Contaminant Levels
ML	Silt
NPDES	National Pollution Discharge Elimination System
PLM	Polarized Light Microscopy
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RFAI	Reservoir Fish Assemblage Index
SAP	Sampling and Analysis Plan
SPP	TVA Standard Programs and Processes
SPT	Standard Penetration Test
TDEC	Tennessee Department of Environment and Conservation
TDEC Order	Commissioner's Order OGC15-0177
TI	Technical Instruction
TVA	Tennessee Valley Authority

1.0 INTRODUCTION

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order), to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Johnsonville Fossil Plant (JOF) on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management at JOF. Prior to the investigation conference for JOF, TDEC sent TVA a letter on June 14, 2016 outlining 'General Guidelines' – a series of general requirements for Environmental Investigation Plans (EIPs). TDEC issued a follow-up letter dated February 23, 2017 to TVA which provided specific questions and tasks to be addressed in an EIP for JOF. TVA developed and submitted the JOF EIP Revision 0 to TDEC on the deadline of July 24, 2017. TVA submitted subsequent revisions to the EIP based on review comments provided by TDEC as documented in Section 1.2 below. This JOF EIP Revision 4 addresses revisions that have been made to EIPs of other plants since the previous version of this EIP was submitted. The previous version of this EIP was available for public comment, and no comments were received.

1.1 PURPOSE

The purpose of this EIP is to comply with Section VII.A.d. of the TDEC Order. This section requires TVA, upon receiving any request for additional information from TDEC, to develop an EIP for each site that, when implemented, will provide the information necessary to "fully identify the extent of soil, surface water, and ground water contamination by CCR." The responses and schedule set forth in this EIP correspond to each individual task in TDEC's information request letters for JOF dated February 23, 2017, October 19, 2017, and March 9, 2018. The Environmental Assessment Report (EAR) will be submitted at a later date, following completion of the environmental investigation identified in the EIP. The EAR will provide "an analysis of the extent of soil, surface water, and ground water contamination by CCR at the site" and thus will provide the information, analyses, and/or evaluations responsive to TDEC's information requests and the TDEC Order.

1.2 MULTI-SITE ORDER TIMELINE

By way of background, a summary of events related to the TDEC Order is provided below:

- TDEC issued Commissioner's Order OGC15-0177 to TVA on August 6, 2015.
- On September 22, 2015, TDEC and TVA met to discuss the TDEC Order. During the meeting, TDEC submitted a list of questions to be addressed at each Investigation Conference.
- On June 14, 2016, TDEC issued a letter outlining 'General Guidelines' for EIPs.

- On August 5, 2016, TVA provided TDEC with an Investigation Conference Data Transmittal for JOF. This transmittal included electronic and hard copies of supporting information files (and a file directory).
- TVA held the Investigation Conference at JOF on August 17-18, 2016. The Investigation Conference included site reconnaissance and a presentation that addressed the questions previously provided by TDEC.
- On February 23, 2017, TDEC provided an Investigation Conference Response Letter. The letter requested additional data, and the EIP. The list of questions and environmental investigative tasks to be addressed in the EIP is included in the letter. The deadline for submittal of the EIP was established as July 24, 2017.
- TVA submitted JOF EIP Revision 0 to TDEC on July 24, 2017.
- TDEC provided JOF EIP Revision 0 review comments to TVA in a letter dated October 19, 2017. The comments requested TVA include responses to TDEC's General Guidelines for Environmental Investigation Plans (General Guidelines) in the JOF EIP. The General Guidelines are addressed in Section 4 of this EIP. The deadline for submittal of the JOF EIP Revision 1 was set for January 12, 2018.
- TVA submitted JOF EIP Revision 1 to TDEC on January 12, 2018.
- TDEC provided JOF EIP Revision 1 review comments to TVA in a letter dated March 9, 2018. This included the request for a new Dye Trace SAP. The deadline for submittal of the JOF EIP Revision 2 was set for May 11, 2018.
- TVA submitted JOF EIP Revision 2 to TDEC on May 11, 2018, including the new Dye Trace SAP.
- TDEC provided JOF EIP Revision 2 comments on June 11, 2018.
- TVA submitted JOF EIP Revision 3 to TDEC on July 20, 2018.
- TDEC accepted JOF EIP Revision 3 for public comment on August 13, 2018. The public comment period was held from September 26, 2018 to November 9, 2018. A public meeting was held in New Johnsonville on October 18, 2018. No public comments were received.

1.3 EIP IMPLEMENTATION (INVESTIGATION)

A summary of the proposed EIP process for JOF is provided below and is included in the proposed EIP implementation schedule in Appendix A:

- TVA will address TDEC's JOF EIP Revision 1 comments and submit JOF EIP Revision 2 including its implementation schedule to TDEC on May 11, 2018.

- TDEC will review and approve JOF EIP Revision 2 or will provide TVA a list of comments to be addressed in a subsequent future EIP revision.
- TVA will address additional comments TDEC may have, submitting additional revisions and repeating the process until TDEC approves the JOF EIP.
- In a letter dated September 28, 2015, from TDEC to the Southern Alliance for Clean Energy, TDEC added an additional opportunity for public involvement in the TDEC Order. TDEC will host a meeting with all interested parties to discuss each proposed EIP before the public comment period stated in the TDEC Order.
- TVA will provide public notice of the EIP published in a manner specified by TDEC and allow a minimum of 30 days for public comment.
- TVA will provide responses to public comments to TDEC within 30 days after the end of the public comment period.
- TVA will work with TDEC to revise the EIP and schedule accordingly.
- TVA will implement the EIP by conducting the investigation in accordance with the approved plan and schedule.
- Within 60 days of completion of EIP activities, TVA will submit an EAR to TDEC. The EAR is described in Section 5.0.

  Refer to Appendix A for additional details regarding the implementation schedule.

2.0 APPROACH

The following describes TVA's overall approach for planning and conducting the EIP.

2.1 EIP DEVELOPMENT AND STRUCTURE

Responses to each TDEC information request will be developed by:

1. **Stating clear objectives and goals of the EIP Response.**
   This will be accomplished by re-stating each original information request from TDEC and identifying specific objectives for developing the information necessary to satisfy that request.

2. **Focusing on the objectives and desired outcomes of the EIP.**
   Each response will identify specific deliverables or information to respond to the request.

3. **Leveraging existing and ongoing data collection efforts, where available.**
   TVA has completed many studies at JOF and has programs underway for the Environmental Protection Agency (EPA) Final CCR Rule (CCR Rule), TDEC permitting requirements, Federal permitting and program commitments, Capital Projects, normal site operations, inspections, and maintenance that can help address TDEC's information requests. TVA will describe how, to the extent possible, data from work already completed, ongoing, or planned will be used to meet the objectives of the information requests.

4. **Conducting on-site and/or off-site studies, activities, plans and analyses in support of the EIP tasks as needed.**
   TVA will work with TDEC to develop and execute Sampling and Analysis Plans (SAPs) to develop new data where needed to respond to TDEC's information requests. The SAPs will provide detailed plans for conducting those studies to obtain new data and will describe how it will be used to respond to specific information requests. The SAPs will be structured as independent documents that guide the work of the SAP execution teams. The SAPs will document and communicate:

   - Background information
   - Objectives
   - Health and safety program
   - Sampling locations
   - Plant-specific field investigation approaches and procedures
   - Data analysis approaches and procedures

- Reporting approaches and deliverables
- Quality assurance/quality control (QA/QC) objectives and program
- Schedules
- Assumptions and limitations

A summary of each SAP will be provided in the response to corresponding information requests. The SAPs are included as appendices to the EIP; therefore, a list of proposed SAPs can be found in the Table of Contents. Field implementation may result in minor modifications of approaches. If this occurs, changes from the procedures specified in SAPs will be communicated to TDEC and documented in the EAR. TVA will notify TDEC of problems that impede the successful completion of the field activities described in the EIP and SAPs.

Where appropriate, a phased approach will be used to execute the EIP and SAP activities. For this approach, existing and ongoing studies will be used to develop additional plans; a broad study or test will then be used to pinpoint the location of a targeted study or test when needed.

5. **Revising the EIP to address TDEC and public comments.**
TDEC and public comments will be addressed in each EIP revision, as appropriate; however, to maintain clarity, these comments will not be listed in the EIP document. Correspondence with TDEC is provided as Appendix B. Public comments will be included in Appendix WW. TVA will work with TDEC and revise the EIP until a final version is approved.

Section 3, TDEC Site Specific Environmental Investigation Requests, addresses 17 site-specific questions from TDEC's Investigation Conference Response Letter. TDEC's information requests are shown in italics. The numbering sequence and format for the requested information provided in TDEC's Letter is provided in its original form. Section 4, TDEC General Guidelines for EIP, was formatted to correlate with TDEC's General Guidelines, which correspond to 36 general information requests. Similar to Section 3, these TDEC information requests are shown in italics. This format will enhance clarity and cross-referencing between the two documents.

During the Investigation and EAR process, TVA will provide monthly progress reports to TDEC. The progress reports will include schedule updates, percent completion on various tasks, and tasks that have been completed. The periodic submittal of schedule and status updates to TDEC is intended to help communication between TVA and TDEC throughout the investigation.

2.2 PROPOSED SCHEDULE

A proposed EIP schedule is provided in Appendix A and provides the following:

- A timetable for the investigation and EAR submittal
- An outline of the activities required to respond to each information request
- Planned start and finish dates for each activity

Since, in most cases, TVA will use information from ongoing and planned studies for other programs to help respond to TDEC's requests, the EIP schedule incorporates TVA's milestone dates for those studies. Consequently, should postponement of a key milestone date occur for such a study that also is on the EIP critical path, it will impact EIP and EAR schedules. Should that occur, TVA may request a time extension for impacted deadlines. Requests for a time extension will include supporting information to demonstrate appropriate cause, if applicable. Any plans for construction will be subject to the completion of all necessary National Environmental Policy Act reviews.

2.3 QUALITY ASSURANCE PROJECT PLAN

The JOF environmental investigation Quality Assurance Project Plan (JOF QAPP) in Appendix C has been developed to ensure that the JOF investigation objectives are met by TVA and its contractors through the generation of fully documented, high-quality, reliable investigative/analytical data. The JOF QAPP describes QA procedures and QC measures to be applied to investigation activities. The JOF QAPP governs the investigation-specific SAPs along with TVA Technical Instructions (TIs).

The JOF QAPP describes the QA implementation for the investigation and identifies the obligations of the various entities responsible for generating environmental data. The JOF QAPP also describes the generation and use of environmental data associated with the investigation and is applicable to sampling and monitoring programs associated with the project.

The JOF QAPP also establishes an overall environmental QA framework for the investigation and provides quantitative quality objectives for analytical data generated under the investigation. Requirements associated with various analyses; data generation, reduction, and management; and results reporting are stipulated therein.

The JOF QAPP addresses the following items:

- Project organizational structure, roles, and responsibilities
- QA objectives
- Training requirements
- Field and laboratory documentation requirements
- Sample collection, handling, and preservation
- Chain-of-Custody procedures
- Field and laboratory instrumentation and equipment calibration and maintenance
- Preventive maintenance procedures and schedules
- Laboratory procedures
- Analytical methods requirements
- Sample analysis, data reduction, validation, and reporting
- QC sample types and frequency
- QA performance and system audits
- Data assessment procedures, including processing, interpretation, and presentation
- Corrective actions
- QA reports to management

Additional investigation-specific QC requirements are presented in the associated SAPs. The JOF QAPP attachments present requirements and quantitative objectives for analytical data for each investigation. Analytical data intended for use under the JOF investigation will be managed in a database in accordance with the Data Management Plan for the TVA Multi-Site Order.

2.4 DATA MANAGEMENT PLAN

In order to address the logistics and technical challenges of managing analytical data generated to address the requirements set forth in the TDEC Order, TVA has developed Data Management Plan (DMP). On March 8, 2018, TVA submitted a revised DMP (Appendix V) which responded to comments provided by TDEC in an email dated February 7. 2018. The DMP has been developed to provide structure to support TVA and EI/EAR Team in the pre-planning, analysis, and reporting activities identified as part of the TDEC Order.

The DMP is intended for use on TVA's seven Tennessee facilities associated with the TDEC Order, and includes the following items:

- Data Management Team structure
- Data Management Process and requirements
- EQuIS Quality and Data Management System
- System Management and Administration

Several datasets will be acquired and generated during the environmental investigations related to the TDEC Order. An EarthSoft EQuIS™ database will provide analytical data control, consistency, reliability, reproducibility and a framework for validating analytical data throughout the life of the TDEC Order. The EQuIS database is the database for analytical chemistry and field parameter data. To support the wide-array of non-analytical data management needs related to the TDEC Order, a SharePoint-based knowledge management portal (KMP) for data access and document management has been developed. The KMP will integrate the EQuIS database, geographic information system database for geospatial data, and various other datasets of historical and EIP generated deliverables. The KMP will thus serve as the central access point for the TDEC Order data including EIPs, the environmental investigation data, and other data necessary for the EAR and Corrective Action/Risk Assessment (CARA) Plan.

3.0 TDEC SITE SPECIFIC ENVIRONMENTAL INVESTIGATION REQUESTS

TDEC requested that TVA provide responses to the information requests presented below which are sequenced to follow the Investigation Conference Response Letter. The information requests from TDEC are printed in italics to distinguish them from TVA's responses.

3.1 GENERAL JOF INVESTIGATION CONFERENCE QUESTIONS AND COMMENTS

3.1.1 TDEC General Request No. 1

The TVA JOF site presents a unique challenge in environmental investigation and remediation because the CCR material generated by burning coal is sluiced from the TVA JOF plant into a surface impoundment that was constructed with Kentucky Lake. Because of this, there are questions about how a ground water monitoring network can be installed to determine if CCR constituents are migrating from the bottom of this CCR surface impoundment into the river or into ground water below the river. Further, the active CCR impoundment is of concern due to its location. The impoundment is in the river channel, subject to continual erosion at the base of the CCR surface impoundment dike, is potentially subject to flooding and may be more subject to a catastrophic loss of CCR material should a substantial seismic event occur.

TVA Response

Active Ash Pond 2 impoundment dikes were constructed from materials that were placed hydraulically by dredging from Kentucky Lake, which was built on the Tennessee River (Stantec, 2010a). Active Ash Pond 2 (formerly Active Ash Pond D) began operating in 1970 (TVA, 1986), and the perimeter dike was raised once in 1978 to an elevation of 390-feet using the upstream method of construction.

Based on work conducted by Stantec for TVA in 2010, the following soils were identified at Active Ash Pond 2:

- The upper soil comprises the "Upper Clay Dike," which extends from an elevation of approximately 390 feet to 378 feet. It has been classified under the Unified Soil Classification System as a lean clay (CL), with textural descriptions of lean clay, lean clay with sand and lean clay with gravel.

- Underlying the "Upper Clay Dike" is the "Lower Clay Dike," which starts at an elevation of approximately 378 feet and extends down to approximately 370 feet. It varies from a CL to silt (ML) and is mixed with sand and gravel in places.
- "Fill Material" is beneath the "Lower Clay Dike," up to Elevation 370 feet. It is classified as CL and ML and consists of clay, silt, sand, and gravel.
- "Alluvial Clay and Silt" is encountered below the Fill Material. This is the shallowest alluvium encountered and was present down to between approximately Elevations 320 and 334 feet. It consists of lean clay, lean clay with sand and gravel, silt and silt with gravel.
- Beneath the "Alluvial Clay and Silt" lies "Alluvial Sand and Gravel". This alluvial unit consists of sands and gravels with silt.

The impoundment has an existing groundwater monitoring network consisting of four wells as indicated on Exhibit 1 (Appendix D). Wells 10-AP1 and 10-AP3 were installed in 2010 and two new wells (JOF-103 and JOF-104) were installed in 2016 (Stantec, 2017). Monitoring well coordinates and construction details are included in Appendix P. The wells are installed immediately adjacent to the CCR unit and are screened within alluvial sands; however, the well sand pack extends into the overlying clay and silt, such that groundwater samples collected from these wells are representative of conditions between Active Ash Pond 2 and Kentucky Lake. If CCR constituents are migrating from the base of the CCR unit, then they must migrate laterally to reach Kentucky Lake. This lateral migration is monitored by the current well network at the edge of the CCR unit.

As part of the Order investigation, TVA proposes to augment the groundwater monitoring network to further assess the potential presence of CCR constituents in the vicinity of Active Ash Pond 2 by installing two or three new wells: JOF-118 north of the surface impoundment proposed to monitor groundwater quality at the northern end of Active Ash Pond 2; JOF-119 south of the impoundment that may serve as a background well; and JOF-120 southeast of Active Ash Pond 2 and south of US Highway 70 on TVA property as an alternate to JOF-119 if analytical results for groundwater samples collected from JOF-119 indicate that this well is not suitable as a background well. If JOF-119 is not suitable as a background well, JOF-120 will be installed and JOF-119 will be retained as a monitoring well. These locations can be seen on Exhibit 2 (Appendix D). Monitoring well installation activities will be conducted under the supervision of a Professional Geologist licensed in the State of Tennessee. TVA will install the wells in accordance with the procedures provided in the Hydrogeological Investigation SAP (Appendix E) and provide investigation results in the EAR.

In addition, TVA has a surface water gauging station to continuously measure the level of the Tennessee River/Kentucky Lake. This data will be used to develop hydrographs to investigate the relationship between lake levels and Active Ash Pond 2. Groundwater flow for Active Ash Pond 2 will be evaluated using existing hydraulic conductivity data, gauging data from recently installed monitoring wells and surface water elevations from the river gauging station. The results of the evaluation will be provided in the EAR.

The proposed new monitoring wells will be used to collect groundwater samples from the same stratigraphic unit (sands and gravels) that the current well network monitors. Groundwater samples collected from the wells will be analyzed for the CCR constituents listed in 40 CFR Part 257, Appendices III and IV, along with additional parameters required by the State groundwater monitoring program (copper, nickel, silver, vanadium, and zinc) to evaluate naturally-occurring levels. These constituents will be hereafter referred to as "CCR Parameters". In addition, groundwater samples will be analyzed for major cations/anions and total alkalinity to characterize general water chemistry. Groundwater samples will be collected bimonthly for one year (six sampling events) for the initial phase of the investigation. Sampling procedures and parameters are provided in the Groundwater Investigation SAP provided in Appendix F.

The analytical data collected will be evaluated, including comparison to background concentrations and Maximum Contaminant Levels (MCLs). Piper diagrams (Piper, 1944) will be used to classify groundwater samples according to their major ionic composition. Groundwater sample results from background and downgradient monitoring wells will be included in the evaluation. Additional Piper diagram comparisons of individual CCR units or geological formations may be included based on the results of the hydrogeological investigation. If needed, TVA will investigate the fate of groundwater and develop a plan to further characterize groundwater, identify potential receptors, and evaluate risk to human health and the environment.

If CCR constituents are detected in the proposed background monitoring well locations at elevated concentrations, additional investigations may be proposed to further identify background levels. If additional investigations are required to identify more suitable sampling locations, an amended groundwater monitoring plan will be prepared and submitted to TDEC for review and comment prior to implementation.

Based on the results of the initial phase of work, additional investigations may be proposed to further identify background levels.

In addition, a dye trace study will be conducted to evaluate if preferential hydrogeologic transport pathways are present between Active Ash Pond 2 and Kentucky Lake using dye detection. The dye trace study activities are provided in the Dye Trace Study SAP contained in Appendix G.

Active Ash Pond 2 has rock (i.e., riprap) wave protection around the outer perimeter of the impoundment to control erosion. Annual inspections and daily observations continue to monitor the outboard slopes for signs of erosion. Between 1995 and 1997, riprap was placed to repair eroded areas along the outboard toe along the northwest portion of the perimeter dike (TVA 1996). A typical section is shown on Figure 1.

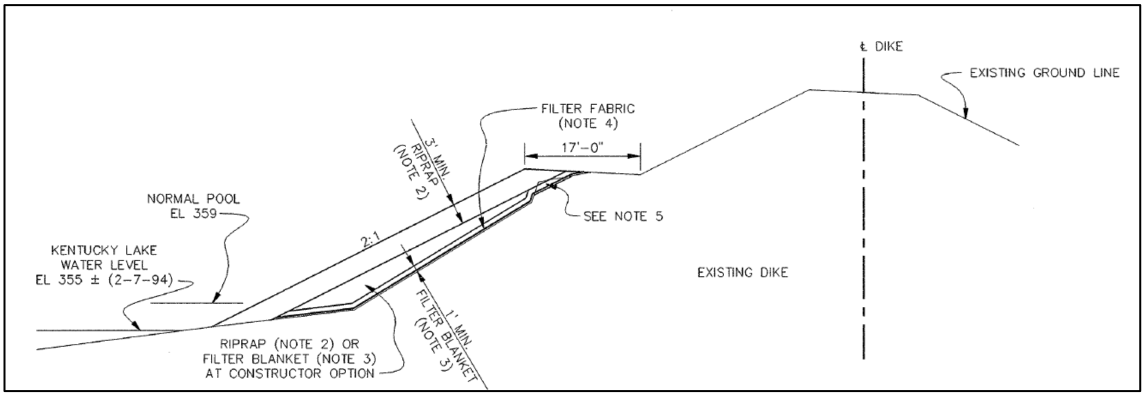

Figure 1. Typical Erosion Protection, Northwest Perimeter Dike (Drawing No. 10W527-1)

The southwest portion of the perimeter dike is protected from higher river flow velocities and erosive forces by a buffer of relatively high ground that creates a shallow water zone. In addition, between 2009 and 2015, trees located along the outslope of the southwest dike were removed and the surface was armored with riprap. A portion of this riprap was placed on the southwest dike outslope during the spillway replacement project in 2010 (TVA Drawing Package JOF-090515-WP-3). A typical section is shown on Figure 2. Note the shallow water buffer zone that extends beyond the toe of the southwest perimeter dike.

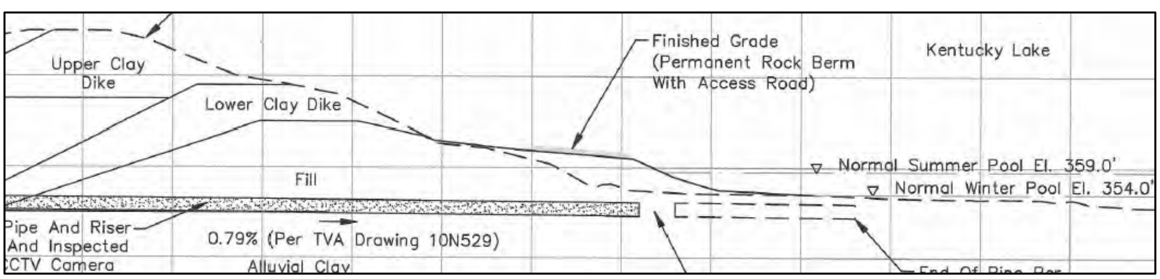

Figure 2. Typical Erosion Protection, Southwest Perimeter Dike (Drawing No. 10W505-12)

In 2010, risk reduction measures were implemented for the northeast and southeast portions of the perimeter dike. To address seepage and stability issues, a graded filter and riprap berm were constructed along the lower slope and into the river channel (TVA Drawing Packages JOF-100702-WP-6 and JOF-100702-WP-7). The riprap berm has the added benefit of providing additional erosion protection. Typical sections are shown on Figure 3 (Northeast) and Figure 4 (Southeast).

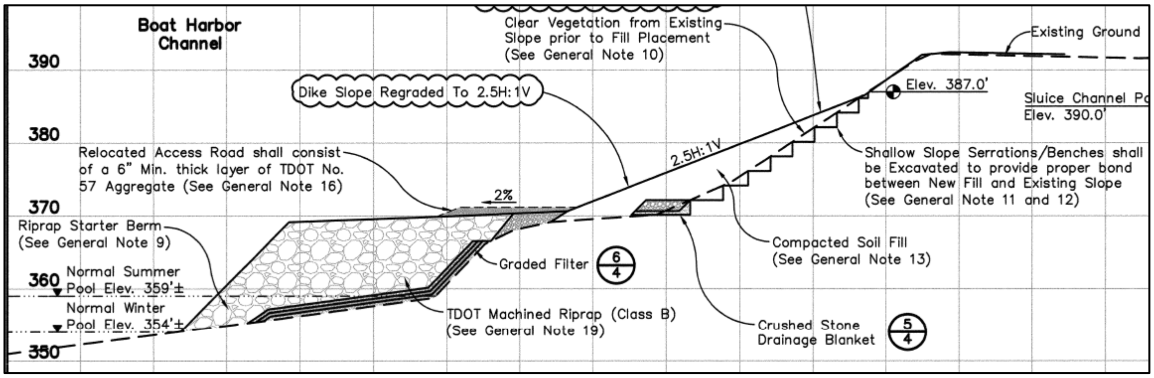

Figure 3. Typical Erosion Protection, Northeast Perimeter Dike (Drawing No. 10W503-04)

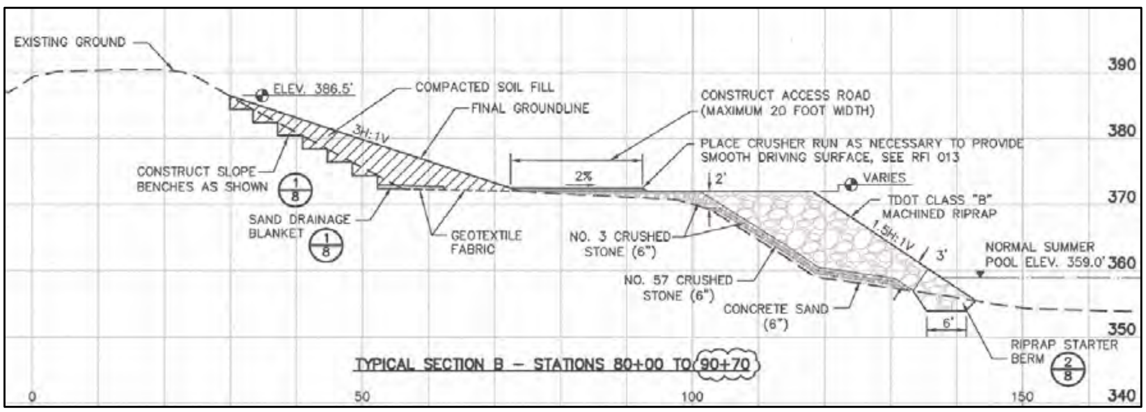

Figure 4. Typical Erosion Protection, Southeast Perimeter Dike (Drawing No. 10W550-08)

Inundation of the Active Ash Pond 2 impoundment by flood waters of Kentucky Lake is unlikely. Currently, the perimeter dike crest is at elevation 390 feet, while the normal river water elevation ranges between 354 and 359 feet. The 100-year and 500-year flood elevations are approximately 375 feet (FEMA, 2009). Therefore, over 30 feet of freeboard is present during normal operating conditions and 15 feet of freeboard is present even during a 500-year flood event (0.2% annual probability of exceedance).

TVA has evaluated seismic stability of Active Ash Pond 2 (Geocomp, 2016a, 2016b) for CCR Rule seismic safety factor compliance. This study included development of site-specific seismic hazards (i.e., ground motions), subsurface exploration, laboratory testing, subsurface characterization, development of material parameters and analysis cross sections, ground response analyses, liquefaction triggering assessment, seismic displacement analyses, pseudostatic slope stability, and post-earthquake slope stability. The study demonstrates that the seismic performance of Active Ash Pond 2 meets the acceptance criteria of the CCR Rule. A summary of this evaluation is included in Appendix H.

Based on the above discussion, TVA proposes to add wells for additional groundwater monitoring. Erosion protection around the perimeter has been addressed through past projects, and the current inspection and maintenance program provides for identification and mitigation of any future erosion.

3.1.2 TDEC General Request No. 2

TVA will face a considerable challenge conducting environmental investigation and corrective action activities at the TVA JOF site because where CCR materials were disposed at locations where the disposal area is on property owned by two or more persons. TVA must provide documentation to TDEC that TVA has an agreement(s) with adjacent property owners that allow TVA to conduct environmental investigations and corrective actions on neighboring properties. This documentation should be included in the draft TVA JOF Environmental Investigation Plan.

TVA Response

TVA understands this information request pertains to historic Ash Disposal Area 1 (i.e. Ponds A, B, and C). Both TVA and DuPont sluiced ash to Ponds A, B, and C and TVA maintained the ponds. In 1952, TVA sold most of the land for Ash Ponds A, B, and C to DuPont, retaining the right to fill portions of the tract with ash from JOF for 15 years. In 1956, DuPont extended TVA's right to fill the tract until July 31, 1986. Figure 5 shows the approximate current property boundary with respect to Ponds A, B, C.

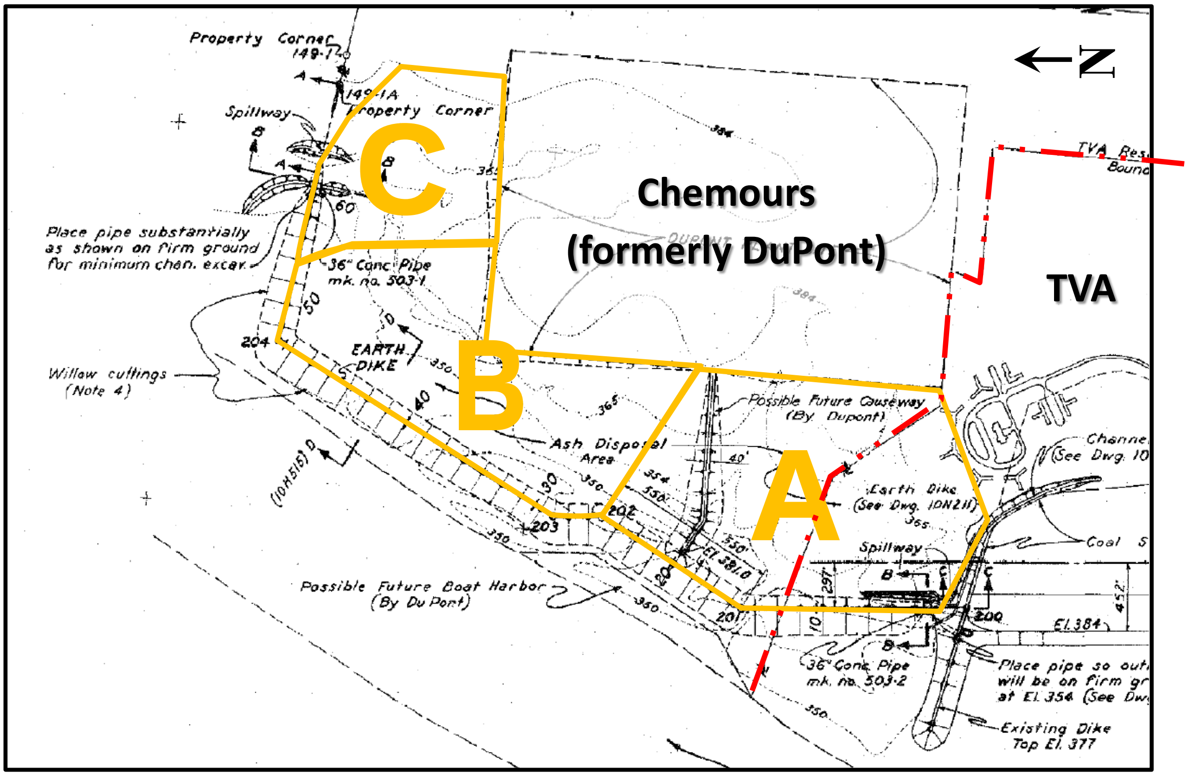

Figure 5. Current Property Boundary (Approximate)

Beginning in 1970, TVA ceased to discharge any ash or water into these ponds. During the 1970s, Ponds A and B were graded, reclaimed, and retired by TVA. Pond C remains in service by Chemours (formerly DuPont). Only a portion of former Pond A is on TVA's property (Ash Disposal Area 1) and the majority of Ponds A, B, and C lies within Chemours' fence line, which is beyond the scope of the TDEC Order. Based on the available information, the subdivision of Pond A between TVA and Chemours is not associated with any surface or subsurface feature of the pond; it is simply associated with the property boundary. Additionally, no formal agreement exists between TVA and Chemours regarding investigations and corrective actions at disposal areas on Chemours' property.

3.1.3 TDEC General Request No. 3

TVA should provide the estimated amount and location of CCR material that is disposed on the TVA JOF property and adjacent property, including CCR material in active surface impoundments and landfills. TVA is not required to report the amount and location of CCR material disposed of offsite in properly permitted solid waste landfills. Is there a memorandum of agreement or similar legal document(s), executed between TVA and owners of adjacent property (ies) where CCR material from the TVA JOF site has been disposed? If so, TVA should include those documents in the EIP.

TVA Response

TVA prepared a Material Quantity SAP, provided as Appendix I, to describe the methods TVA will use during the investigation to answer TDEC's information requests regarding CCR material location and quantity for the Coal Yard (see Section 3.1.5), Active Ash Pond 2, South Rail Loop Area 4, DuPont Road Dredge Cell, and Ash Disposal Area 1. The objectives and approach for the Material Quantity SAP are summarized below. As for adjacent properties, as discussed in Section 3.1.2, no formal agreement exists between TVA and Chemours regarding CCR material located on Chemours' property. Additionally, TVA has no information on quantities or types of materials disposed by private property owners on their property.

Three-Dimensional Models

TVA will develop three-dimensional models to estimate the amount and location of CCR materials at the Coal Yard, Active Ash Pond 2, South Rail Loop Area 4, DuPont Road Dredge Cell, and Ash Disposal Area 1 using the existing data summarized below and new data obtained during the EIP activities.

1. Ground and aerial survey data will be used with record drawings to model features such as a soil cap and riprap layers.

2. Contour data from the most recent aerial and hydrographic surveys, recent as-built closure surveys and borings shown on Exhibits 3, 4, and 5 (Appendix D) will be used to model the upper CCR limits.

3. Pre-construction topographic information from TVA drawings 10N502 and 10N527 (Active Ash Pond No. 2), 10W530-1(South Rail Loop Area 4), 10N503 (Ash Disposal Area 1) and data from borings that penetrated the lower boundary of the CCR surface shown in Exhibits 6, 7, and 8 (Appendix D) will be used to model the lower CCR surface.

4. TVA surveyed slopes, embankments, and benches to develop stability sections of Active Ash Pond 2 (Stantec, 2010a) will be used along with the most recent aerial survey data to model the geometry of the dikes and benches.

5. Data from borings shown on Exhibits 9, 10, and 11 (Appendix D) will be used to model the foundation soils underlying each site.

6. Data from borings that encountered top of bedrock shown on Exhibits 12, 13, and 14 (Appendix D) will be used to model the top of bedrock surface.

7. Estimated piezometric levels of saturation observed during the investigation will be incorporated into the models.

8. Groundwater levels estimated as part of the investigation will be incorporated into the models.

As documented in the Evaluation of Existing Geotechnical Data (Appendix H), TVA evaluated the adequacy of the existing data, listed above, in responding to information requests regarding CCR location and quantity. Existing borings that penetrated the lower boundary of CCR shown on Exhibits 6 and 7 (Appendix D) provide sufficient spatial coverage to develop a three-dimensional model and volumetric estimates for the DuPont Road Dredge Cell, Coal Yard Area and Active Ash Pond 2; however, additional data will be collected to supplement the data set. Additional borings are proposed in Active Ash Pond 2, Ash Disposal Area 1, DuPont Road Dredge Cell, the Coal Yard, and the South Rail Loop Area 4 to provide further CCR thickness information and geotechnical data. For additional detail on the proposed borings, refer to the Exploratory Drilling SAP (Appendix J).

<u>Drawings</u>

Once the three-dimensional model has been developed, it will be used to produce drawings showing the following:

- Subsurface material types, properties, elevations, and thickness from the ground surface to top of bedrock
- Upper and lower CCR surfaces and CCR thickness for each facility
- Top of bedrock contours
- Estimated piezometric saturation levels, contours, and river stage
- Estimated groundwater elevations, contours, and river stage
- Plan view showing areas where CCR is saturated
- Normal/minimum pool elevation (lowest spillway rim elevation) and minimum embankment crest elevation (maximum pool elevation) in Active Ash Pond 2
- Estimated extent of clay foundation between CCR and bedrock and estimated groundwater elevation

<u>Volumetric Estimates</u>

The three-dimensional model will be generated using software capable of rendering three-dimensional surfaces and calculating volumes such as Autodesk's AutoCAD Civil 3D or ArcGIS. Environmental Visualization Software may also be used to visualize the three-dimensional model of the facilities. The following volumetric estimates will be calculated:

- Total volume of CCR in each CCR unit

- Volume of CCR below estimated piezometric saturation levels
- Volume of CCR below estimated groundwater elevations
- Volume of CCR above estimated piezometric saturation levels
- Volume of CCR above estimated groundwater elevations
- Volume of CCR above and below normal river/reservoir elevations

The total volume of CCR at JOF will also be estimated. These volumetric estimates will be calculated using two methods to validate the model and results.

Reporting

The results of the CCR material quantity assessment, including the three-dimensional model of the facilities, drawings, and volumetric estimates will be incorporated into the EAR.

3.1.4 TDEC General Request No. 4

TVA should include Annual Inspection Reports referenced in its presentation to TDEC. This includes the August 9, 1973 and September 16, 1976 annual inspection reports. If an annual inspection report was prepared for an inspection(s) performed in 1995, provide this document as well.

TVA Response

As requested, the annual inspection reports from August 9, 1973, September 16, 1976, and March 9, 1995, are included in Appendix K.

3.1.5 TDEC General Request No. 5

Note 9(c) from drawing 10W211-1 indicates bottom ash and fly ash were obtained from the JOF disposal area and used when TVA implemented the Coal Yard grading plan. TVA should provide information that reports the amount of CCR material disposed in the coal yard and a map with this.

TVA Response

CCR material was not placed in the Coal Yard for disposal purposes; CCR was placed as structural fill to construct the Coal Yard. The scope of work to estimate the location and quantity of CCR material placed as structural fill in the Coal Yard is addressed in Section 3.1.3 and the Material Quantity SAP (Appendix I). TVA also plans to characterize the geology, hydrogeology, and CCR material characteristics beneath the Coal Yard as part of this EIP.

3.2 GROUNDWATER MONITORING

3.2.1 TDEC Groundwater Request No. 1

TVA shall demonstrate that the proposed background monitoring well at each ash disposal unit represents groundwater that passes under each ash disposal unit. TDEC shall approve the location(s) of the background ground water monitoring wells.

TVA Response

TVA has other investigative activities underway at JOF for TDEC Solid Waste Management permit requirements and the CCR Rule that include the installation of monitoring wells and collection of groundwater levels and samples for Active Ash Pond 2, the DuPont Road Dredge Cell and South Rail Loop Area 4. The information provided by programs that include these monitoring well networks will be used to respond to TDEC's Information Requests related to the identification of background and downgradient groundwater monitoring locations for these CCR units. TVA will incorporate pertinent data from these investigations that meet the QA/QC requirements of the JOF QAPP into the EAR.

In addition to the monitoring well network and proposed background well locations for Active Ash Pond 2 discussed in Section 3.1.1, monitoring well networks are currently in place for the DuPont Road Dredge Cell and South Rail Loop Area 4 as shown on Exhibit 1 (Appendix D). The DuPont Road Dredge Cell network includes background well B-13; downgradient monitoring wells 89-B10, 99-B20A, B-11, B-12 and JOF-105; and observation wells 94-B16 and 99-B19. The South Rail Loop Area 4 includes background monitoring wells B-9 and JOF-101; downgradient monitoring wells B-6R, B-8R and JOF-102; and observation well A-3. Monitoring wells are screened within the unconsolidated materials above bedrock. For this investigation, observation wells are defined as wells that will be used primarily to observe changes in groundwater levels over time, and monitoring wells are defined as wells that will be used to monitor groundwater quality and measure groundwater levels.

As part of TVA's ongoing investigations at JOF, one new potential background monitoring well (JOF-101) and one new downgradient monitoring well (JOF-102) were installed in the unconsolidated materials above bedrock for the South Rail Loop Area 4. Monitoring well JOF-101 was installed up gradient of the unit and monitoring well JOF-102 was installed in an expected downgradient location south of the unit. Monitoring wells JOF-101 and JOF-102 are in a similar geological setting as the South Rail Loop Area 4 well network. New and existing well locations are shown on Exhibit 2 (Appendix D). Monitoring well coordinates and construction details are included in Appendix E.

In addition, a downgradient monitoring well (JOF-105) was installed in the unconsolidated materials above bedrock to supplement the existing monitoring well network for the DuPont Road Dredge Cell.

Monitoring well JOF-105 was installed downgradient of the unit to provide a downgradient sampling location in a similar geological setting as the DuPont Road Dredge Cell well network. New and existing well locations are shown on Exhibit 2 (Appendix D). Monitoring well coordinates and construction details are included in Appendix E.

TVA is in the process of obtaining and reviewing data to determine if the existing wells may be suitable for use as background monitoring locations for the groundwater monitoring networks. TVA will continue to collect groundwater elevation data and groundwater quality samples from existing monitoring wells and review the analytical results as a part of TDEC Solid Waste Management permit requirements and the CCR Rule. If TVA determines that the existing or new wells installed as part of this investigation are suitable, then TVA will propose them to TDEC for concurrence that they are appropriate groundwater monitoring locations. TVA will communicate with TDEC on the rationale and supporting data and information for selecting each background location prior to finalizing the monitoring well networks.

In addition to the investigations discussed above, TVA proposes to install 10 wells, one potential alternate well, if needed, and one vibrating wire piezometer under the supervision of a Tennessee licensed Professional Geologist, as part of this investigation as discussed in Sections 3.1.1, 3.2.2 and 3.4.2. After the ongoing and proposed hydrogeological investigations have been completed, TVA will utilize pertinent data from these investigations that meet the QA/QC requirements of the JOF QAPP to identify proposed background monitoring wells that are representative of groundwater that passes under each CCR unit. If a background location is unavailable upgradient of a CCR unit, then the background monitoring well will be installed in a location free of impacts from the CCR unit and in a hydrogeological setting similar to that of the CCR unit. TVA will evaluate hydrogeological and geochemical data to identify background locations that are representative of each CCR unit or area of interest.

Groundwater samples will be collected bimonthly for one year (six sampling events) and analyzed for the CCR Parameters for the initial phase of the investigation. Piper diagrams will be used to classify groundwater samples according to their major ionic composition. Groundwater sample results from background and downgradient monitoring wells will be included in the evaluation. Additional Piper diagram comparisons of individual CCR units or geological formations may be included based on the results of the hydrogeological investigation. If, after completion of the above referenced investigations and others included in this EIP, data gaps exist, then TVA, in communication with TDEC, will perform additional investigations to fill those data gaps.

The results of investigations, including updated groundwater contour maps showing current groundwater elevations, will be reported in the EAR.

The selection of background monitoring wells proposed in this EIP will be finalized after monitoring bimonthly for one year to evaluate if the wells are appropriate background locations. TVA will provide this evaluation to TDEC for input and concurrence prior to finalizing the monitoring well networks for each CCR unit.

3.2.2 TDEC Groundwater Request No. 2

TVA shall explain how groundwater will be monitored for Ash Disposal Area 1. Monitoring on the North side of the unit should be included.

TVA Response

TVA plans to install four monitoring wells and one piezometer, under the supervision of a Tennessee licensed Professional Geologist, around Ash Disposal Area 1 as part of this investigation to monitor groundwater within the unconsolidated materials above bedrock. The five locations will fall within the TVA site boundary, with one being an upgradient well and the remaining four being downgradient wells and a piezometer.

Groundwater flow near Ash Disposal Area 1 is inferred to primarily flow from east to west toward the Tennessee River/Kentucky Lake. Based upon the inferred flow direction, two monitoring wells (JOF-110 and JOF-111) are proposed to be installed on the downgradient western edge of Ash Disposal Area 1. Piezometer JOF-116-PZ is proposed to be installed between JOF-109 and JOF-110. This vibrating wire piezometer will be grouted in place in foundation soils beneath the unit and will allow water level (i.e. pore water pressure) readings in the soils and improve subsurface characterization on the northern side of the CCR unit. Monitoring well JOF-108 is proposed to be installed on the southern side of Ash Disposal Area 1 to provide a monitoring point for groundwater that may flow beneath the CCR unit into the Coal Yard Runoff pond. An inferred upgradient monitoring well JOF-109 is proposed to be installed east of Ash Disposal Area 1 and will be evaluated for use as a potential background monitoring well. Exhibit 2 (Appendix D) shows the proposed well/piezometer locations, and details of the proposed well/piezometer installations are included in the Hydrogeological Investigation SAP provided in Appendix E. Three wells (JOF-108, JOF-110, and JOF-111) may be installed through perimeter dikes that contain ash fill, but no wells are proposed to be screened within the CCR unit itself.

Groundwater samples will be collected bimonthly for one year (six sampling events) and analyzed for the CCR Parameters plus major cations/anions for the initial phase of the investigation. Piper diagrams will be used to classify groundwater samples according to their major ionic composition. Groundwater sample results from background and downgradient monitoring wells will be included in the evaluation. Additional Piper diagram comparisons of individual CCR units or geological formations may be included based on the results of the hydrogeological investigation. Sampling procedures and parameters are provided in the Groundwater Investigation SAP provided in Appendix F.

TVA will provide a summary of sampling results from the wells in the EAR. Based on the results of the initial phase of work, revisions to the groundwater monitoring plan may be proposed.

3.2.3 TDEC Groundwater Request No. 3

TVA shall submit reports for all ground water monitoring events for each unit to TDEC.

TVA Response

Historical groundwater monitoring data was submitted to TDEC on August 5, 2016, as part of the Investigation Conference Data Transmittal for JOF. Historical and ongoing groundwater monitoring reports for Active Ash Pond 2, the DuPont Road Dredge Cell, and the South Rail Loop Area 4 have been, and will continue to be, submitted to TDEC. Historical data have been collected for a variety of reasons since approximately 1980 (TVA, 1995a). TVA may use these historical groundwater data for qualitative purposes, but only data evaluated in accordance with the JOF QAPP will be used quantitatively. Report submittals will include voluntary groundwater monitoring Utility Solid Waste Activities Group reports, CCR Rule groundwater quality reports, and groundwater monitoring reports associated with future sampling events.

The EAR will include groundwater monitoring data, as well as a discussion of the existing and closed monitoring wells and the analytical data for samples collected from these sampling points.

3.2.4 Miscellaneous Groundwater

We believe it is important to define the differences between the ground water monitoring requirements for the Commissioner's Order and the U.S. EPA regulatory criteria for establishing a Ground Water Monitoring Assessment Plan for CCR sites. The Commissioner's Order requires TVA to create a ground water monitoring network for the entire TVA CUF site. This includes all active and inactive CCR permitted landfills and surface impoundments as well as any locations where CCR material was disposed on site that were not subject to permitting under current or past TDEC statutory or regulatory requirements. The U.S. EPA requirements primarily address only permitted CCR disposal areas.

TVA Response

A groundwater monitoring network is in place for Active Ash Pond 2 that satisfies the requirements of the CCR Rule. The DuPont Road Dredge Cell and the South Rail Loop Area 4 have existing well networks in place to meet TDEC solid waste monitoring requirements. Additional monitoring wells are proposed to be installed as part of this investigation in response to the Order for Ash Disposal Area 1 and the Coal Yard.

As discussed in Section 3.1.1, additional wells are planned to add monitoring coverage for Active Ash Pond 2. Section 3.2.2 discusses how groundwater monitoring will occur at Ash Disposal Area 1 within TVA property boundaries. Section 3.2.1 discusses the monitoring networks in place for other programs for the DuPont Road Dredge Cell and South Rail Loop Area 4. In addition, CCR material was historically placed as structural fill in the northern portion of the Coal Yard and TVA plans to install four monitoring wells to investigate the groundwater quality in this area as discussed in Section 3.4.2. Additionally, groundwater may not be present in the unconsolidated materials above bedrock south of JOF-114 because shallow bedrock has been observed near that location. The results of the initial phase of work will be evaluated and additional wells may be proposed if data gaps exist. Additional details of the approach to investigating the Coal Yard are provided in the Hydrogeological Investigation SAP included as Appendix E.

Five groundwater monitoring well networks will be monitored under TDEC Solid Waste regulations, the CCR Rule, other state compliance requirements, and the Order, as applicable. These programs currently have different monitoring requirements. The differences between the networks will be summarized in a table in the EAR, but collectively the individual networks will comprise a monitoring network for the entire JOF site. Based on the results of the initial phase of work, additional investigation activities may be proposed to further evaluate groundwater quality and flow direction.

3.3 ACTIVE ASH POND 2

3.3.1 TDEC Active Ash Pond 2 Request No. 1

JOF94_JOF INSP FY1972 dated September 20, 1972 states on page 1 "Areas A and B are to be reclaimed by TVA. Under an informal agreement DuPont has sole responsibility for area "C." Recommendations on page 4 states "Raise the dike from the south harbor road to the north end of the ash area to elevation 378 as soon as heavy bottom ash is available" indicating ash may be incorporated into the dike construction. Please clarify if the action above was taken.

TVA Response

The first two sentences of the information request appear to reference historic Ash Disposal Area 1 (i.e., Ponds A, B, C). However, the quoted recommendation from the 1972 inspection report (TVA, 1972) is in reference to Active Ash Pond 2. Therefore, TVA understands this information request is regarding the potential use of CCR material to raise a portion of the Active Ash Pond 2 perimeter dike.

As a follow-up inspection to the 1972 recommendation, the 1973 inspection report (TVA, 1973) noted that heavy bottom ash was not available to raise this east dike. The 1974 inspection report (TVA, 1974) noted that the east dike had not been raised and a recommendation was stated to use a mixture of earth fill and obliterated asphaltic pavement to raise the east dike (see also Section 3.3.2 of this EIP). Once again, the 1975 inspection report (TVA, 1975) noted that the east dike had not been raised the one foot to elevation 378 feet. Finally, the 1976 inspection report (TVA, 1976) documents that the Active Ash Pond 2 east dike from south harbor road to the north end of the ash area was raised by one foot to elevation 378 feet with compacted earth fill. The earth fill was reportedly obtained from an excavation associated with construction of gas turbines at the plant.

TVA has advanced over 50 geotechnical soil borings along the eastern perimeter dike (TVA,1977; Law, 1994; Stantec, 2010; Stantec, 2012; and Geocomp, 2016a). Boring locations are shown on Exhibit 4 (Appendix D). None of these borings encountered bottom ash within the eastern perimeter dike between elevations 377 and 378 feet.

Based on the available inspection reports during the time period in question, and numerous borings advanced through the raised dike since that time, we conclude that the dike was raised with earth fill, not CCR. The three-dimensional model (Section 3.1.3) developed for the EAR will include this area.

3.3.2 TDEC Active Ash Pond 2 Request No. 2

JOF94_JOF INSP FY1994 dated September 30, 1974 states on page 2 "DEC has hauled waste material, mixtures of earth and obliterated asphaltic pavement, from the electrostatic precipitators and has piled the material along the outside of the dike (Recommendation, No. 3). Recommendation No. 3 suggests using this material to raise the east dike with the removed asphaltic pavement. Have subsequent subsurface evaluations encountered any of these materials and are they accounted for in stability calculations?

TVA Response

TVA understands this information request is regarding the potential use of certain waste materials ("obliterated asphaltic pavement") to raise a portion of the Active Ash Pond 2 perimeter dike.

As a follow-up to the 1974 recommendation, the 1975 inspection report (TVA 1975) noted that the east dike had not been raised the one foot to elevation 378 feet. Finally, the 1976 inspection report (TVA 1976) documents that the Active Ash Pond 2 east dike from south harbor road to the north end of the ash area was raised by one foot to elevation 378 feet with compacted earth fill. The earth fill was reportedly obtained from an excavation associated with construction of gas turbines at the plant.

TVA has advanced over 50 geotechnical soil borings along the eastern perimeter dike (TVA 1977, Law 1994, Stantec 2010, Stantec 2012; and Geocomp 2016a). Boring locations are shown on Exhibit 4 (Appendix D). None of these borings encountered obliterated asphaltic pavement within the eastern perimeter dike.

Based on the available inspection reports during the time period in question, and numerous borings advanced through the raised dike since that time, we conclude that the dike was raised with earth fill that did not incorporate obliterated asphaltic pavement. Therefore, stability calculations of the eastern perimeter dike do not include such waste materials.

3.3.3 TDEC Active Ash Pond 2 Request No. 3

Document JOF45_JOF1977 SOIL EXPLORATION & TESTING on page 4, please clarify the reference to Colbert ash dike. Page 5 states" Softer conditions exist in the foundation soils, particularly in SS-7, 8, and 9, and may require special attention". Are construction records available that document how "special conditions" in these areas were managed during construction?

TVA Response

Upon review of the referenced memorandum (TVA 1977), it appears that the author mistakenly typed "Colbert" and should have typed "Johnsonville". As such, TVA understands this information request is regarding the condition of certain foundation soils along the perimeter dike of Active Ash Pond 2.

In the 1977 soil exploration, eleven borings were advanced. Borings SS-7, SS-8, and SS-9 are located along the central portion of the eastern perimeter dike of Active Ash Pond 2. Borings SS-7 and SS-8 are north of the ash pond access road and SS-9 is south of the ash pond access road (Exhibit 10 – Appendix D). These borings sampled both the fill and foundation materials using Standard Penetration Testing (SPT). SPT sampling also measures penetration resistance in terms of blow-counts, which can be correlated to in-situ consistency (soft, stiff, etc.).

Borings SS-7, SS-8, and SS-9 did identify some sample intervals with relatively low SPT blow-counts. However, additional undisturbed samples of these soils were collected and tested in the laboratory for shear strength. The results were considered when recommending design strengths for the foundation soils.

Based on the available construction records for the dike raise (TVA Drawing No. 10N527), no special methods or treatments were employed with respect to these relatively "softer" foundation soils.

In recent years, the foundation soils of Active Ash Pond 2 have been a subject of additional geotechnical exploration, laboratory testing, and slope stability (static and seismic) analyses. In 2010, a geotechnical exploration and laboratory testing program was conducted. Slope stability analyses were performed for several cross sections along the eastern perimeter dike and the soil strengths were estimated using data from the 1977 and 2010 explorations. The resulting slope stability factors of safety for long-term (i.e., drained) conditions were greater than or equal to 1.2 (Stantec 2010). The following risk reduction measures were recommended (and later implemented) regarding seepage and slope stability of Active Ash Pond 2:

- Installation of a new spillway system located on the southwest dike, lowering the pool and resulting in lower pore water pressures
- Re-routing of the sluice channel away from the northeast dike resulting in lower pore water pressures
- Flattening of northeast dike exterior slope using compacted clay and installing a rock stability berm along the toe of the lower bench
- Flattening of southeast dike exterior slope and installing a rock stability berm along the toe of the lower bench

During the design, the long-term slope stability of the eastern perimeter was re-assessed, and factors of safety were greater than or equal to 1.5 (Stantec 2010).

More recently, for CCR Rule compliance the static slope stability of the facility was assessed, and factors of safety met or exceeded the acceptance criteria for both long-term maximum storage pool and maximum surcharge pool loading conditions (Stantec 2016a). Also, for CCR Rule compliance, the seismic slope stability of the facility was assessed, and factors of safety met or exceeded the acceptance criteria for both pseudostatic and post-earthquake loading conditions (Geocomp 2016b).

3.3.4 TDEC Active Ash Pond 2 Request No. 4

Document JOF46_JOF 1994 GEOTECHNICAL EVALUATION-ASH POND DIKE on page 4 identifies the discovery of three sinkholes. TVA should provide TDEC with the construction documentation of remediation of the sinkholes, the repair method used for the sinkholes and any information that reports the frequency of new sinkholes occurring. Please describe the methods TVA will use to prevent the occurrence of future sinkholes and the methods TVA uses to "close" sinkholes.

TVA Response

TVA understands this information request is regarding past remediation of "sinkholes" associated with internal erosion around or into spillway pipes at Active Ash Pond 2, as well as identification and/or repair of other such "sinkholes".

For context, it is useful to describe the "sinkholes" and their identified cause. During regular inspections of the perimeter dike in 1993, TVA observed surface depressions above two of the three concrete spillway pipes at the southwest corner of Active Ash Pond 2 (Law 1994). Based on a geotechnical evaluation, Law (1994) concluded that the subsidence was associated with internal erosion of soil into or along the outside of the spillway pipes.

It is useful to differentiate the above internal erosion failure mode from internal erosion that would be associated with a geologic sinkhole. A geologic sinkhole is typically related to a solution channel or void in rock and movement of subsurface water, which progressively transports soil from above into the rock, and may ultimately cause subsidence at the ground surface. Geologic sinkholes were not of issue for the subsidence at the JOF spillways, and thus are not discussed further here.

Law (1994) recommended several repairs to address the subsidence and internal erosion failure mode at the spillway pipes. Based on the available documentation, it is unclear which of the recommended repairs were implemented by TVA. However, during the 1995 annual inspection (TVA 1995b), it was noted that "The holes on the outer slope of the west dike at the south spillway was *[sic]* repaired along with the dike erosion repairs."

In a separate, earlier occasion, TVA Drawing No. 10W529 documents repair of a similar subsidence feature above the downstream portion of the central pipe of the same spillway. The repair drawing is dated 1992, but the date when subsidence was first observed is unclear based on the available documentation. The subsidence feature was roughly circular (about 5 feet in diameter) with nearly vertical sidewalls, extending down to an elevation roughly equal to the spillway pipe invert. See Figure 6 (page 27) for plan view and Figure 7 (page 28) for cross-sectional sketch of the subsidence feature location and the repair. The cross-sectional sketch of the repair is based on verbal information from the Johnsonville Plant personnel.

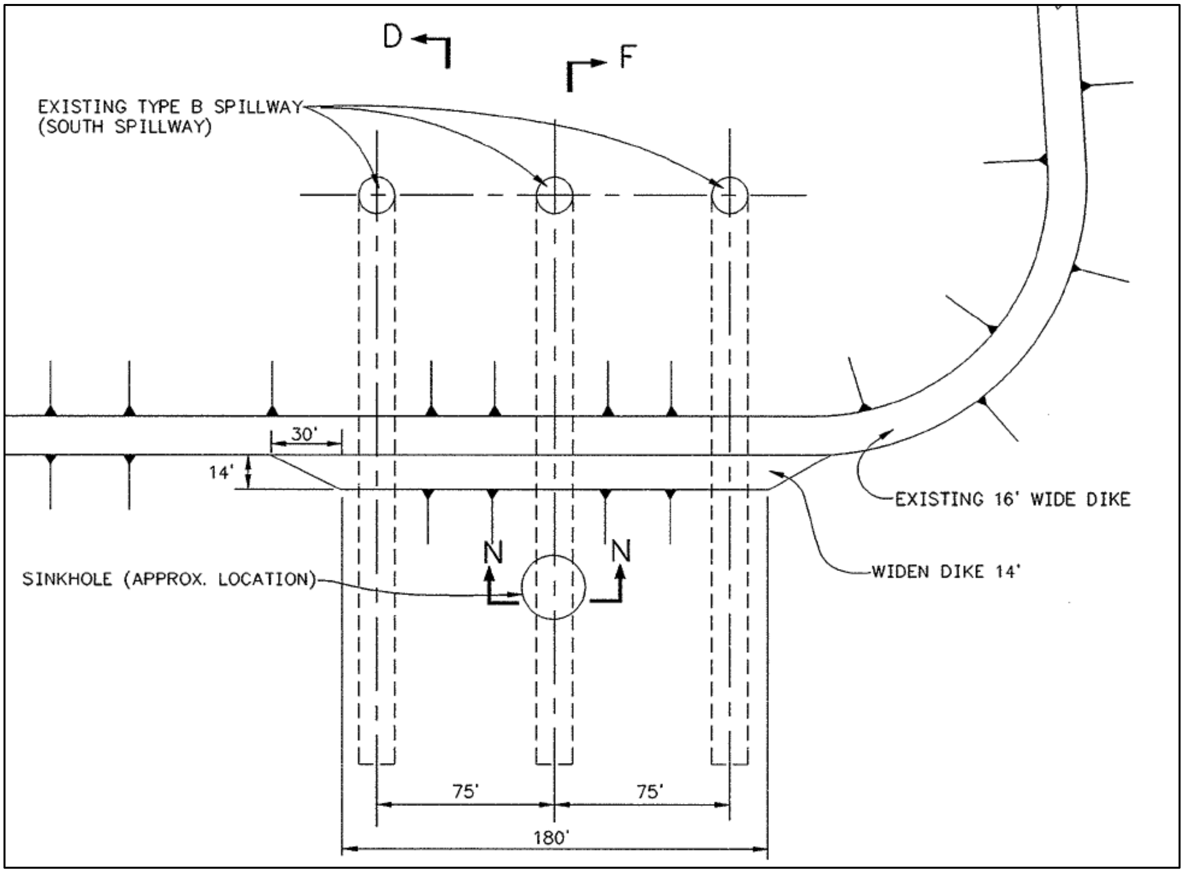

Figure 6. Plan View, Subsidence Feature Over South Spillway Pipe (TVA Drawing No. 10W529R6)

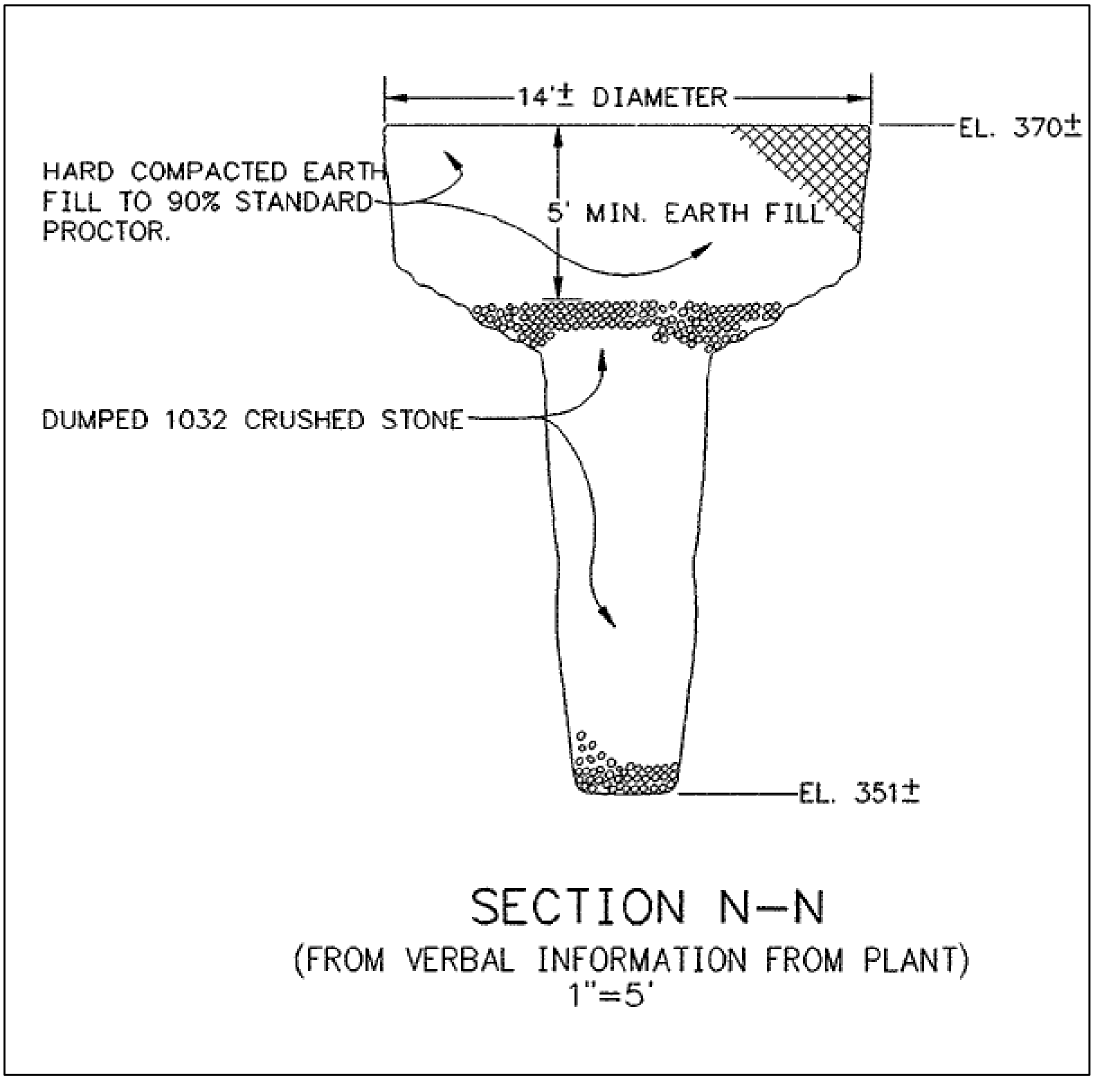

Figure 7. Section View, Subsidence Repair (TVA Drawing No. 10W529R6)

The 2003 annual inspection (TVA 2003) notes three areas of subsidence, but based on a review of this inspection report these are interpreted as shallow sloughs associated with wet areas on the slope or depressions associated with tree removal. These do not appear to be similar to the internal erosion subsidence areas described previously.

In recent years, TVA has implemented a number of risk reduction measures with regard to potential internal erosion failure modes, particularly around conduits. Measures include:

- Nine historic spillway pipes were grouted in place and graded filters were installed at the outlets in 2011 (Stantec 2011a; TVA Drawing No. 10W505 Sheet 09).

- New spillway pipes with surrounding graded filters (to reduce piping potential) were installed in 2009 (Stantec 2010).
- Operating pool elevation has been lowered, reducing hydraulic gradients within the soil.
- Routine observations combined with annual site inspections to look for depressions, subsidence, etc.
- Seepage analyses which include consideration of potential for internal erosion (i.e., piping) due to vertical exit gradients. Where necessary, graded filters have been installed along perimeter outslopes to reduce potential for such piping.

3.3.5 TDEC Active Ash Pond 2 Request No. 5

In Document JOF54_JOF-GE-100413 (rpt_jof_final_20100413) Page v of the Executive Summary states, in reference to the dike's construction "this material in not compacted and it contains zones of higher permeability which transmit seepage from the ash disposal area." Given this, has TVA conducted testing that would indicate horizontal permeability of the in-place dike material.

TVA Response

TVA understands this information request is regarding the hydraulic conductivity of the hydraulic fill beneath the perimeter clay dikes of Active Ash Pond 2. Stantec (2010) described the hydraulic fill as follows: "This layer is the zone of heterogeneous materials that was initially placed to form a perimeter dike and elevate it above the level of Kentucky Lake. It consists of clay, silt, sand and gravel. The outslopes are variable, relatively flat, and they extend to Elevation 370 feet."

Slope stability cross-sections from Stantec (2010) characterize the subsurface around the perimeter of Active Ash Pond 2. Except along the northeastern portion of the perimeter dike, the Lower Dike separates the CCR from the hydraulic fill. Along the northeastern perimeter, a portion of the CCR is placed against the interior slope of the hydraulic fill dike.

Recent subsurface explorations to support seepage and slope stability analyses (Stantec 2010, Stantec 2016a, Geocomp 2016a) did not include direct laboratory or field measurement of vertical or horizontal hydraulic conductivity of the hydraulic fill. Instead, seepage parameters were initially estimated based on published correlations to material type. Seepage parameters were then refined within the models by comparing predicted (i.e., modeled) pore water pressures against piezometer readings within various materials. Also, seepage parameters were refined by comparing predicted seepage exit points around the perimeter with historic field observations.

Laboratory testing of undisturbed samples obtained from vertical borings can be used to measure the vertical hydraulic conductivity of a soil. The horizontal hydraulic conductivity is typically estimated based on in-situ testing. Both proposed methods provide direct, quantitative measurements of hydraulic conductivity in the materials of interest. TVA proposes to perform slug tests (ASTM D4044) in the seven existing piezometers that are screened within the hydraulic fill material, as shown on Exhibit 15 (Appendix D). Depending on the results, subsequent phases of work using other methods may be warranted.

Although flow in or out of a piezometer during the slug test is three-dimensional, it is primarily horizontal and thus is a common method to estimate horizontal hydraulic conductivity. This in-situ test is particularly useful in materials that are likely to be horizontally stratified/variable, such as the hydraulic fill. Refer to the Exploratory Drilling SAP (Appendix J) for details of the proposed testing.

After completion of the slug testing and processing of the data, the results will be evaluated in terms of how the pore water pressure regime might be similar to or different than that modeled in recent slope stability analyses.

In an effort to improve the characterization of the pore water pressure regime around the perimeter of Active Ash Pond 2, the Exploratory Drilling SAP also includes the following:

- Slug testing of active piezometers and monitoring wells screened in dike fill, CCR, and alluvium.
- Laboratory testing to measure vertical hydraulic conductivity using available undisturbed samples from other recent/ongoing projects. Testing would be performed per ASTM D5084. Even if one or more of the surplus undisturbed samples prove to be unsuitable for testing, the available historical data and the testing from temporary well borings will be sufficient to address the information request. Testing of the surplus samples is proposed because the relative benefit is significant considering these samples already exist; but these samples are not vital to addressing the information request.

If any of the above data becomes available through other ongoing projects prior to execution of the Exploratory Drilling SAP (Appendix J), TVA will incorporate this information into the EAR in lieu of repeating the same testing.

3.4 MISCELLANEOUS

3.4.1 TDEC Miscellaneous Request No. 1

A complete review of these documents is not possible until TDEC has legible copies. The following list of documents have portions that are not legible:

a. Document JOF39_29 JOF ASH POND – SOIL & FOUNDATION EXPLORATION pages 25 through 28.

b. Document JOF45_JOF1977 SOIL EXPLORATION & TESTING page 37 is not legible.

c. Document JOF48_JOF AUGUST 2003 REPORT OF ASH POND INVESTIGATION page 9.

Please provide legible copies of these documents.

TVA Response

TVA has obtained legible copies of the referenced documents. These documents can be found in Appendix L.

3.4.2 TDEC Miscellaneous Request No. 2

From our on-site meeting, TDEC is aware that TVA has some information it has collected previously at the TVA JOF site; as an example, data from soil borings and analysis of samples collected from ground water monitoring wells. This information provided a good reference when the data was collected, but the soil borings and ground water monitoring wells may not have been installed and constructed to meet the criteria for environmental investigation of this site per the Order. TVA should consider proposing additional activities at the TVA JOF site to fully determine the amount and location of CCR material disposed, migration of CCR constituents through soil and ground water, identification of the upper most aquifer, migration of ground water with CCR constituents into surface water, structural stability, etc.

TVA Response

Evaluation of Existing Data

As discussed herein and in the site-specific SAPs, TVA proposes the installation of new monitoring wells and background soil borings to supplement existing data to respond to specific TDEC information requests. The JOF QAPP (Appendix C) outlines TVA's proposed processes for evaluating existing data to determine if it meets QA/QC requirements defined in the JOF QAPP and the investigation objectives outlined in the SAPs.

CCR Location and Quantity

Proposed activities to answer TDEC's information requests regarding CCR location and quantity are addressed in Section 3.1.3 and the Material Quantity SAP (Appendix I).

Migration of CCR Constituents via Soil, Groundwater, and Surface Water and Identification of Uppermost Aquifer

The Hydrogeological Investigation, Groundwater Investigation, and Background Soil SAPs (Appendices E, F, and L) form the framework for developing a conceptual model to evaluate the potential for migration of CCR constituents via soil, groundwater, and surface water in response to the TDEC Commissioner's Multi Site Order. The objectives of the Hydrogeological Investigation SAP (Appendix E) are to install monitoring wells to augment the current observation and monitoring well network and provide locations to collect groundwater quality samples for analysis of CCR constituents. The purpose of the Groundwater Investigation SAP (Appendix F) is to provide the procedures necessary to characterize and create baseline data for existing groundwater quality, measure groundwater quality as compared to the baseline to identify impacts, if any, and evaluate groundwater flow conditions at the TVA plant. TVA developed the Background Soil SAP (Appendix M) to characterize background soils on or adjacent to the JOF site.

Hydrogeological and Groundwater Investigation SAPs

As discussed in Sections 3.1.1 and 3.2.1, groundwater monitoring wells have been installed around the Active Ash Pond 2, the DuPont Road Dredge Cell and the South Rail Loop Area 4. These were screened in the alluvium to monitor groundwater quality. Details of well installation methods, boring logs and data from existing groundwater monitoring wells will be reviewed and validated in accordance with the JOF QAPP and submitted to TDEC.

Four wells and one piezometer will be installed under the supervision of a Tennessee licensed Professional Geologist around Ash Disposal Area 1 as discussed in Section 3.2.2. These will be drilled into the alluvium and will allow groundwater monitoring in areas that have not previously been monitored.

Two or three additional wells will also be added in Active Ash Pond 2, as discussed in Section 3.1.1. These are proposed to be installed into the alluvium to evaluate groundwater flow conditions and groundwater quality in the alluvium.

TVA proposes to install four groundwater monitoring wells for the Coal Yard. Stantec drilled thirty-seven borings in 2016 (Stantec 2016b). The borings in the northern section of the Coal Yard showed ash up to 33.3-feet below ground surface. Beneath the ash is typically lean clay or lean clay with gravels and sand.

The southern section of the Coal Yard differs from the northern section in that the ash layer is thinner and was compacted after being placed. The borings show that the ash layer is 8.0-feet thick and gets progressively thinner to the south. Underlying the ash in the southern section is a mixture of clay, gravels with sand and shale. In borings where each soil type occurs, they occur in the following lithological sequence; clay, gravel with sand and shale at the bottom.

Due to the subsurface differences present across the area, TVA proposes to install three downgradient monitoring wells (JOF-113, JOF-114 and JOF-117) on the western edge of the Coal Yard. They will be screened below the ash layer in the underlying unconsolidated materials above bedrock. The proposed locations are hydraulically downgradient of the Coal Yard based on the inferred groundwater gradient from east to west toward the Kentucky Lake. An up gradient well (JOF-112) is proposed to be installed to the east of the Coal Yard. The ash fill is also shallow in this area, and underlying the ash is a sandy clay followed by a poorly graded sand with gravel. The proposed well locations can be seen on Exhibit 2 (Appendix D).

Additional details regarding the installation of these wells is provided in the Hydrogeological Investigation SAP (Appendix E).

Groundwater samples will be collected bimonthly for one year (six sampling events) and analyzed for the CCR Parameters and major cations/anions for the initial phase of the investigation. Piper diagrams will be used to classify groundwater samples according to their major ionic composition. Groundwater sample results from background and downgradient monitoring wells will be included in the evaluation. Additional Piper diagram comparisons of individual CCR units or geological formations may be included based on the results of the hydrogeological investigation. Sampling procedures and parameters are provided in the Groundwater Investigation SAP provided in Appendix F. TVA will provide a summary of sampling results from the wells in the EAR. Based on the results of the initial phase of work, revisions to the groundwater monitoring plan may be proposed.

3.4.3 TDEC Miscellaneous Request No. 3

The TVA JOF EIP should include a schedule of activities to be completed during the environmental investigation of the TVA JOF site. As an example, it is TDEC's expectation that the schedule for installing, developing and sampling ground water monitoring wells will be specifically described in the TVA JOF EIP and the schedule to perform this work will be provided. A full description of the methods used to install, drill, construct and sample ground water monitoring wells may be included in an appendix to the TVA JOF EIP or if TVA plans to use an established method or protocol, it can be included by reference.

TVA Response

An overall schedule is included in Appendix A for the activities required to respond to each TDEC information request, as well as assumptions on the EIP approval process as the predecessor to start these investigations.

Time durations to complete the additional sampling and analysis work for the environmental investigation are included in the applicable SAPs. The SAPs also include the methods and procedures to complete the specified activities. Prepared environmental investigation SAPs will be subject to their individual schedules.

4.0 TDEC GENERAL GUIDELINES FOR EIP

Per the letter dated June 14, 2016, TDEC divided the General Guidelines for Environmental Investigation Plans, TVA Fossil Plants, into the following five categories:

A. Site Information
B. Water Use Survey
C. Groundwater Monitoring and Mapping
D. TVA Site Conditions
E. Surface Water Impacts

Each category and its related tasks are addressed in the following subsections and follow the numbering sequence format of the General Guidelines. The information requests are further distinguished from the responses by being printed in italics.

4.1 A. SITE INFORMATION

TVA shall provide information about CCR storage and disposal sites at the TVA Fossil Plant. TDEC expects TVA to include how it will provide the following information about each TVA Fossil Plant site as a part of its EIP:

4.1.1 A.1 TDEC Site Information Request No. 1

All information about the natural chemistry of the soils in the area of the TVA Fossil Plant. This includes the naturally occurring levels of metals and other CCR constituents present in the soil. TVA shall propose, in the EIP, the collection of soil samples within a one-mile radius of the specific fossil plant to supplement the information gained from local soil studies, reports or soil profiles. Of particular interest are all constituents listed in the federal CCR regulations Appendix 3 Detection Monitoring and Appendix 4 Assessment Monitoring found on page 21500 of the Friday, April 17, 2015 Federal Register (Appendices 3 and 4 CCR constituents).

TVA shall report the levels of naturally occurring CCR constituents as reported in existing documents and the results of soil samples collected per a TDEC Approved EIS in the (EAR) for that site. TVA shall submit maps that identify the location of soil samples in proximity to the TVA Fossil Plant when the EAR is submitted.

TVA Response

TDEC has requested the characterization of the local soils in a one-mile radius of JOF to evaluate the background levels of constituents of concern, previously defined as CCR Parameters.

TVA has prepared a Background Soil SAP (Appendix M) to characterize background soils on TVA property in the vicinity of the TVA JOF Plant. The approach in characterizing the background soils is to identify locations where naturally occurring, in-situ, native soils are present, yet unaffected by CCR material. Soil samples will be analyzed for the CCR Parameters to determine the naturally occurring levels. The surficial soil at each location will additionally be analyzed for percent ash, to determine the presence or absence of windblown CCR.

This Background Soil SAP establishes the procedures necessary to conduct investigation activities associated with the sampling and analysis of background soils. Exhibit 16 (Appendix D) depicts the locations of twelve proposed background soil sampling locations, selected for collecting background soil data.

Exhibit 17 (Appendix D) shows the locations of the proposed background soil sampling locations overlain by a United States Department of Agriculture soil map, which depicts surficial soil types. The locations were selected based on access, current hydrogeologic knowledge, sample location criteria previously set forth by TDEC, and when feasible, proximity to existing background groundwater monitoring wells (proposed locations BG-05 and BG-06 are located adjacent to existing background groundwater monitoring wells B-9 and JOF-101, respectively).

Proposed sampling locations were evaluated for past placement of CCR material on those areas, and to our knowledge, CCR material has not been placed in these areas. Areas known or expected to be in contact with CCR constituents during rain events, flood events, or currently being influenced by groundwater flow from JOF were additionally excluded.

Prior to mobilization for sample collection, the twelve sampling locations will be verified for access. If necessary, sampling points may be slightly adjusted to the closest possible location that can be safely accessed. If a proposed boring location is discovered to have accessibility restrictions related to agricultural, cultural, biological, or other such limiting factors, then a replacement boring will be proposed at a location that will meet the study’s goals with approval from TDEC.

An initial grab sample representing the surficial soils (i.e., top six inches) will be collected by hand auger and submitted for laboratory analysis of percent ash by polarized light microscopy (PLM) in addition to CCR Parameters. Borings will then be advanced using a direct push technology (DPT) drill rig equipped with five-foot, 3.25-inch outside diameter probe rods, or equivalent technology. In collecting soil samples, borings will be advanced to refusal. Grab samples will be collected from the mid-point of each five-foot boring interval. The mid-point for grab samples will be the mid-point based on recovery.

If soils are expected to be hard to recover during core retrieval core catchers will be used to prevent loss of sample material. Composite samples are not proposed.

If a change in lithology, such as a change in residuum, colluvium, alluvium, etc., occurs within a core interval, separate grab samples will be collected from the mid-point of both lithologies in the core. Samples collected by DPT will be sent to the laboratory to be analyzed for CCR Parameters. A complete description of the sampling methods and protocols is provided in the Background Soil SAP (Appendix M).

In addition to the soil data that will be collected from the twelve proposed sampling locations, TVA will collect soil samples through the well screen interval at locations of proposed background groundwater monitoring wells. TVA will also review the soil data previously collected during the instillation of three Utility Solid Waste Activities Group monitoring wells: JOF-10-AP1, JOF-10-AP2, and JOF-10-AP3.

Once sampling has been completed and analytical results have been received, the analytical data for background soil will be evaluated and addressed in the EAR. In doing so, TVA proposes to utilize Background Threshold Values (BTVs) as the method to statistically evaluate and quantify site specific background concentrations for CCR Parameters. BVTs will be calculated for each soil horizon and/or geologic unit using a statistical population consisting of a minimum of ten soil samples from each unit. If a particular horizon or geologic unit is under represented in the statistical population, additional borings will be installed.

BTVs are calculated using sampling data collected from un-impacted site-specific reference areas and represent an upper threshold of background concentration(s) expected to exist naturally in the environment.

The choice of BTV (Upper Confidence Limit, Upper Threshold Limit, Upper Prediction Limits) will be determined based on characteristics of the data (e.g. sample size, statistical distribution). All statistical analyses will be conducted utilizing the latest version of EPA ProUCL software (currently version 5.1.0) and consistent with ProUCL Technical Guidance Document (EPA 2015).

4.1.2 A.2 TDEC Site Information Request No. 2

TVA shall propose a sampling plan to determine the leachability of CCR constituents from CCR material in surface Impoundments, landfills and non-registered sites at each TVA site. The plan should include sampling points at each disposal area and at different depths in each disposal area. TVA shall describe sample collection methods, sample transport, analytical methodology and the qualifications of the laboratory selected to perform the analyses.

TVA Response

As requested, the proposed leachability study will involve the implementation of a CCR Material Characteristics SAP (Appendix N), and an evaluation of CCR Parameters from pore water samples and CCR material samples.

The CCR Material Characteristics SAP will help determine the leachability of CCR constituents from material in active and closed CCR units. The approach will include the collection and analysis of both pore water and CCR material from the Active Ash Pond 2, Ash Disposal Area 1, Coal Yard, Dupont Road Dredge Cell, and the South Rail Loop Area 4.

Sixteen temporary wells will be installed at locations proposed in Exhibits 18, 19, and 20 (Appendix D), then filtered and unfiltered pore water samples will be collected from the phreatic zone at the base of the unit to obtain in-situ leaching information for the material. The pore water analyses will provide real-time measurements of constituents that have leached from the CCR material.

Samples of CCR material will be collected from the soil borings advanced prior to installing the temporary wells from both the saturated and unsaturated zones in the CCR unit. These samples will be analyzed for the CCR Parameters, after application of the most applicable method based on emerging science in the industry, which could include the Synthetic Precipitation Leaching Procedure (SPLP) method. Total organic carbon, iron, and manganese have been added to the CCR Parameters list as specific parameters of interest under this SAP.

The CCR Material Characteristics SAP will provide procedures necessary to conduct the sampling of pore water and CCR material in the CCR unit, and methods to analyze them for the CCR Parameters list. Proposed activities will include the following major tasks:

- Verify proposed sampling locations using the global positioning system (GPS)
- Develop temporary wells in the ash disposal area (drilling and installation procedures of the temporary wells are outlined in the Exploratory Drilling SAP)
- Collect CCR material samples during installation of the temporary wells

- Collect pore water samples from the completed temporary wells
- Conduct laboratory testing and analysis of samples

Sample collection methods, sample transport, and analytical methodology shall be addressed in the CCR Material Characteristics SAP and the JOF QAPP. Laboratory Qualifications shall be addressed in the JOF QAPP. Once sampling is complete and analytical results have been received, the CCR material leaching results will be compared to the pore water data and evaluated for trends. Existing CCR leachability data will be reviewed and evaluated if available for the CCR units. Results, conclusions, and recommendations will be provided in the EAR.

4.1.3 A.3 TDEC Site Information Request No. 3

Information about the area surrounding the TVA Fossil Plant location before the TVA Fossil Plant was constructed. TVA shall provide in its EIP, geologic maps before the impoundment was created; if an impoundment is adjacent to the TVA Fossil Plant site. TVA discuss topographic maps from the pre-embayment time period and how these maps will be used to identify surface water features such as springs, the original flow of surface streams, etc. in the Environmental Assessment Report (EAR);

TVA Response

Kentucky Dam was completed in 1944. Plant construction started in May 1949 and power generation began with the first unit in October 1951. The 1936 USGS Topographic Map of the Johnsonville Quadrangle and the 1966 West Central Geologic Map of Tennessee (Hardeman 1966) show the area surrounding the plant before the CCR units were constructed. TVA will review the maps during the Investigation and discuss surface water features and the flow direction of streams before JOF was constructed in the EAR.

4.1.4 A.4 TDEC Site Information Request No. 4

Discuss if construction design information for original CCR surface impoundments, specifically any construction drawings or engineering plans, are available. It is important to identify the surface elevation and location of surface impoundments, landfills or non-registered disposal areas when originally constructed. TVA should explain if/how the information to identify the materials used to construct these disposal areas.

TVA Response

TVA plans to use information from the documents identified below to summarize the design and materials used to construct Active Ash Pond No. 2, Ash Disposal Area 1, DuPont Road Dredge Cell, and South Rail Loop Area 4. TVA will also use this information to estimate the pre-construction surface elevations at the location of these CCR units. TVA will report this information in the EAR.

- **Pre-construction Topographic Maps:** TVA will use maps referenced in Section 4.1.3 which show pre-construction topography to estimate the original surface elevations at the location of the CCR units.
- **Construction Drawings:** Record drawings 10N502 and 10N527 depict the construction of Active Ash Pond No. 2. Record drawing 10N503 and the 10W392 Drawing series set depict the construction of Ash Disposal Area 1. Record drawing series 10W530 depicts the construction of the South Rail Loop Area 4. Record drawings 10W217 and 10W218 depicts the construction of the DuPont Road Dredge Cell. TVA provided these drawings to TDEC in the Investigation Conference Data Transmittal.
- **Geotechnical Reports:** Geotechnical reports summarized in the Evaluation of Existing Geotechnical Data (Appendix H) provide information including dike configurations and material classifications.

TVA will summarize the design and materials used to construct these units and identify the original surface elevation at the location of these CCR units in the EAR. Based on the amount and context of data available to support a response, no additional field work is anticipated to answer this information request. However, additional field work, as outlined in the Exploratory Drilling SAP, will be performed and will provide supplemental data for this request. The supplemental data will be presented in the EAR.

4.1.5 A.5 TDEC Site Information Request No. 5

Discuss the information available and additional information that will be gathered to provide a three-dimensional profile of the CCR materials from the current elevation of all surface impoundments, landfills and/or non-registered disposal sites to the natural occurring surface below each structure. Also discuss how TVA plans to provide an estimated amount of CCR material disposed within each structure and the total amount of CCR material disposed at each site. Discuss the methods that TVA will use to provide drawings (to scale) that illustrate the height, length and breadth of the CCR disposal areas in relation to the naturally occurring features of each site. Comprehensively define the amount and location off CCR material at each site.

TVA Response

TVA prepared a Material Quantity SAP, provided as Appendix I to describe the methods TVA will use during the Investigation to answer TDEC’s information requests regarding CCR unit geometry, CCR material quantity, groundwater elevations, saturation levels, and subsurface conditions. A summary of the Material Quantity SAP is provided in Section 3.1.3 which includes a description of how existing and new data will be used to develop a three-dimensional model of the CCR units and use the model to develop volumetric estimates and drawings; therefore, the scope to address this information request is provided in Section 3.1.3.

4.1.6 A.6 TDEC Site Information Request No. 6

Describe the method TVA shall use to provide a water balance analysis for active surface impoundments at each TVA site. This should include all wastewater and surface water runoff entering the impoundment from the TVA site and the amount of water discharged from the surface impoundment(s) into receiving streams at the National Pollution Discharge Elimination System (NPDES) permitted discharge point. TVA shall also describe briefly how it will determine the transpiration rate of water from the surface impoundment(s) into the atmosphere;

TVA Response

This General Guideline request for a water balance analysis for active surface impoundments is not applicable at JOF. TVA JOF is currently retired. Activities to reduce impounding water in Active Ash Pond 2 is expected to begin in early 2018 and continue until pond closure in 2019 therefore a water balance is impractical.

4.2 B. WATER USE SURVEY

As a part of the Environmental Assessment, TVA is required to conduct a water use survey. The purpose of the water use survey is to determine if any surface water or ground water (water wells or springs) are being used by local residents or by TVA as domestic water supplies. TVA shall describe how it will conduct a water use survey within ½ mile of the boundary of the TVA site. TVA shall describe how it will determine the construction, depth and location of private water wells identified in the survey. If TVA determines local surface water and/or ground water is used as a source of domestic water supply within a ½ mile radius of the TVA site, the EIP shall include an offsite ground water and surface water sampling plan as a part of the EIP.

4.2.1 B.1 TDEC Water Use Survey Request No. 1

TVA Response

TVA's Water Use Survey SAP (Appendix O) includes details to complete a water survey for the JOF property. TVA will review existing documentation and the state database to identify existing water supply wells within a 1/2-mile radius of the boundary of the site, including water well inventory records on file with TDEC for Humphreys County. TVA will also review the local New Johnsonville City Public Utilities water service map area to identify water service hookup locations in the search area.

As clarified in Section B of the General Guidelines, TVA will develop a field verification plan to demonstrate the procedure for conducting a water use survey for off-site water wells and surface water supplies.

The plan will include a field verification map with the location of identified water wells, homes, and businesses within a 1/2-mile radius of the boundary of the site, and will consist of the following steps:

- Conduct a door-to-door survey to identify registered and unregistered surface water sources and water supply wells and their construction metrics, based on the homes and businesses located on the field verification map
- Obtain permission (in writing) from the property owner to access their property
- Physically verify water supply wells and surface water-supply sources
- Obtain permission (in writing) from the property owner to sample the water well(s) and/or surface water supply, from the wellhead or closest tap, [Note: samples will not be collected without the well owner's approval]
- Take a GPS reading of the verified water well(s) and of surface water supply intakes (e.g., pumps) for map updates
- Update and prepare the field verification map and survey report after completion of survey for inclusion in the EAR

In the event that TVA is unable to gain permission to enter a property for field verification of private water wells and surface water supplies, TDEC has offered assistance in field verifying the locations, well construction information, withdrawal rates, and collecting samples. Property access and water well sampling permission forms are included as Attachment C in the Water Use Survey SAP (Appendix O).

TVA and TDEC will discuss the construction, depth, and location of private water-supply wells identified during the survey as detailed in the Water Use Survey SAP and evaluate the method of sampling. Details of sampling methods and analytical parameters are included in the Water Use Survey SAP (Appendix O).

If results for CCR-related constituents that may be attributable to JOF are detected at levels exceeding MCLs during the first round of sampling, confirmatory sampling will be performed. A final private water well(s) and surface-water supply survey report, and associated map showing the updated and verified location of private water well(s) and surface-water supplies, and associated sampling locations (if sampling is required) will be provided in the EAR.

If sampling reveals CCR constituents present above MCLs that may be attributable to JOF within the ½ mile initial survey boundary, then TVA will promptly report the information to TDEC and a groundwater monitoring program will be implemented to monitor the water supplies.

4.3 C. GROUNDWATER MONITORING AND MAPPING

The EPA CCR rule specify constituents that should be included for analysis for ground water sampling. The constituents for Ground Water Detection Monitoring are listed in Appendix 3 of the EPA CCR regulations and the constituents for Ground Water Assessment Monitoring are listed in Appendix 4 of the EPA CCR regulations. TDEC is requiring TVA to include a description of the ground water monitoring plan it will implement at each TVA site. All ground water samples collected as a part of the Ground Water Monitoring Plan will be analyzed for the CCR constituents listed in Appendices 3 and 4 of the federal CCR regulations. Items to include in the EIP are:

4.3.1 C.1 TDEC Groundwater Monitoring and Mapping Request No. 1

A discussion of all ground water monitoring wells TVA has installed/abandoned/closed at the TVA site as well and any springs that have been monitored at the TVA site or adjacent to the TVA site. TVA shall discuss the data it TVA has generated from historical sampling of ground water monitoring wells and springs. TVA shall include all ground water monitoring construction information, location and historical ground water monitoring data in each TVA site's EAR.

TVA Response

This general guideline request is similar to section 3.2.3. TVA has compiled current and available (at the time of the submittal of this EIP) groundwater sampling results into a database, including the following categories of parameters:

- Chemical
- Physical
- Groundwater elevation

The database includes wells installed for CCR Rule and closed groundwater monitoring wells at the site. This information is provided in Appendix P in tabular form. This data has been collected for a variety of reasons since approximately 1982. TVA may use these historical data for qualitative purposes but will use such data only after evaluating it in accordance with the JOF QAPP. In addition, a figure showing existing and closed monitoring wells that correspond to the tables is included in Exhibit 1 (Appendix D).

In addition to the analytical data, the construction and location of newly installed and closed groundwater monitoring wells and information will be researched, collected, reviewed and compiled into a report to be provided in the EAR.

Historically, no springs have been located on site and are not currently anticipated to be encountered. If observed, TVA's inspection program will identify and document the new springs around the CCR units. The newly identified springs will be added to the groundwater monitoring plan in the monitoring networks, as described in Sections 3.1.1, 3.2.1, 3.2.2 or 3.4.2, depending on where the spring is identified.

4.3.2 C.2 TDEC Groundwater Monitoring and Mapping Request No. 2

A discussion of the location of at least two background ground water monitoring wells including the reasons for proposed their proposed location.

TVA Response

This General Guideline request is similar to other information requests. Refer to Section 3.2.1 for information related to this request. Hydrogeological characterization activities including the rationale for background monitoring wells will be completed as part of the ongoing investigation activities and will be provided in the EAR. If, based on the results of the ongoing work, data gaps are identified to meet the objectives of the TDEC Order, then TVA will propose additional investigations to address the data gaps and submit plans to TDEC for review.

4.3.3 C.3 TDEC Groundwater Monitoring and Mapping Request No. 3

A discussion of additional ground water monitoring wells that will be installed to complete a ground water monitoring network at the TVA site around all surface impoundments, landfills and/or non-registered disposal sites; including the location of existing or proposed ground water monitoring wells down gradient of all CCR disposal areas on the TVA site. TVA shall propose a ground water monitoring network that will provide data to develop a TVA site wide ground water potentiometric surface map. TVA shall ensure that the ground water monitoring locations (current and proposed) in the EIP will accurately determine groundwater flow and direction.

TVA Response

This General Guideline request is related to work being conducted as part of the ongoing investigation activities. Refer to Sections 3.1.1, 3.2.1, 3.2.2, and 3.4.2 for information related to this request. Hydrogeological characterization activities including the rationale for placement of groundwater monitoring wells to evaluate groundwater flow conditions and prepare groundwater contour maps will be completed as part of the ongoing investigation activities and will be provided in the EAR. If, based on the results of the ongoing work, data gaps are identified to meet the objectives of the TDEC Order, then TVA will propose additional investigations to address the data gaps and submit plans to TDEC for review.

4.3.4 C.4 TDEC Groundwater Monitoring and Mapping Request No. 4

A discussion of the construction methods TVA will use to install additional ground water monitoring wells. This includes drilling method, methods and personnel for logging cuttings and cores, well construction and well development. A scaled diagram of a properly completed monitoring well shall be provided in the EIP.

TVA Response

This General Guideline request is related to work being conducted as part of the ongoing investigation activities. Refer to Sections 3.1.1, 3.2.1, 3.2.2, and 3.4.2. Monitoring well installation details including proposed drilling, logging, well construction and well development methods used to complete the ongoing investigation activities are provided in the Hydrogeological Investigation SAP (Appendix E).

4.3.5 C.5 TDEC Groundwater Monitoring and Mapping Request No. 5

A ground-water monitoring plan for sampling all wells and springs included in the monitoring network. This should include the methods TVA shall use to collect ground water samples, the analytical methods to be used for ground water sample analyses, methods for sample transport from point of collection to the laboratory and identification and qualification of the laboratory(ies) that will perform sample analyses.

TVA Response

This General Guideline request is related to work being conducted as part of the ongoing investigation activities. Refer to Sections 3.1.1, 3.2.1, 3.2.2, 3.2.4 and 3.4.2. Collected sample packaging and shipping, and transportation requirements used to complete the ongoing investigation activities will be provided in the JOF QAPP and SAPs.

4.3.6 C.6 TDEC Groundwater Monitoring and Mapping Request No. 6

Describe any existing information available and additional data needed to develop a map which identifies the current ground water surface elevation under the landfill(s), surface impoundment(s) and/or non-registered site(s). If additional data is needed to provide ground water elevations across the TVA site, below the footprint of the landfill(s), surface impoundment(s) and/or non-registered site(s), describe the methods TVA plans to use to collect the data. TVA shall collect sufficient data to create a map that clearly delineates the ground water surface in the ash disposal areas such that (1) the CCR material between the original ground surface and the top of the current ground water table is defined and (2) CCR material between the current ground water surface and the surface elevation of the CCR disposal area is clearly defined. TVA shall also collect *pore water samples from CCR material that is below the current ground water surface and from CCR material that is below the projected ground water surface with closure in place. TDEC has not determined that closure in place is a corrective action option at any TVA site; however; this information is needed should TVA propose closure in place.*

TVA Response

This General Guideline request is related to work being conducted as part of the ongoing investigation activities. Refer to Sections 3.1.1, 3.2.1, 3.2.2, 3.4.2, and 4.1.5 for information related to this request. Groundwater elevation data will be collected as part of the TDEC-approved ongoing investigation activities. The request regarding the estimated amount of CCR material below the groundwater surface is similar to the information requested in Sections 3.1.3, 3.1.5 and 3.4.2. Refer to those sections for preparation of groundwater contour maps and estimating the three-dimensional profile of CCR material.

The request regarding pore water sampling is related to work being conducted as part of the ongoing investigation activities. Refer to Section 4.1.2 for information related to this request. Pore water sampling will be conducted in accordance with the CCR Material Characteristics SAP (Appendix N), developed to characterize the leachability of CCR material in the units, and addressed in greater detail in Section 4.1.2. Pore water sampling will be completed as part of the ongoing investigation activities and the results, conclusions and recommendations will be addressed in the EAR. If, based on the results of the ongoing work, data gaps are identified to meet the objectives of the TDEC Order, then TVA will propose additional investigations to address the data gaps and submit plans to TDEC for review.

4.3.7 C.7 TDEC Groundwater Monitoring and Mapping Request No. 7

Describe how TVA will define groundwater contaminant plumes identified using currently available groundwater monitoring data and new groundwater monitoring data gathered from the installation and sampling of new groundwater monitoring wells. TVA will also discuss its strategy to determine the extent of any CCR constituent plume should the initial groundwater monitoring network not define the full extent of the CCR constituent groundwater plume at the site. This should include the science it will use to extend its groundwater monitoring network.

TVA Response

This General Guideline request is related to work being conducted as part of the ongoing investigation activities. Refer to Sections 3.1.1, 3.2.1, 3.2.2, 3.2.4 and 3.4.2. TVA will continue to collect groundwater samples and review the analytical results as a part of TDEC Solid Waste Management permit requirements and the CCR Rule. The results of the evaluation will be used to determine if these wells may be suitable for use in groundwater monitoring networks. If TVA determines that the new wells are suitable for addition into the TDEC permitted groundwater monitoring network, then TVA will include them in an amended groundwater monitoring network.

The initial phase of the environmental investigation is to characterize the site by assessing current subsurface conditions at JOF. Potential groundwater impacts will be identified by collecting background and downgradient groundwater samples. TVA will use industry accepted methods for delineating the extent of CCR constituents, if needed, and will install additional wells in appropriate locations based on groundwater flow conditions. Methodologies and procedures for installing monitoring wells are provided in the TVA TI for Monitoring Well and Piezometer Installation and Development (ENV-TI-05.80.25). New monitoring wells will be monitored bimonthly for one year.

TVA may propose additional methods of evaluation, such as groundwater flow and transport models, as appropriate and guided by sound scientific principles based on the data collected. The proposed investigation is designed to collect groundwater data representative of site conditions that would be needed as input into models. The exact approach will depend on the data collected and will be proposed after evaluation of the data collected during the environmental investigation.

4.4 D. TVA SITE CONDITIONS

4.4.1 D.1 TDEC Site Conditions Request No. 1

Discuss all current information available about the geologic lithology (formations, bedding planes, etc.) and their relevance to natural seeps, springs and karst features on the TVA site; including the CCR disposal areas. Some limestone formations are very susceptible to solution channeling, especially when they have been disturbed through natural events or construction activities such as blasting. TVA shall describe the methods it will use to determine whether solution channeling has occurred at and near the soil/rock interface;

TVA Response

Existing geological characterization data, including boring logs from previous geotechnical work and related reports (e.g. Stantec 2016a, TVA 1948, TVA 1995b), as well as construction and facility performance records will be reviewed. The review will focus on information related to geologic lithology, geologic features, solution channeling, and/or springs at the JOF site. The response will discuss how the geologic lithology influences the construction and performance of the different units.

Available information indicates that the CCR units at JOF are underlain (from top to bottom) by bedrock of the Ridgetop Formation, Chattanooga Shale, and Camden Chert. The Ridgetop Formation (described as clay, shale, chert, and weathered limestone) is generally only present beneath the eastern part of the Plant, farther away from the river. These formations are not subject to extensive karstic solutioning and karst features are not likely to be present (TVA 1948).

No known geologic sinkholes or karst features have been identified at JOF in the available historical construction reports, drawings, inspections, or geotechnical explorations. Further, natural seeps or springs have not been identified at JOF.

A summary of the pertinent existing and new information will be provided in the EAR.

4.4.2 D.2 TDEC Site Conditions Request No. 2

Discuss all current information about the geologic structure below the TVA site and how it may be used to help determine if faults and/or fractures have been identified in the subsurface. TVA shall describe the methods it will use to collect additional data (faults, fractures, bedding planes, karst features, etc.) to determine whether faulting and fracturing has impacted and/or controls groundwater movement. Describe how TVA will determine if identified faults, fractures, bedding planes, karst features, etc. are filled to the point that they limit or eliminate ground water flow.

TVA Response

The information required for this response is similar to that for D.1 (Section 4.4.1). TVA will use existing data and reports to describe the geologic structure beneath the CCR units with a focus on faults, fractures, and bedding planes.

The locations of known faults near JOF will be provided based on existing literature. Observations regarding fractures and bedding planes identified in rock cores collected during previous investigations (TVA 1948) will be summarized in the EAR. TVA will use this and other information from historical construction reports, drawings, inspections and explorations to describe the geologic structure below JOF, including the proximity of faults below the CCR units and the degree of infilling of fractures and bedding planes. The understanding of the geologic structure will be combined with hydrogeological information to evaluate its influence on groundwater flow. This evaluation will be provided in the EAR.

4.4.3 D.3 TDEC Site Conditions Request No. 3

Discuss existing data available to TVA to map top of bedrock; i.e. existing boring and ground water monitoring well construction data. TVA shall describe the methods (surface geophysics; installation of borings/ground water monitoring wells) it will use to collect additional data to map top of bedrock. The EIP shall include a description of the data collection methods TVA will use to determine the thickness and types of natural material overlying bedrock as well as the top of bedrock contours. For all new soil borings, TVA shall provide the location of the borings, the information used to determine boring location, the drilling method to be used, how the borings will be logged. Logging shall be performed by a Professional Geologist licensed to practice in Tennessee.

Logs shall provide the following information when presented in the EAR; soil type, depth and changes, identify geologic formations, depth of formation, karst features, fractures, bedding planes, and any other pertinent information. TVA shall provide an example of a boring log in the EIP.

TVA Response

TVA prepared a Material Quantity SAP, provided as Appendix I, to describe the methods TVA will use during the Investigation to answer TDEC's information requests regarding CCR material quantity and subsurface conditions. The scope of the Material Quantity SAP includes modeling subsurface conditions from final grade to bedrock. The Material Quantity SAP describes how existing and new top of bedrock data will be incorporated into three-dimensional models of the units to develop top of bedrock contours. Requirements related to information and logging procedures for new borings are addressed in the Exploratory Drilling SAP (Appendix J).

TVA proposes that for environmental investigation wells and soil borings, a TN-licensed professional geologist will be present and will log the borings. For geotechnical investigation borings and piezometer installations, a TN-licensed professional geologist or professional engineer will be present and will log the borings. This approach has been used at current investigations at other TVA sites in TN.

4.4.4 D.4 TDEC Site Conditions Request No. 4

When/if TVA divided original Coal Combustion Residual (fly ash, bottom ash and gypsum) surface impoundments into individual units (surface impoundments, non-registered disposal areas and or landfills), TVA shall discuss where this has happened on each TVA site. As a part of the EAR, TVA shall discuss the source of information reviewed to provide the specifications of those structural changes. Discuss if there are as built drawings or engineering plans for the modifications TVA has made at each site made. If there is not existing information that describes the structural changes in the original surface impoundment(s) or non-registered site(s), TVA shall discuss in the EIP how it will *collect the information needed to document structural changes over time. This information is needed in determining the structural and seismic stability of each TVA site.*

TVA Response

This information request does not apply to JOF because surface impoundments have not been divided into individual CCR units.

4.4.5 D.5 TDEC Site Conditions Request No. 5

Stipulate whether there are any as-built designs for the interface between the originally disposed CCR material and any disposal structures constructed above the original disposal area.

TVA Response

This information request does not apply to the CCR units at JOF because disposal structures were not constructed above original disposal areas.

4.4.6 D.6 TDEC Site Conditions Request No. 6

TVA shall discuss any existing stability calculations for final permitted design elevation for all landfills. Unless TDEC specifies otherwise, TVA shall conduct new stability calculations for all landfills, surface impoundments and/or non-registered disposal sites. The EIP shall describe the method TVA will use to determine structural stability. TVA shall provide stability calculations for each disposal area based upon (1) the permitted final elevation or planned final elevation for each landfill, (2) the current elevation for all surface impoundments and/or (3) the current elevation for all non-registered disposal location.

TVA Response

As described below and in the Stability SAP (Appendix Q), new stability analyses will be performed where necessary to address this information request. Otherwise, the existing data is sufficient to establish appropriate shear strengths and stability results for static and seismic load cases. The summaries of existing geotechnical data in Appendix H (Evaluation of Existing Geotechnical Data) demonstrate that existing data is representative and suitable to support the stability analyses.

The load cases to be evaluated in the stability analyses are based on conventional practice and appropriate industry standards for landfills and surface impoundments, as applicable.

- Static, long-term (i.e., normal operation conditions) global stability
- Static, long-term veneer (i.e., final cover) stability

- Seismic, pseudostatic global stability
- Seismic, pseudostatic veneer stability
- Seismic, post-earthquake global stability (includes a preceding liquefaction triggering assessment)

The proposed assessment framework will comply with the overall goals of the TDEC Multisite Order as outlined in several Information Requests in Section D of the General Guidelines for EIPs. In general, the program may consist of geotechnical explorations (field and laboratory), followed by analysis. Data from previous geotechnical explorations (field and laboratory) and existing static/seismic stability analyses are available to fulfill certain components of this information request. For proposed stability analyses, recent water levels, including those measured per the EIP, will be considered. When existing models are leveraged, recent water levels will be compared to the modeled levels to confirm that the analyses are still suitable. Specific data that is available for each unit is described below. Where proposed below, the stability evaluation analysis methodology and acceptance criteria are in the Stability SAP (Appendix Q). The analyses will be submitted in the EAR.

Based on the amount and context of data available to support a response, additional field work is anticipated at the Ash Disposal Area 1 and South Rail Loop Area 4 to answer this information request. Refer to the Exploratory Drilling SAP (Appendix J) for more information.

Ash Disposal Area 1: Existing analyses are not available for the Ash Disposal Area 1. The above listed static and seismic analyses will be performed for the existing (closed) conditions in accordance with the Stability SAP (Appendix Q). A summary of these analyses, including a discussion of modeled water levels, will be included in the EAR.

Active Ash Pond No. 2: Existing analyses are available for the Active Pond No. 2, from the following sources:

- Stantec (2010a, 2016a): Static long-term global stability analyses of existing conditions, incorporating results of additional geotechnical exploration
- Geocomp (2016a, 2016b): Static long-term global, seismic pseudostatic global, and seismic post-earthquake global stability analyses (including liquefaction triggering) of existing conditions

The existing analyses are sufficient to address each of the necessary load cases. Recent water levels will be documented in the EAR and compared to the modeled levels to confirm that the analyses are still suitable. A summary of these analyses will be included in the EAR.

The Active Ash Pond 2 closure design (subject to TDEC approval) is ongoing, but static and seismic stability analyses have yet to be performed (see also Section 3.1.1). Although the closure design has not yet been developed enough to allow analysis, the current concept includes dewatering of the surface impoundment, and lowering of the perimeter dikes. The CCR will be regraded to gentle slopes and a final cap will be constructed. The final cap will have a low hydraulic conductivity and will be sloped to limit surface water infiltration. By limiting infiltration, the closure design will, over time, lead to lower phreatic levels and reduced pore water pressures within the unit. These activities are expected to improve static and seismic stability of the closed unit, relative to the existing conditions.

Given that the existing conditions have been shown to have adequate stability, the closed conditions would also be expected to have adequate stability. TVA will provide the results from the closure design analyses in the EAR (if analyses are available at the time of EAR issuance). Documentation of the closure design will include discussion of the modeled pore water pressures (i.e., water levels).

As part of the upcoming decanting project, several borings with nested vibrating wire piezometers (VWPZ) will be installed within the interior of the Active Ash Pond 2 footprint. Each location will monitor pore water pressures in the CCR and foundation soils during decanting, closure, and post-closure. The spatial coverage provided by the VWPZs will provide useful post-closure data.

DuPont Road Dredge Cell: Existing analyses are available for the DuPont Road Dredge Cell, from the following sources:

- Stantec (2010b): Static long-term global stability analyses of existing conditions, incorporating results of additional geotechnical exploration

Static stability analyses in Stantec (2010b) reflect the existing (closed) conditions. Recent water levels will be documented in the EAR and compared to the modeled levels to confirm that the analyses are still suitable. Note that static long-term veneer, seismic pseudostatic global, seismic pseudostatic veneer, liquefaction triggering, and seismic post-earthquake global analyses are not available for the existing closed conditions and will be performed in accordance with the Stability SAP (Appendix Q). A summary of these analyses, including a discussion of modeled water levels, will be included in the EAR.

South Rail Loop Area 4: Existing analyses are not available for the South Rail Loop Area 4. The above listed static and seismic analyses will be performed for the existing (closed) conditions in accordance with the Stability SAP (Appendix Q). A summary of these analyses, including a discussion of modeled water levels, will be included in the EAR.

4.4.7 D.7 TDEC Site Conditions Request No. 7

TVA shall specify how it will determine the construction methods and properties of the drainage layers between each "stacked layer" for permitted CCR landfills; including where the drainage layer discharges.

TVA Response

DuPont Road Dredge Cell: This unit was permitted as a solid waste facility under TDEC Solid Waste Permit No. IDL 43-102-0082. This unit does not have a drainage layer; therefore, this information request does not apply to this unit.

Active Ash Area No. 2, Ash Disposal Area 1, and South Rail Loop Area 4: These units are not permitted CCR landfills, and do not have drainage layers; therefore, this information request does not apply to these units.

4.4.8 D.8 TDEC Site Conditions Request No. 8

TVA shall review Section VI.D.5 (page 21373) of the section of the Federal CCR Preamble that describes areas of concern regarding overfill at landfills. TVA shall explain how it will determine if there are potential overfill situations for each surface impoundment/landfill at the TVA site.

TVA Response

The Active Ash Pond 2, Ash Disposal Area 1, DuPont Road Dredge Cell, and the South Rail Loop Area 4 do not meet the definition of an overfill per the CCR Rule, i.e., "a new CCR landfill constructed over a closed CCR surface impoundment," 40 CFR § 257.53. Therefore, this information request does not apply to JOF.

Regarding the Ash Disposal Area 1, DuPont Road Dredge Cell, and the South Rail Loop Area 4, it should be noted that the EPA excluded from regulation inactive CCR landfills, § 257.50(d), as well as CCR surface impoundments that no longer impound water and that are "capped or otherwise maintained," 80 Fed. Reg. at 21343. EPA explained in its preamble that this exclusion is due to the lower risk associated with such units. Section VI.A.5 (page 21342) of the preamble states:

"As noted, EPA's risk assessment shows that the highest risks are associated with CCR surface impoundments due to the hydraulic head imposed by impounded water. Dewatered CCR surface impoundments will no longer be subjected to hydraulic head so the risk of releases, including the risk that the unit will leach into the groundwater, would be no greater than those from CCR landfills. Similarly, the requirements of this rule do not apply to inactive CCR landfills—which are CCR landfills that do not accept waste after the effective date of the regulations. The Agency is not aware of any damage cases associated with inactive CCR landfills, and as noted, the risks of release from such units are significantly lower than CCR surface impoundments or active CCR landfills. In the absence of this type of evidence, and consistent with the proposal, the Agency has decided not to cover these units in this final rule."

Throughout their service life, TVA has constructed and operated the Ash Disposal Area 1, DuPont Road Dredge Cell, and the South Rail Loop Area 4 in compliance with the state and/or federal regulatory frameworks in effect at the time.

In 1992, TDEC issued permit IDL 43-102-0082 to allow for construction of the DuPont Road Dredge Cell. Since 1992, TDEC has approved various permit modifications for this CCR unit.

Ash Disposal Area 1 and the DuPont Road Dredge Cell are surface impoundments that no longer impound water as defined by the CCR Rule. The South Rail Loop Area 4 is an inactive landfill as defined by the CCR Rule. The CCR Rule became effective in 2015 and does not apply retroactively to these units.

4.4.9 D.9 TDEC Site Conditions Request No. 9

Discuss current information/data that is available to estimate the shear strength of the CCR materials in the landfill(s), surface impoundment(s) and/or nonregistered sites. If there is not sufficient data available to determine shear strength, describe the methods TVA shall use to collect this data. If there is existing data collected during installation of soil/rock borings or construction of ground water monitoring wells, provide a brief description of this data and how it will be presented for use in the EIP.

TVA Response

Active Ash Pond 2: Recent geotechnical explorations have characterized the CCR materials present in this unit. Shear strengths for CCR materials were developed based on historical data, typical values, and published correlations to field testing data (Stantec 2010a) as described in the Evaluation of Existing Geotechnical Data (Appendix H). Stantec (2010a) also considered prior drilling and testing results in the vicinity of this unit (MACTEC 2003, TVA 1977). Stantec (2012) considered results from additional drilling and testing.

Stantec (2016b) leveraged prior reports to assign CCR shear strengths for analyses. Geocomp (2016a, 2016b) included drilling, lab testing, and development of shear strength parameters. Boring locations from available studies are shown on Exhibit 4 (Appendix D).

A review of the referenced existing stability analyses shows that due to the location of the sluiced ash in the cross sections, this material did not significantly influence the existing conditions slope stability results for an outboard failure of the perimeter dike system. This would also be the case for the proposed closure geometry (pending TDEC approval). However, the shear strength of the sluiced ash is more influential for the existing conditions for an inboard failure of the raised perimeter dike. When evaluating the suitability of existing stability analyses to address the TDEC Order information requests, the use of shear strengths based on previous studies and typical/published values will be considered. Factors to be considered include the sensitivity (or lack thereof) of the analysis to the strength and the degree of conservatism of the assigned strength value relative to the site-specific material. In addition, because exploratory drilling and sampling is already proposed (see the Exploratory Drilling SAP, Appendix J) due to other information requests, supplemental samples of CCR will be obtained from Active Ash Pond 2. The samples will be tested in the laboratory for shear strength, and the results considered in the proposed slope stability analyses. The EAR will present a summary of the historical and new data and characterization of the CCR shear strengths for this unit.

Ash Disposal Area 1: Limited data is available for Ash Disposal Area 1. The Report of Monitoring Well Abandonment (Stantec 2011b) discussed six monitoring wells in Ash Disposal Area 1 but did not include investigations useful for shear strength derivations. Additional explorations are proposed to obtain CCR data to support shear strength development. Undisturbed samples will be obtained and tested in the laboratory for shear strength parameters. Penetration resistance data will be collected and can be used to supplement the laboratory testing. Refer to the Exploratory Drilling SAP (Appendix J) for more information.

DuPont Road Dredge Cell: Recent geotechnical explorations have characterized the CCR materials present in this unit. Shear strengths were developed based on historical data and typical values (Stantec 2010b) as described in the Evaluation of Existing Geotechnical Data (Appendix H). Stantec (2010b) also considered prior drilling and testing results in the vicinity of this unit (TVA 1988, 1995b, 2005). Boring locations from available studies are shown on Exhibit 3 (Appendix D).

A review of the referenced existing stability analyses shows that due to the location of the CCR materials in the cross sections, this material could influence the perimeter slope stability results. When evaluating the suitability of existing stability analyses to address the TDEC Order information requests, the use of shear strengths based on previous studies and typical/published values will be considered. In addition, because exploratory drilling and sampling is already proposed (see the Exploratory Drilling SAP, Appendix J) due to other information requests, explorations are proposed to obtain CCR data to support shear strength development. Undisturbed samples will be obtained and tested in the laboratory for shear strength parameters. Penetration resistance data will be collected and can be used to supplement the laboratory testing. Refer to the Exploratory Drilling SAP (Appendix J) for more information.

The EAR will present a summary of the historical data and characterization of the CCR shear strengths for this unit.

South Rail Loop Area 4: Limited data is available for the South Rail Loop Area 4. The Report of Subsurface Exploration and Stability Analysis (Law 1997) considered results from laboratory testing of remolded (i.e., compacted) samples to assign shear strength to CCR materials. Additional explorations are proposed to obtain CCR data to support shear strength development. Undisturbed samples will be obtained and tested in the laboratory for shear strength parameters. Penetration resistance data will be collected and can be used to supplement the laboratory testing. Refer to the Exploratory Drilling SAP (Appendix J) for more information.

4.4.10 D.10 TDEC Site Conditions Request No. 10

TVA shall provide static, seismic and liquefaction analysis in accordance with 257.63 and 257.73 of the Federal CCR regulations for final permitted design elevations for Landfills that are defined by the Federal Regulations as overfills. If the analyses have not been completed, then TVA shall provide analyses for each landfill based upon either the permitted final elevation for each or for the planned final elevation for each; should TVA decide it does not need to use the entire permitted capacity of any permitted CCR landfill. TVA shall identify and analyze the critical cross section(s) and document that the modeling represents the actual field conditions at the cross-section location(s). TVA shall also address foundation settlement of these Landfills.

TVA Response

As noted in Section 4.4.8, none of the JOF CCR units in the Study Area meet the definition of an overfill per the CCR Rule. Therefore, this information request does not apply to JOF.

4.4.11 D.11 TDEC Site Conditions Request No. 11

TVA shall discuss any current dam safety analysis performed at the TVA site for all landfills, surface impoundments and/or non-registered disposal areas. If dam safety analysis has not been performed for each disposal area or if TDEC determines the dam safety analysis is inadequate, then TVA shall describe the method(s) it will use to determine the "dam safety factor" for all disposal areas at the TVA site.

TVA Response

The Ash Disposal Area 1, DuPont Road Dredge Cell, and South Rail Loop Area 4 do not constitute dams, as defined by TVA Standard Programs and Processes (SPP) manual on Dam Safety (TVA-SPP-27.0). Likewise, these perimeter dikes do not constitute dams under Federal Emergency Management Agency (FEMA) guidelines, which consider both dam height and impounding capacity.

The above-listed units at JOF no longer have the capacity to impound 50 acre-feet or more, thus they do not meet the definition of a dam. Therefore, this information request does not apply to these units.

The perimeter dike of Active Ash Pond 2 has historically been included in TVA's Dam Safety Program. TVA has applicable SPPs that govern the safety analysis for dams and impoundments. TVA utilizes procedural standards for managing dam safety activities and support. Objectives of the program include:

- Ensure dams and impoundments are designed, constructed, operated, maintained, and repaired in accordance with the Federal Guidelines for Dam Safety and TVA Procedures
- Maintain a Dam Safety Independent Review Board to provide technical expertise and guidance
- Perform assessments to provide quality assurance
- Prepare programmatic performance metrics and reporting including the biennial report to FEMA
- Provide a forum for dam safety related communications, lessons learned and best practices sharing
- Facilitate consistent and effective administration of dam safety work through management of the Dam Safety Steering Committee, with the goal of efficiently reducing TVA's overall dam safety risk

TVA has completed or will perform slope stability evaluations for each CCR unit in the Study Area as outlined in Section 4.4.6 of this EIP. These evaluations include the stability of the perimeter dike system, where present, of each unit. TVA has also performed, or will perform, assessments of the disposal areas in accordance with Item D.13 of the TDEC General Guidelines, which include structural stability and safety factor assessments. See Section 4.4.13 for a description of these assessments. These assessments will be provided in the EAR.

4.4.12 D.12 TDEC Site Conditions Request No. 12

TVA shall discuss any current information or assessments regarding seismic stability for the TVA site, including existing seismic analysis for each surface impoundment(s), landfill(s) and/or nonregistered site(s) s at the TVA site. TVA shall describe in the EIP the method it will use to determine the size of the seismic event that would cause structural failure for entire area of the surface impoundments, landfills and/or non-registered disposal sites at the TVA site. The seismic analysis method proposed by TVA shall provide seismic data comparable to the requirements for seismic analysis in the federal CCR regulations at CFR 257.63.

The seismic analysis plan shall determine the seismic stability of the entire TVA site and any improvements need to ensure seismic stability for the site, as it exists today and for closure in place. Soils below the surface impoundments and landfill shall be evaluated for liquefaction potential. If these soils are found to be susceptible to liquefaction, stability calculations shall be performed which account for liquefaction.

TVA Response

The industry standard practice for seismic analysis during design is to select an earthquake return period that is appropriate for a particular scenario. The design condition is then evaluated for adequate performance under the design earthquake(s). For example, this approach was used for the CCR Rule seismic safety factor assessment of the Active Ash Pond No. 2 (Geocomp 2016a).

As noted in Section 4.4.6, an industry-standard structural stability evaluation will be performed. The evaluation will consider static and seismic slope stability, as well as liquefaction triggering, as applicable. Existing and proposed seismic stability assessments are outlined in Section 4.4.6. Proposed analyses will be performed per the Stability SAP (Appendix Q). Existing and proposed slope stability analysis cross section locations are shown in Exhibits 21, 22, and 23 (Appendix D). Results will be presented in the EAR.

4.4.13 D.13 TDEC Site Conditions Request No. 13

TVA shall discuss how the structural integrity of the entire area of CCR disposal (surface impoundment(s), landfill(s) and non-registered sites) shall be determined. TVA shall include in the EIP the methods and models it will use to evaluate structural integrity as discussed in CFR 257.73(d) and (e).

TVA Response

As part of TVA's ongoing efforts to comply with the CCR Rule, structural stability assessments have been performed for the Active Ash Pond 2 (Stantec 2016a). With respect to structural integrity, this assessment considered the following aspects:

- Foundation and abutment conditions (cracking, settlement, deformation, erosion, heave due to seepage)
- Slope protection
- Embankment dike compaction
- Vegetation of slopes
- Spillway condition and capacity
- Sudden drawdown assessment (slope stability)

Regarding the future closed condition of the Active Ash Pond 2, the ongoing closure design (subject to TDEC approval) will address many aspects of structural integrity listed in the CCR Rule CFR 257.73(d) such as settlement, erosion protection, vegetative cover, and spillway adequacy.

The JOF Study Area (with the exception of the Active Ash Pond 2) is not subject to the CCR Rule for active units (see Section 4.4.8). While the units are not subject to CFR 257.73(d) or (e), TDEC-approved Operations Manual (TVA 2001) for the DuPont Road Dredge Cell and the Closure/Post-Closure Plan for the South Rail Loop Area 4 (TVA 1998) addressed many aspects of structural integrity listed in the CCR Rule CFR 257.73(d) such as erosion protection and vegetative cover. In 2016, rock buttressing (as shown on TVA Drawing 10W391) was placed for erosion protection along the Ash Disposal Area 1 perimeter dike adjacent to Kentucky Lake.

TVA further promotes structural integrity of the units by performing routine inspections and by evaluating proper abandonment of hydraulic structures and pipe penetrations through the unit perimeter. A summary of the structural evaluations will be presented in the EAR. Additionally, the stability program described in Sections 4.4.6 and 4.4.12 will consider the safety factor aspects of the CCR Rule CFR 257.73(e) such as static and seismic stability.

The Stability SAP (Appendix Q) for the Study Area (described in Section 4.4.6) will present the analysis methodology and acceptance criteria for the evaluation.

4.4.14 D.14 TDEC Site Conditions Request No. 14

Discuss any current information available that may be used to determine the ability of the local geology to provide sufficient structural stability for the existing surface impoundments, landfills and/or non-registered disposal areas at the TVA site as well as any disposal area considered for closure in place. TDEC anticipates there will not be sufficient existing structural stability information for this analysis. Describe the methods TVA shall employ to collect data that may be used to determine the capability of the geologic formation at the TVA site to provide structurally sound/load bearing strength for existing CCR disposal areas as well as for those disposal areas should TVA consider closure in place of those areas.

TVA Response

TVA will review the available bedrock data from several sources, including historic geologic lithology data and mapping, construction data, and rock core data, to evaluate the ability of the geologic formations underlying the Study Area to provide structural stability for these units in their existing condition. Relevant information from Sections 4.4.1 and 4.4.2, including results of proposed investigations, will also be taken into consideration. This evaluation will be provided in the EAR.

4.5 E. SURFACE WATER IMPACTS

Because of the long operating history of the TVA Fossil Plants, there have been potential opportunities for CCR materials to move into surface water and for dissolved CCR constituents to migrate via ground water flow into surface water. As part of the EIP, TVA shall describe how it will determine if CCR material and/or dissolved CCR constituents have entered surface water at or adjacent to TVA sites. TVA will also describe how it will assess any impact CCR material and/or dissolved CCR constituents may have had on water quality and/or fish and aquatic life.

The requests above are addressed in Items E.1 through E.8 below.

4.5.1 E.1 TDEC Surface Water Impacts Request No. 1

TVA shall discuss any current information it has for the TVA site that identifies CCR deposition on the streambed for surface water on the TVA site or surface water adjacent to the TVA site.

TVA Response

From 1990 to 2015, sediment samples were collected from two locations in the Tennessee River, at Tennessee River Miles (TRM) 23.0 and 85.0. These samples were collected downstream from the Plant, which is located at TRM 99.0. From 1993 to 2015, sediment samples were collected from a location in the Big Sandy River Embayment located more than 25 miles downstream from the Plant. In 2003 and 2006, sediment samples were collected from seven additional embayments located upstream and downstream from the Plant. The nearest of the embayments sampled in 2003 and 2006 is the Birdsong Creek Embayment, which is located approximately five miles upstream from the Plant. The sediment samples were analyzed for multiple parameters including some of the CCR Parameters (arsenic, cadmium, calcium, chromium, copper, lead, mercury, nickel, selenium, and zinc). Existing sediment sampling results will be reviewed and evaluated in accordance with the JOF QAPP along with the new data obtained from the proposed benthic study discussed in Section 4.5.2. Results will be presented in the EAR.

TVA conducts aquatic community studies per its NPDES permit requirements. Existing aquatic community study results will be reviewed and evaluated in accordance with the JOF QAPP, along with the new data obtained from the proposed benthic study discussed in Section 4.5.2 and addressed in the EAR.

4.5.2 E.2 TDEC Surface Water Impacts Request No. 2

TVA shall describe in the EIP the methods it will use to determine if CCR material has moved from the TVA site into surface water on the TVA site or adjacent to the TVA site. TVA shall propose a procedure for sampling the streambed for CCR material. TVA shall describe sample collection methods, sample preservation and sample analysis methods for CCR materials. All samples shall be analyzed for the CCR constituents listed in Appendices 3 and 4 of the federal CCR regulations. Further, TVA shall propose how it will test sediment and CCR samples taken from riverbeds to determine if CCR constituents dissolve into surface water.

TVA Response

TDEC has requested a sampling plan to determine if CCR material has moved into surface water (see Section 4.5.5 for the Surface Stream Characterization Study), to characterize sediment in streambeds for the CCR Parameters, and to assess whether CCR has been deposited on the streambed. TVA proposes to perform a sediment characterization study to address this request.

The objectives of the sediment characterization study include:

- Delineation of CCR material deposited on streambeds
- Assessment of potential transport of CCR constituents from CCR units to surface streams on or adjacent to the TVA site

The sediment characterization study will include the following steps:

1. Research and review existing documentation on sediment analyses
2. Approval of and coordination with the Surface Stream SAP
3. Approval of and coordination with the Benthic SAP
4. Record sediment sample locations using GPS during the investigation
5. Collect and analyze sediment samples per a two-phased approach in accordance with the SAP
6. Review and evaluate existing and new analytical data
7. Prepare the EAR

A two-phased approach is proposed in conducting the sediment characterization study, as provided in the Benthic SAP (Appendix R). Phase 1 will include:

- Conduct three Vibracore borings at each of sixteen transects, to six-foot depth or refusal, whichever comes first
- Collect samples of top six inches of sediment at each sampling location (for a total of forty-eight samples)
- Collect grab samples of remainder of each sediment core, segregated by strata types. Native soils will not be collected, since the focus is on deposited sediment material.]
- Analyze all samples for percent ash, using PLM
- Analyze all the top six-inch sediment samples for CCR Parameters
- Hold the deeper sediment samples for potential future analyses in Phase 2 (if >20% ash)

Proposed sampling locations for Phase 1 of the Benthic SAP have been selected based on areas subject to past/potential CCR releases or ongoing operations that have potential to impact adjacent surface waters. A map of proposed sediment sampling locations for Phase 1 is provided as Exhibit 24 (Appendix D), and a complete description of the sampling methods and protocols is provided in the Benthic SAP, which can be found in Appendix R.

Quantitative benthic macroinvertebrate (invertebrate) samples will be collected during Phase 1 and are included in the Benthic SAP in Appendix R. The benthic invertebrate samples will be collected along transects at the locations depicted on Exhibits 25 and 26 (Appendix D). The results of the quantitative sampling will be used to assess the status of the benthic community. The benthic invertebrate evaluation will also include collecting composite samples of mayfly nymphs from locations within the areas indicated on Exhibit 27 (Appendix D). Composite adult mayfly samples will be collected by direct removal from vegetation or other structures along the shoreline or by use of sweep nets. The mayfly nymphs (both depurated and non-depurated) and adult mayflies will be submitted for laboratory analysis of metals included in the CCR Parameters list (excluding radium). The mayfly analytical results will be used in conjunction with sediment and fish tissue data to evaluate contaminant bioaccumulation.

Should ash in an individual sediment sample exceed 20 percent, Phase 2 sediment sampling will be implemented for that location, and would include:

- Analysis of held sediment core sample(s) at sampling locations that exceeded the 20 percent ash content for the CCR Parameters
- Preparation of an updated sampling location map showing new boring sampling locations adjacent to and including the original coring location(s) exhibiting a greater than 20 percent ash content
- Analysis of new sediment core samples for the CCR Parameters and percent ash

Once sampling is complete and analytical results have been received for the required phases of the study, the results will be evaluated in accordance with the JOF QAPP and reported in the EAR.

4.5.3 E.3 TDEC Surface Water Impacts Request No. 3

TVA shall describe how streambed sample results will be used to develop a map identifying the location of CCR material on the streambed and the depth of the CCR material on the streambed.

TVA Response

If CCR material is found during the sampling conducted to address Item E.2 in Section 4.5.2 above, the results will be used to prepare maps showing the distribution and depths of CCR material in the Tennessee River, the Intake Channel, and/or the Boat Harbor near the Plant. The maps and volume estimates will be presented in the EAR.

4.5.4 E.4 TDEC Surface Water Impacts Request No. 4

TVA shall discuss any current information it has for the TVA site that identifies the movement of ground water with dissolved CCR constituents into surface streams on or adjacent to the TVA site. This includes any surface water analyses TVA has performed for samples taken from the seeps and surface stream(s).

TVA Response

TVA will provide a discussion of any current information identifying the movement of groundwater with dissolved CCR constituents into surface streams on or adjacent to the site, in the EAR. Former seeps have been monitored for structural concerns, but historically have not been sampled for the CCR Parameters. There are currently no known active CCR-related seeps at the facility.

4.5.5 E.5 TDEC Surface Water Impacts Request No. 5

TVA shall propose a plan to collect and analyze water samples from seeps and surface stream(s) on the TVA site and/or adjacent to the TVA site. This plan shall include sampling locations, sample collection methods, sample preservation and transport and methods for sample analysis. All samples shall be analyzed for the CCR constituents listed in Appendices 3 and 4 of the federal CCR regulations.

TVA Response

Seep Characterization Study and Associated SAP
TDEC has requested a sampling plan to characterize seeps on the TVA site and/or adjacent to the TVA site at JOF, for the CCR Parameters. To this end, TVA will investigate mitigated seeps and areas historically noted as seeps, for current seep activity. Active seeps will be sampled, for soil and water, and analyzed for the CCR Parameters. Analytical results will be evaluated to help develop an assessment of potential movement of groundwater with dissolved CCR Parameters into surface streams on or adjacent to the TVA site, as requested in Section 4.5.4.

The objective of the seep characterization study is to assess the transport potential of CCR constituents from CCR units to surface streams on or adjacent to the TVA site due to seeps. TVA's seep characterization study consists of the following steps:

1. Research and review existing documentation on the location of historical seeps
2. Investigate site for active seeps
3. Identify location of active seeps on a map
4. Implement Seep SAP (Appendix S) based on active seep location map
5. Collect seep soil and water samples

6. Record sample location using GPS
7. Analyze seep soil and water samples for CCR Parameters per the Seep SAP in accordance with the JOF QAPP
8. Review and evaluate existing and new analytical data
9. Prepare the EAR

Filtered and unfiltered water samples will be taken. A complete description of the sampling methods and protocols is provided in the Seep SAP (Appendix S).

Once sampling is complete and analytical results have been received, the CCR Parameters analyses for the seep samples will be evaluated in accordance with the JOF QAPP and reported in the EAR.

Information regarding historic seeps at JOF is summarized in Appendix T.

Surface Stream Characterization Study and Associated SAP

TDEC has requested a sampling plan to characterize surface streams on and/or adjacent to JOF for the CCR Parameters. TVA will obtain surface stream samples from the Tennessee River, associated Kentucky Lake Coves, Boat Harbor, and Intake Channel. The analytical results from the surface stream samples will be evaluated and the information provided to address the request on identifying the movement of groundwater with dissolved CCR Parameters into surface streams on or adjacent to the TVA site in Section 4.5.4.

The purpose of the Surface Stream SAP (Appendix U) is to characterize water quality on or adjacent to the JOF plant for CCR constituents.

A two-phased approach is proposed for conducting the surface stream characterization study as described below.

Phase 1:

- Collection of general water quality parameters insitu using a Hydrolab® multi-probe water quality meter along seven sampling locations in the Tennessee River, two sampling locations in the Intake Channel, and an additional three sampling locations in the Boat Harbor. Hydrolab data will be evaluated in the field to determine the presence of thermal stratification across the transects. As described below, water quality samples will be collected from the thalweg (deepest point), right bank, and left bank of each transect. Based on the results of field measurements, one of the following sample plans will be implemented:

  - If thermally stratified, collect near-bottom (epibenthic) sample 0.5 m above streambed, mid-hypolimnion sample (midway between bottom of thermocline and streambed), mid-epilimnion sample (midway between top of thermocline and water surface, and near-surface (0.5 m depth) sample.
  - If not thermally stratified, collect surface, mid-depth, and epibenthic samples.
- For waterbodies that may not have adequate depth to collect multiple samples from the water column, the field sampling team may adjust the number of samples to accommodate. Similarly, if the width of the waterbody along a sampling transect is not sufficient to support the collection of multiple samples along the transect, the field sampling team may adjust the procedure accordingly.

Samples will be analyzed for total and dissolved CCR Parameters. A map of proposed surface stream sampling locations is provided in Exhibit 28 (Appendix D). Sample locations are co-located with sediment sampling locations. To account for seasonal variations, two surface stream sampling events are proposed.

Phase 2

Phase 2 of surface stream sampling will be conducted if there is an exceedance of 20% ash content (based on PLM analysis) in one or more of the sediment samples collected in accordance with the Benthic SAP (Appendix R). Phase 2 will consist of collecting additional surface stream samples from the location(s) where greater than 20% ash occurs. Several surface stream sample transects at the location(s) with greater than 20% ash content may be necessary to delineate the extent of potential contamination. Should this second phase be implemented, a new sampling location map will be developed. Phase 2 sampling procedures will remain the same as those described in this SAP. Only the sampling locations will differ.

Once sampling is complete and analytical results have been received for the required phases of study, the CCR Parameters analyses for the surface stream samples will be evaluated in accordance with the JOF QAPP and reported in the EAR.

4.5.6 E.6 TDEC Surface Water Impacts Request No. 6

TVA shall describe how seep and stream sample results will be used to develop a map identifying the location of seep and stream sampling points and the results of the analyses. This map shall also include the location of any public water intakes within 1 mile of the downstream side of the TVA site.

TVA Response

Once surface stream and seep sample results are received, maps will be developed identifying the location of the sampling points, along with the analytical results. Each map will include the location of any public water intakes within 1 mile of the downstream side of the TVA site and placed in the respective Seep and Surface Stream sections of the EAR.

4.5.7 E.7 TDEC Surface Water Impacts Request No. 7

TVA shall provide a brief discussion of any studies conducted by TVA or any other agency to determine if CCR materials or dissolved CCR constituents have impacted fish and/or aquatic life.

TVA Response

TVA presented results of biological monitoring, specifically from the Tennessee River to TDEC in the Investigation Conference (Slides 105-114) and Investigation Conference Data Transmittal. TVA has collected and analyzed biological data upstream and downstream of its fossil-fueled power plants to assess health and structure of the aquatic communities surrounding them. These data include monitoring of fish and benthic invertebrate communities, and visual encounter surveys for wildlife along the shoreline.

The results of the most recent benthic invertebrate studies were presented in the *Biological Monitoring of the Tennessee River Near Johnsonville Fossil Plant Discharge, Summer and Autumn 2011* report dated October 2012 (TVA 2012). According to the October 2012 report, benthic invertebrate community samples were collected from transects located upstream and downstream of the Plant in August and October 2011. The resulting benthic invertebrate data were evaluated using community characteristics/metrics and through statistical diversity comparisons. The October 2012 report indicated that a healthy benthic community existed in the vicinity of the Plant. Benthic invertebrate sampling locations proposed in the Benthic SAP (Appendix R) include transects at the locations referenced in the June 2012 report.

The October 2012 report details the most recent Reservoir Fish Assemblage Index (RFAI) surveys (fish community surveys) completed in 2011 and compares the data to previous RFAI surveys. The surveys were completed upstream and downstream of the JOF Plant using electrofishing and gill netting methods. The 2011 RFAI surveys were completed in the summer and autumn to compare the data from the upstream and downstream sampling sites under different seasonal conditions. The RFAI scores indicated that the fish community of the downstream site was similar to that of the upstream site and the scores were within the range of acceptable variation during both seasons. RFAI scores from 2001 to 2011 have averaged “Good” for both upstream and downstream sampling sites and the RFAI scores were within the range of accepted variability, indicating that the fish community downstream of JOF was not adversely affected.

Historical fish sampling in the vicinity of the JOF plant is detailed in the report titled *Fish Population Surveys in the Vicinity of Johnsonville Steam-Electric Plant* completed by TVA and dated September 1981 (TVA 1981). Fish sampling was performed from 1949 to 1980 by cove sampling, electrofishing, and gill netting upstream and downstream of the JOF Plant. The data was used to investigate variations in biomass and species occurrence following the beginning of operations in 1951. Based on the results of the data collected, it was concluded that the JOF Plant has had little or no measurable effect on the fish populations of the Kentucky Reservoir.

Per the plant's NPDES permit, whole effluent toxicity testing has been conducted on an annual basis. From March 2011 through October 2017, the whole effluent toxicity results have been designated as "Pass" for Outfall 001. The biological monitoring data and information described will be evaluated in accordance with the JOF QAPP and results will be summarized in the EAR.

The studies and results of fish and benthic invertebrate sampling summarized in previously completed historical biological monitoring reports will be summarized in the EAR.

4.5.8 E.8 TDEC Surface Water Impacts Request No. 8

Upon a determination by TDEC of the need to assess the impact of CCR material in surface streams or migration of ground water containing dissolved CCR constituents, TVA shall provide a plan to study the impact of CCR materials and/or constituents on fish and/or aquatic life in surface streams on the TVA site or adjacent to the TVA site.

TVA Response

A Fish Tissue SAP (Appendix V) has been prepared to help assess the potential impact of the JOF site activities on fish and/or aquatic life in surface streams adjacent to the site, and to assist in providing an overall view of JOF site conditions.

The objective of the fish tissue sampling is to set forth the procedures to be followed to capture fish, remove tissue samples, and store and ship samples to a laboratory. Five surface water reaches have been selected for the collection of fish and associated fish tissue as shown in Exhibit 29 (Appendix D).

These five sites are strategically located based on access, current hydrogeologic knowledge, and the greatest expectation of successfully capturing target fish species. The results from the analysis of fish tissue will be used to determine whether fish in the immediate vicinity and downstream of JOF have higher concentrations of CCR-related parameters than fish from reference locations not adjacent to or downstream from JOF. The results from implementation of this SAP will be evaluated and addressed in the EAR.

Other biological studies TVA will include as part of the investigation include a benthic invertebrate study developed to assess the status of the benthic community, and a bioaccumulation study on mayflies. These biological studies are included in the Benthic SAP (see Section 4.5.2 and Appendix R).

5.0 ENVIRONMENTAL ASSESSMENT REPORT

The EIP and EAR process is described in the TDEC Order. Within 60 days of completion of the EIP activities, TVA will submit the EAR to TDEC. The EAR will address the list of tasks required by TDEC in its response to the Investigation Conference meeting.

TDEC will review the report to evaluate whether the tasks have been addressed in helping determine if there are unacceptable risks resulting from the management and disposal of CCR. The EIP and EAR process will be repeated until TDEC concludes that there is sufficient information to adequately characterize the extent of CCR contamination in the soil, surface water, and groundwater at the site.

Upon approval of the EAR by TDEC, TVA will then submit, within 60 days, a Corrective Action/Risk Assessment (CARA) Plan. The CARA Plan will specify the actions TVA will take at the site and the basis of those actions. Corrective measures may include (1) soil, surface water, and groundwater remediation, (2) risk assessment and institutional controls, or (3) no further corrective action.

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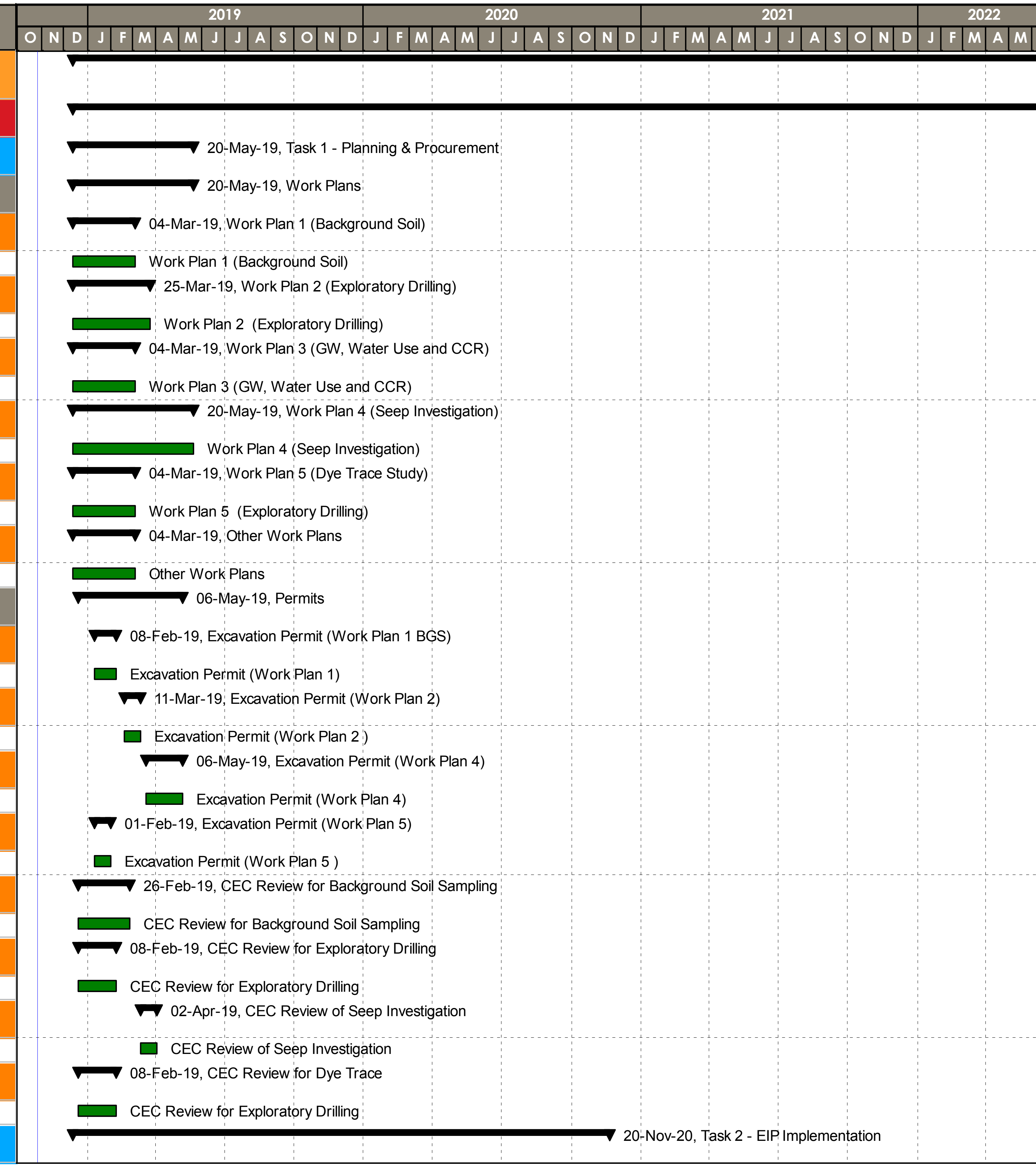
APPENDIX A
SCHEDULE

ST612106-003 TDEC Order JOF Phase 2-TDEC Reporting

Activity ID	Activity Name	Remaining Duration	Start	Finish
	TDEC Order JOF Phase 2	889d	12-Dec-18	27-Jun-22
	Environmental Investigation	889d	12-Dec-18	27-Jun-22
	Task 1 - Planning & Procurement	110d	12-Dec-18	20-May-19
	Work Plans	110d	12-Dec-18	20-May-19
	Work Plan 1 (Background Soil)	55d	12-Dec-18	04-Mar-19
STN-11015	Work Plan 1 (Background Soil)	55d	12-Dec-18	04-Mar-19
	Work Plan 2 (Exploratory Drilling)	70d	12-Dec-18	25-Mar-19
STN-11115	Work Plan 2 (Exploratory Drilling)	70d	12-Dec-18	25-Mar-19
	Work Plan 3 (GW, Water Use and CCR)	55d	12-Dec-18	04-Mar-19
STN-11215	Work Plan 3 (GW, Water Use and CCR)	55d	12-Dec-18	04-Mar-19
	Work Plan 4 (Seep Investigation)	110d	12-Dec-18	20-May-19
STN-11315	Work Plan 4 (Seep Investigation)	110d	12-Dec-18	20-May-19
	Work Plan 5 (Dye Trace Study)	55d	12-Dec-18	04-Mar-19
STN-11515	Work Plan 5 (Exploratory Drilling)	55d	12-Dec-18	04-Mar-19
	Other Work Plans	55d	12-Dec-18	04-Mar-19
STN-11415	Other Work Plans	55d	12-Dec-18	04-Mar-19
	Permits	95d	19-Dec-18	06-May-19
	Excavation Permit (Work Plan 1 BGS)	20d	11-Jan-19	08-Feb-19
STN-12115	Excavation Permit (Work Plan 1)	20d	11-Jan-19	08-Feb-19
	Excavation Permit (Work Plan 2)	15d	19-Feb-19	11-Mar-19
STN-12215	Excavation Permit (Work Plan 2)	15d	19-Feb-19	11-Mar-19
	Excavation Permit (Work Plan 4)	35d	19-Mar-19	06-May-19
STN-12315	Excavation Permit (Work Plan 4)	35d	19-Mar-19	06-May-19
	Excavation Permit (Work Plan 5)	15d	11-Jan-19	01-Feb-19
STN-12515	Excavation Permit (Work Plan 5)	15d	11-Jan-19	01-Feb-19
	CEC Review for Background Soil Sampling	46d	19-Dec-18	26-Feb-19
STN-12615	CEC Review for Background Soil Sampling	46d	19-Dec-18	26-Feb-19
	CEC Review for Exploratory Drilling	35d	19-Dec-18	08-Feb-19
STN-12715	CEC Review for Exploratory Drilling	35d	19-Dec-18	08-Feb-19
	CEC Review of Seep Investigation	16d	12-Mar-19	02-Apr-19
STN-12815	CEC Review of Seep Investigation	16d	12-Mar-19	02-Apr-19
	CEC Review for Dye Trace	35d	19-Dec-18	08-Feb-19
STN-12915	CEC Review for Exploratory Drilling	35d	19-Dec-18	08-Feb-19
	Task 2 - EIP Implementation	489d	12-Dec-18	20-Nov-20



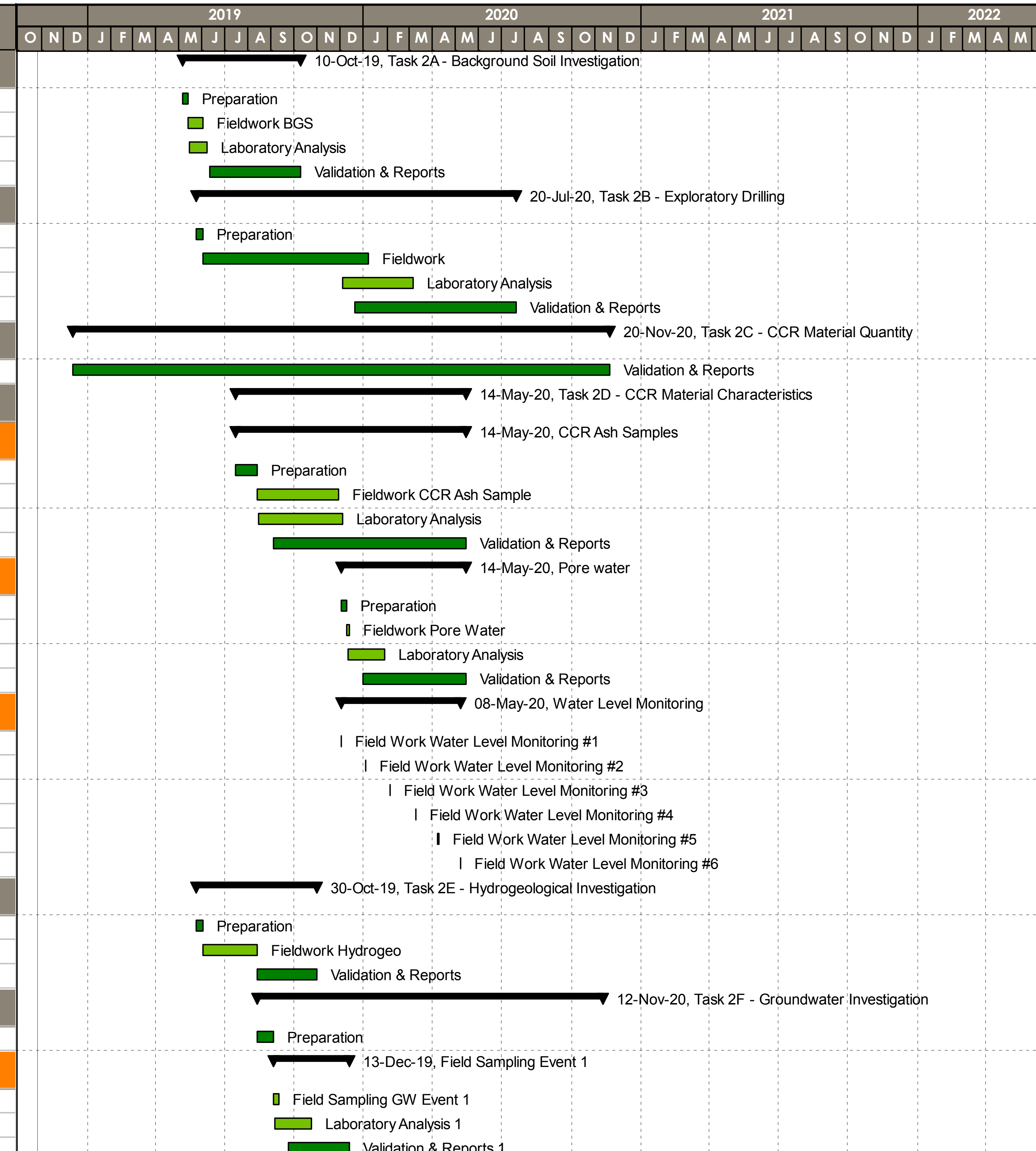
Remaining Level of Effort | Actual Work | Critical Remaining Work
Actual Level of Effort | Remaining Work | ◆ Milestone

Layout: Execution Schedule EIP (WBS) TDEC

Data Date:27-Oct-18
Print Date:06-Dec-18

ST612106-003 TDEC Order JOF Phase 2-TDEC Reporting

Activity ID	Activity Name	Remaining Duration	Start	Finish
Task 2A - Background Soil Investigation		111d	06-May-19	10-Oct-19
STN-21096	Preparation	6d	06-May-19	13-May-19
STN-21010	Fieldwork BGS	15d	13-May-19*	03-Jun-19
TVA-21020	Laboratory Analysis	17d	15-May-19	07-Jun-19
STN-21098	Validation & Reports	86d	11-Jun-19	10-Oct-19
Task 2B - Exploratory Drilling		290d	24-May-19	20-Jul-20
STN-22096	Preparation	6d	24-May-19	03-Jun-19
STN-22097	Fieldwork	150d	03-Jun-19	07-Jan-20
STN-22040	Laboratory Analysis	63d	04-Dec-19	05-Mar-20
STN-22098	Validation & Reports	146d	20-Dec-19	20-Jul-20
Task 2C - CCR Material Quantity		489d	12-Dec-18	20-Nov-20
STN-23098	Validation & Reports	489d	12-Dec-18	20-Nov-20
Task 2D - CCR Material Characteristics		210d	16-Jul-19	14-May-20
CCR Ash Samples		210d	16-Jul-19	14-May-20
STN-24096	Preparation	21d	16-Jul-19	13-Aug-19
STN-24010	Fieldwork CCR Ash Sample	75d	13-Aug-19	29-Nov-19
TVA-24020	Laboratory Analysis	75d	15-Aug-19	03-Dec-19
STN-24098	Validation & Reports	176d	03-Sep-19	14-May-20
Pore water		115d	02-Dec-19	14-May-20
STN-24094	Preparation	6d	02-Dec-19	09-Dec-19
STN-24110	Fieldwork Pore Water	5d	09-Dec-19	13-Dec-19
TVA-24120	Laboratory Analysis	33d	11-Dec-19	29-Jan-20
STN-24099	Validation & Reports	96d	30-Dec-19	14-May-20
Water Level Monitoring		111d	02-Dec-19	08-May-20
STN-24300	Field Work Water Level Monitoring #1	1d	02-Dec-19	02-Dec-19
STN-24310	Field Work Water Level Monitoring #2	1d	03-Jan-20	03-Jan-20
STN-24320	Field Work Water Level Monitoring #3	1d	05-Feb-20	05-Feb-20
STN-24330	Field Work Water Level Monitoring #4	1d	09-Mar-20	09-Mar-20
STN-24340	Field Work Water Level Monitoring #5	1d	08-Apr-20	08-Apr-20
STN-24350	Field Work Water Level Monitoring #6	1d	08-May-20	08-May-20
Task 2E - Hydrogeological Investigation		110d	24-May-19	30-Oct-19
STN-25096	Preparation	6d	24-May-19	03-Jun-19
STN-25010	Fieldwork Hydrogeo	50d	03-Jun-19	12-Aug-19
STN-25098	Validation & Reports	55d	13-Aug-19	30-Oct-19
Task 2F - Groundwater Investigation		315d	13-Aug-19	12-Nov-20
STN-26096	Preparation	16d	13-Aug-19	04-Sep-19
Field Sampling Event 1		70d	04-Sep-19	13-Dec-19
STN-26110	Field Sampling GW Event 1	5d	04-Sep-19	10-Sep-19
TVA-26120	Laboratory Analysis 1	33d	06-Sep-19	23-Oct-19
STN-26145	Validation & Reports 1	56d	24-Sep-19	13-Dec-19



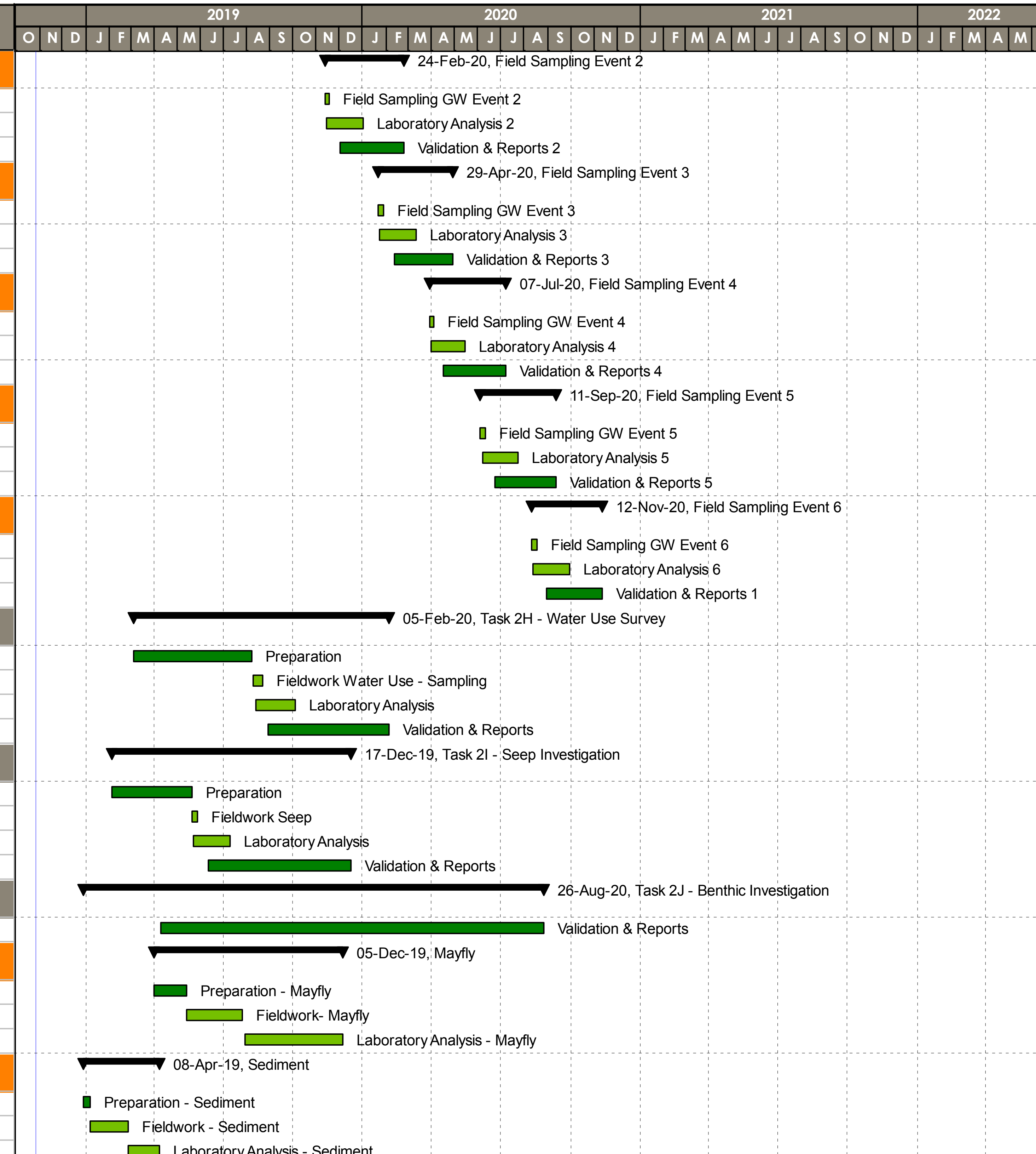
Remaining Level of Effort | Actual Work | Critical Remaining Work
Actual Level of Effort | Remaining Work | ◆ Milestone

Layout: Execution Schedule EIP (WBS) TDEC

Data Date:27-Oct-18
Print Date:06-Dec-18

ST612106-003 TDEC Order JOF Phase 2-TDEC Reporting

Activity ID	Activity Name	Remaining Duration	Start	Finish
Field Sampling Event 2		70d	12-Nov-19	24-Feb-20
STN-26210	Field Sampling GW Event 2	5d	12-Nov-19	18-Nov-19
TVA-26220	Laboratory Analysis 2	33d	14-Nov-19	02-Jan-20
STN-26245	Validation & Reports 2	56d	03-Dec-19	24-Feb-20
Field Sampling Event 3		70d	22-Jan-20	29-Apr-20
STN-26310	Field Sampling GW Event 3	5d	22-Jan-20	28-Jan-20
TVA-26320	Laboratory Analysis 3	33d	24-Jan-20	11-Mar-20
STN-26345	Validation & Reports 3	56d	11-Feb-20	29-Apr-20
Field Sampling Event 4		70d	30-Mar-20	07-Jul-20
STN-26410	Field Sampling GW Event 4	5d	30-Mar-20	03-Apr-20
TVA-26420	Laboratory Analysis 4	33d	01-Apr-20	15-May-20
STN-26445	Validation & Reports 4	56d	17-Apr-20	07-Jul-20
Field Sampling Event 5		70d	04-Jun-20	11-Sep-20
STN-26510	Field Sampling GW Event 5	5d	04-Jun-20	10-Jun-20
TVA-26520	Laboratory Analysis 5	33d	08-Jun-20	23-Jul-20
STN-26545	Validation & Reports 5	56d	24-Jun-20	11-Sep-20
Field Sampling Event 6		65d	11-Aug-20	12-Nov-20
STN-26610	Field Sampling GW Event 6	5d	11-Aug-20	17-Aug-20
TVA-26620	Laboratory Analysis 6	33d	13-Aug-20	29-Sep-20
STN-26645	Validation & Reports 1	51d	31-Aug-20	12-Nov-20
Task 2H - Water Use Survey		233d	05-Mar-19	05-Feb-20
STN-28096	Preparation	111d	05-Mar-19	08-Aug-19
STN-28130	Fieldwork Water Use - Sampling	10d	09-Aug-19	22-Aug-19
TVA-28140	Laboratory Analysis	38d	13-Aug-19	04-Oct-19
STN-28098	Validation & Reports	108d	29-Aug-19	05-Feb-20
Task 2I - Seep Investigation		219d	05-Feb-19	17-Dec-19
STN-29096	Preparation	75d	05-Feb-19	21-May-19
STN-29110	Fieldwork Seep	5d	21-May-19	28-May-19
TVA-29120	Laboratory Analysis	33d	23-May-19	10-Jul-19
STN-29098	Validation & Reports	131d	11-Jun-19	17-Dec-19
Task 2J - Benthic Investigation		419d	28-Dec-18	26-Aug-20
STN-29A098	Validation & Reports	350d	09-Apr-19	26-Aug-20
Mayfly		173d	01-Apr-19	05-Dec-19
STN-29202	Preparation - Mayfly	31d	01-Apr-19	13-May-19
TVA-29210	Fieldwork- Mayfly	53d	13-May-19*	26-Jul-19
TVA-29212	Laboratory Analysis - Mayfly	90d	29-Jul-19	05-Dec-19
Sediment		69d	28-Dec-18	08-Apr-19
STN-29216	Preparation - Sediment	6d	28-Dec-18	07-Jan-19
TVA-29221	Fieldwork - Sediment	34d	07-Jan-19*	25-Feb-19
TVA-29222	Laboratory Analysis - Sediment	30d	26-Feb-19	08-Apr-19



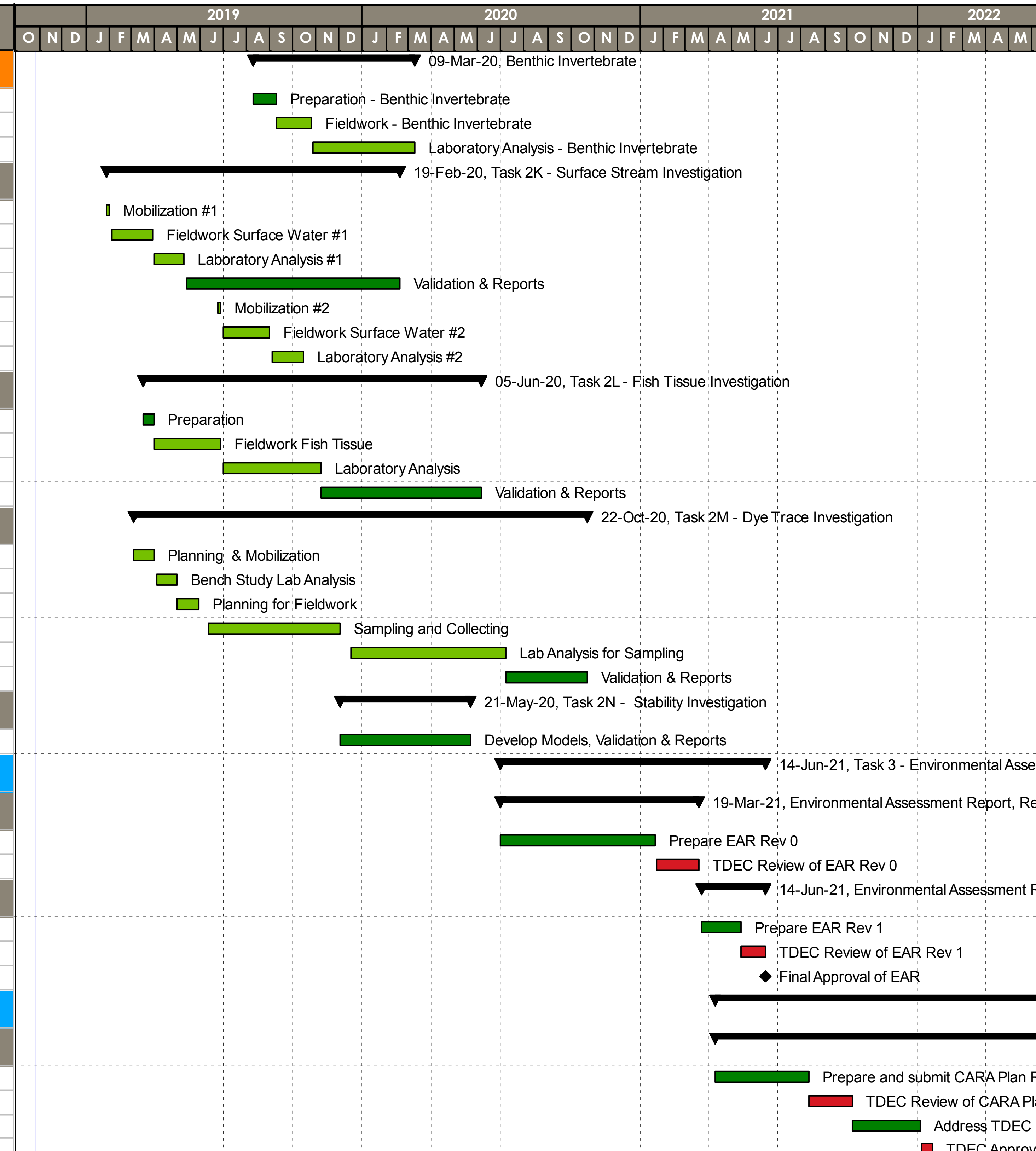
Remaining Level of Effort | Actual Work | Critical Remaining Work
Actual Level of Effort | Remaining Work | ◆ Milestone

Layout: Execution Schedule EIP (WBS) TDEC

Data Date:27-Oct-18
Print Date:06-Dec-18

ST612106-003 TDEC Order JOF Phase 2-TDEC Reporting

Activity ID	Activity Name	Remaining Duration	Start	Finish
Benthic Invertebrate		144d	09-Aug-19	09-Mar-20
STN-29227	Preparation - Benthic Invertebrate	21d	09-Aug-19	09-Sep-19
TVA-29228	Fieldwork - Benthic Invertebrate	34d	09-Sep-19*	25-Oct-19
TVA-29232	Laboratory Analysis - Benthic Invertebrate	90d	28-Oct-19	09-Mar-20
Task 2K - Surface Stream Investigation		267d	28-Jan-19	19-Feb-20
TVA-29320	Mobilization #1	5d	28-Jan-19	01-Feb-19
TVA-29330	Fieldwork Surface Water #1	39d	04-Feb-19*	29-Mar-19
TVA-29332	Laboratory Analysis #1	30d	01-Apr-19	10-May-19
STN-29362	Validation & Reports	193d	13-May-19	19-Feb-20
TVA-29340	Mobilization #2	5d	24-Jun-19*	28-Jun-19
TVA-29350	Fieldwork Surface Water #2	44d	01-Jul-19	30-Aug-19
TVA-29360	Laboratory Analysis #2	30d	03-Sep-19	15-Oct-19
Task 2L - Fish Tissue Investigation		309d	18-Mar-19	05-Jun-20
STN-29509	Preparation	11d	18-Mar-19	01-Apr-19
TVA-29510	Fieldwork Fish Tissue	64d	01-Apr-19*	28-Jun-19
TVA-29520	Laboratory Analysis	90d	01-Jul-19	06-Nov-19
STN-29522	Validation & Reports	145d	07-Nov-19	05-Jun-20
Task 2M - Dye Trace Investigation		414d	05-Mar-19	22-Oct-20
STN-29610	Planning & Mobilization	20d	05-Mar-19	01-Apr-19
STN-29630	Bench Study Lab Analysis	20d	04-Apr-19	01-May-19
STN-29640	Planning for Fieldwork	20d	02-May-19	30-May-19
STN-29660	Sampling and Collecting	120d	11-Jun-19	02-Dec-19
STN-29670	Lab Analysis for Sampling	140d	17-Dec-19	07-Jul-20
STN-29705	Validation & Reports	75d	08-Jul-20	22-Oct-20
Task 2N - Stability Investigation		120d	02-Dec-19	21-May-20
STN-29760	Develop Models, Validation & Reports	120d	02-Dec-19	21-May-20
Task 3 - Environmental Assessment Report (EAR)		240d	30-Jun-20	14-Jun-21
Environmental Assessment Report, Rev 0		180d	30-Jun-20	19-Mar-21
STN-31096	Prepare EAR Rev 0	140d	30-Jun-20	21-Jan-21
STN-31150	TDEC Review of EAR Rev 0	40d	22-Jan-21	19-Mar-21
Environmental Assessment Report, Rev 1		60d	22-Mar-21	14-Jun-21
STN-32096	Prepare EAR Rev 1	39d	22-Mar-21	13-May-21
STN-32170	TDEC Review of EAR Rev 1	21d	14-May-21	14-Jun-21
STN-32180	Final Approval of EAR	0d		14-Jun-21
Task 10 - CARA		306d	09-Apr-21	27-Jun-22
Meetings & Deliverables		306d	09-Apr-21	27-Jun-22
STN-98254	Prepare and submit CARA Plan Rev 0 for TDEC Review	86d	09-Apr-21	10-Aug-21
TVA-98255	TDEC Review of CARA Plan Rev 0	40d	11-Aug-21	06-Oct-21
STN-98256	Address TDEC Comments on CARA Plan Rev 0, Prepare and submit Rev 1 to TDEC	60d	07-Oct-21	05-Jan-22
TVA-98295	TDEC Approval of CARA Plan Rev 1	10d	06-Jan-22	20-Jan-22



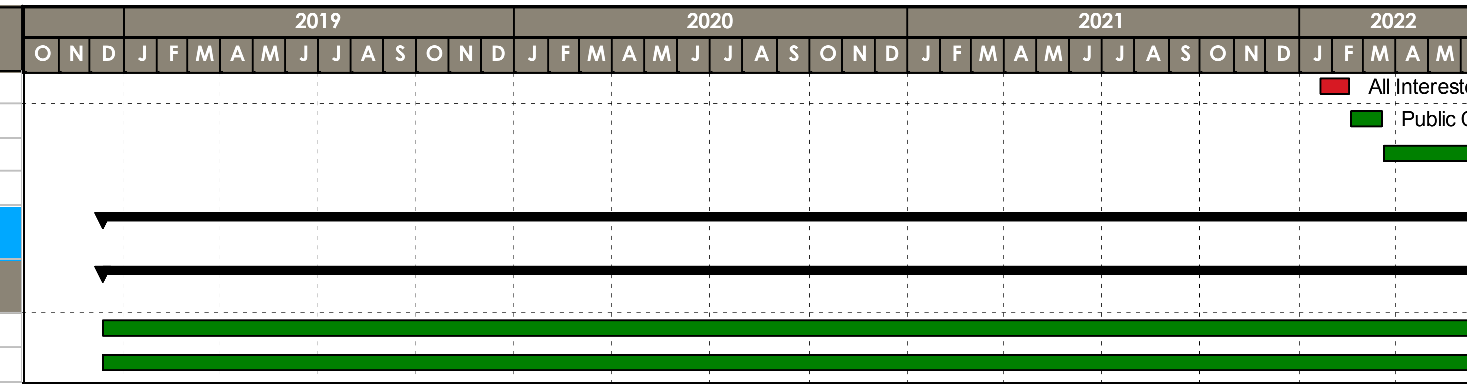
Remaining Level of Effort | Actual Work | Critical Remaining Work
Actual Level of Effort | Remaining Work | ◆ Milestone

Layout: Execution Schedule EIP (WBS) TDEC

Data Date:27-Oct-18
Print Date:06-Dec-18

ST612106-003 TDEC Order JOF Phase 2-TDEC Reporting

Activity ID	Activity Name	Remaining Duration	Start	Finish
TVA-98296	All Interested Party Meeting (AIP)	20d	21-Jan-22	17-Feb-22
STN-98296	Public Comment Period	20d	18-Feb-22	18-Mar-22
STN-98298	Address Public Comments on CARA Plan Rev 1 and Prepare CARA Plan Rev 2 for T	60d	21-Mar-22	13-Jun-22
TVA-98345	TDEC Final Approval of CARA Plan Rev 2	10d	14-Jun-22	27-Jun-22
Task 11 - Project Communications & Reporting		889d	12-Dec-18	27-Jun-22
Task 11A - TDEC Updates		889d	12-Dec-18	27-Jun-22
TVA-96110	TDEC Monthly Progress Reports	889d	12-Dec-18	27-Jun-22
TVA-96120	TDEC Progress Update Meetings (Quarterly)	889d	12-Dec-18	27-Jun-22



Remaining Level of Effort | Actual Work | Critical Remaining Work
Actual Level of Effort | Remaining Work | ◆ Milestone

Layout: Execution Schedule EIP (WBS) TDEC

Data Date:27-Oct-18
Print Date:06-Dec-18

APPENDIX B
TDEC CORRESPONDENCE

Rec'd 7/14/05

STATE OF TENNESSEE
TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
ENVIRONMENTAL ASSISTANCE CENTER
711 R. S. GASS BOULEVARD
NASHVILLE, TENNESSEE 37216
PHONE (615) 687-7000 STATEWIDE 1-888-891-8332 FAX (615) 687-7078

June 29, 2005

CERTIFIED MAIL 7004 0550 0000 9790 6334
RETURN RECEIPT REQUESTED

Ms. Janet K. Watts
Manager
Tennessee Valley Authority
Environmental Affairs
5D Lookout Place
1101 Market Street
Chattanooga, Tennessee 37402-2801

Re: Approval of Closure Certification
South Rail Loop Dredge Cell

Dear Ms. Watts:

On October 20, 2003, the Division of Solid Waste Management (DSWM), Nashville Field Office, received the certification of closure from the referenced facility. Based on a review of the certification document and upon a facility inspection conducted on February 25, 2005, verification of final closure for this facility has been determined to be complete and approval is hereby granted.

Since the Tennessee Valley Authority is an agency of the Federal Government, no financial assurance for closure and post-closure care of the facility was required per Rule 1200-1-7-.03(1)(b)2.

Further, the post closure care period for this facility parcel begins upon receipt of this approval letter. All post closure care activities specified in the facility's approved Closure/Post Closure Plan must be followed to ensure the final cover system integrity is not compromise.

If you have any questions regarding this letter, feel free to contact this office at (615) 687-7000.

Sincerely,

Al Majors

Alfred Majors, Field Office Manager
Division of Solid Waste Management

cc: Mr. Glen Pugh, Manager, DSWM - Central Office
Mr. Larry Bowers, TVA
Mr. O. J. Wingfield, DSWM - Central Office
Mr. Bradford Martin, P.E., DSWM - NEAC
SWM Central Files

RECEIVED
JUL 15 2005
ENVIRONMENTAL AFFAIRS
FOSSIL POWER GROUP

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
Division of Solid Waste Management
Fifth Floor, L & C Tower
401 Church Street
Nashville, Tennessee 37243 – 1535
615-532-0780

September 19, 2012

Mr. Clay C. Cherry, Plant Manager
Tennessee Valley Authority (TVA) Johnsonville Fossil Plant
535 Steam Plant Road
New Johnsonville, TN 37134

RE: Approval of Closure Certification: TVA Johnsonville Fossil Plant
Dredged Ash Landfill IDL 43-0082

Dear Mr. Cherry:

On April 27, 2012, the Division of Solid Waste Management (DSWM), Nashville Environmental Field Office, received closure certification from the above referenced facility. Based on a review of the certification document and upon a facility inspection conducted on January 23, 2012, verification of final closure for this facility TVA Dredged Ash Landfill has been determined to be complete and approval is hereby granted.

Since TVA is a federal government entity, they are not required to post any financial assurance; however, the State of Tennessee does require TVA to maintain post-closure procedures for the TVA Dredged Ash Landfill.

Further, the thirty (30) year post-closure care period for TVA Dredged Ash Landfill begins upon receipt of this approval letter. All post closure care activities outlined in Rule 1200-1-7-.04(8)(e) and all post closure care activities specified in the facility's approved Closure-Post Closure Plan must be followed as required.

Please contact Bassam Faleh at 615-532-0796 with questions concerning the closure certification.

Sincerely,

Patrick J. Flood

Patrick J. Flood, PE
Director

RECEIVED
SEP 27 2012

PJF/BHF/ljb

cc: Glen Pugh, Solid Waste Program Manager
Al Majors, Nashville Environmental Field Office Manager
Robert Dickinson, Financial Responsibility Program Manager
Cynthia M. Anderson, Senior Manager, TVA, 1101 Market Street, Chattanooga, TN 37402

Charles L. Head, Senior Advisor
2nd Floor TN Tower, W.R. Snodgrass Building
312 Rosa L. Parks Avenue
Nashville, TN 37243615 532-0998
e-mail: chuck.head@tn.gov

Robert J. Martineau, Jr.
Commissioner

Bill Haslam
Governor

February 23, 2017

Paul J. Pearman, Project Manager
Tennessee Valley Authority
1101 Market Street, MR 4K
Chattanooga, TN 37402

Subject: TVA Johnsonville Fossil Plant
Environmental Investigation Plan
Due Date – July 24, 2017

Dear Paul:

This letter serves as a follow-up to the investigation conference meeting with Tennessee Valley Authorities (TVA) on August 17 & 18, 2016 regarding the TVA Johnsonville Fossil Plant (JOF). This meeting fulfilled Section VII.A.a of Commissioner's Order OGC15-00177 (the Order). The TN Department of Environment and Conservation (TDEC appreciates the time and effort made by TVA staff and consultants presenting a summary of the geologic, hydrologic, analytical, engineering and historic data for the JOF site. TDEC's staff understood the information presented and greatly appreciate the opportunity to ask question and discuss technical issues. The JOF Site has CCR disposal sites adjacent to and in the Tennessee River/ Kentucky Lake.

TDEC requests that TVA provide responses to the points presented below in the EIP for the JOF site.

General JOF Investigation Conference Questions and Comments

1. The TVA JOF site presents a unique challenge in environmental investigation and remediation because the CCR material generated by burning coal is

sluiced from the TVA JOF plant into a surface impoundment that was constructed with Kentucky Lake. Because of this, there are questions about how a ground water monitoring network can be installed to determine if CCR constituents are migrating from the bottom of this CCR surface impoundment into the river or into ground water below the river. Further, the active CCR impoundment is of concern due to its location. The impoundment is in the river channel, subject to continual erosion at the base of the CCR surface impoundment dike, is potentially subject to flooding and may be more subject to a catastrophic loss of CCR material should a substantial seismic event occur.

2. TVA will face a considerable challenge conducting environmental investigation and corrective action activities at the TVA JOF site because where CCR materials were disposed at locations where the disposal area is on property owned by two or more persons. TVA must provide documentation to TDEC that TVA has an agreement(s) with adjacent property owners that allow TVA to conduct environmental investigations and corrective actions on neighboring properties. This documentation should be included in the draft TVA JOF Environmental Investigation Plan.

3. TVA should provide the estimated amount and location of CCR material that is disposed on the TVA JOF property and adjacent property, including CCR material in active surface impoundments and landfills. TVA is not required to report the amount and location of CCR material disposed of offsite in properly permitted solid waste landfills. Is there a memorandum of agreement or similar legal document(s), executed between TVA and owners of adjacent property (ies) where CCR material from the TVA JOF site has been disposed? If so, TVA should include those documents in the EIP.

4. TVA should include Annual Inspection Reports referenced in its presentation to TDEC. This includes the August 9, 1973 and September 16, 1976 annual inspection reports. If an annual inspection report was prepared for an inspection(s) performed in 1995, provide this document as well.

5. Note 9(c) from drawing 10W211-1 indicates bottom ash and fly ash were obtained from the JOF disposal area and used when TVA implemented the Coal Yard grading plan. TVA should provide information that reports the amount of CCR material disposed in the coal yard and a map with this

<u>Groundwater Monitoring</u>

1. TVA shall demonstrate that the proposed background monitoring well at each ash disposal unit represents groundwater that passes under each ash disposal unit. TDEC shall approve the location(s) of the background ground water monitoring wells.

2. TVA shall explain how groundwater will be monitored for Ash Disposal Area 1. Monitoring on the North side of the unit should be included.

3. TVA shall submit reports for all ground water monitoring events for each unit to TDEC.

We believe it is important to define the differences between the ground water monitoring requirements for the Commissioner's Order and the U.S. EPA regulatory criteria for establishing a Ground Water Monitoring Assessment Plan for CCR sites. The Commissioner's Order requires TVA to create a ground water monitoring network for the entire TVA CUF site. This includes all active and inactive CCR permitted landfills and surface impoundments as well as any locations where CCR material was disposed on site that were not subject to permitting under current or past TDEC statutory or regulatory requirements. The U.S. EPA requirements primarily address only permitted CCR disposal areas.

Active Ash Pond No. 2

1. JOF94_JOF INSP FY1972 dated September 20, 1972 states on page 1 "Areas A and B are to be reclaimed by TVA. Under an informal agreement DuPont has sole responsibility for area "C." Recommendations on page 4 states "Raise the dike from the south harbor road to the north end of the ash area to elevation 378 as soon as heavy bottom ash is available" indicating ash may be incorporated into the dike construction. Please clarify if the action above was taken.

2. JOF94_JOF INSP FY1994 dated September 30, 1974 states on page 2 "DEC has hauled waste material, mixtures of earth and obliterated asphaltic pavement, from the electrostatic precipitators and has piled the material along the outside of the dike (Recommendation, No. 3). Recommendation No. 3 suggests using this material to raise the east dike with the removed asphaltic pavement. Have subsequent subsurface evaluations encountered any of these materials and are they accounted for in stability calculations?

2. Document JOF45_JOF1977 SOIL EXPLORATION & TESTING on page 4, please clarify the reference to Colbert ash dike. Page 5 states "Softer conditions exist in the foundation soils, particularly in SS-7, 8, and 9, and may require special attention". Are construction records available that document how "special conditions" in these areas were managed during construction?

3. Document JOF46_JOF 1994 GEOTECHNICAL EVALUATION-ASH POND DIKE on page 4 identifies the discovery of three sinkholes. TVA should provide TDEC with the construction documentation of remediation of the sinkholes, the repair method used for the sinkholes and any information that reports the frequency of new sinkholes occurring. Please describe the

methods TVA will use to prevent the occurrence of future sinkholes and the methods TVA uses to “close” sinkholes.

4. In Document JOF54_JOF-GE-100413 (rpt_jof_final_20100413) Page v of the Executive Summary states, in reference to the dike’s construction “this material in not compacted and it contains zones of higher permeability which transmit seepage from the ash disposal area.” Given this, has TVA conducted testing that would indicate horizontal permeability of the in place dike material.

Miscellaneous

1. A complete review of these documents is not possible until TDEC has legible copies. The following list of documents have portions that are not legible:

   a. Document JOF39_29 JOF ASH POND – SOIL & FOUNDATION EXPLORATION pages 25 through 28.

   b. Document JOF45_JOF1977 SOIL EXPLORATION & TESTING page 37 is not legible.

   c. Document JOF48_JOF AUGUST 2003 REPORT OF ASH POND INVESTIGATION page 9.

Please provide legible copies of these documents.

From our on-site meeting, TDEC is aware that TVA has some information it has collected previously at the TVA JOF site; as an example data from soil borings and analysis of samples collected from ground water monitoring wells. This information provided a good reference when the data was collected, but the soil borings and ground water monitoring wells may not have been installed and constructed to meet the criteria for environmental investigation of this site per the Order. TVA should consider proposing additional activities at the TVA JOF site to fully determine the amount and location of CCR material disposed, migration of CCR constituents through soil and ground water, identification of the upper most aquifer, migration of ground water with CCR constituents into surface water, structural stability, etc.

The TVA JOF EIP should include a schedule of activities to be completed during the environmental investigation of the TVA JOF site. As an example, it is TDEC’s expectation that the schedule for installing, developing and sampling ground water monitoring wells will be specifically described in the TVA JOF EIP and the schedule to perform this work will be provided. A full description of the methods used to install, drill, construct and sample ground water monitoring wells may be included in an appendix to the TVA JOF EIP or if TVA plans to use an established method or protocol, it can be included by reference.

Once TDEC approves the TVA JOF EIP, the environmental investigation activities should provide a very good overall view of TVA JOF site conditions within 9 to 12 months of TDEC's approval of the TVA JOF EIP. This will allow TVA to prepare an Environmental Assessment Report within 12 to 15 months of approval of the TVA JOF EIP.

TDEC understands from documents prepared by TVA in 2011 that it plans to close the CCR disposal areas at the TVA JOF site, including Ash Pond 2. in place. Should TVA decide to close the CCR disposal areas the TVA JOF site in place before the environmental investigation required under the TDEC Order has been completed, it does so at its own risk. Under the Order, TVA is required to perform a comprehensive environmental assessment. The results of the TVA JOF environmental assessment will be used to determine the appropriate corrective action for soil, ground water and surface water and to ensure protection of public health. Approved TDEC Corrective action at the TVA JOF site may range from closure in place of the CCR disposal areas to complete removal of CCR material from the CCR disposal areas and disposal at a properly permitted landfill.

TVA shall submit the draft EIP for the JOF site on or before the close of business on **July 24, 2017.**

TDEC's goal is to work with TVA to ensure the environmental investigation of the JOF site is complete, accurate and timely. Please contact TDEC with any questions or comments regarding these comments.

Sincerely,

Chuck Head

Chuck Head

CC:	Shari Meghreblian, Ph. D.	Tisha C. Benton	Susan Smelley.
	E. Joseph Sanders	Britton Dotson	Paul J. Pearman, P.E.
	Patrick J. Flood, P.E.	Glen Pugh	Scotty Sorrells
	James Clark	Rob Burnette	

Robert Wilkinson, PG, CHMM CCR Technical Manager
2nd Floor TN Tower, W.R. Snodgrass Building
312 Rosa L. Parks Avenue
Nashville, TN 37243
Office: (615) 253-0689
e-mail: Robert.S.Wilkinson@tn.gov

Robert J. Martineau, Jr.
Commissioner

Bill Haslam
Governor

October 19, 2017

M. Susan Smelley
Director
Environmental Compliance and Operations
Tennessee Valley Authority
1101 Market Street, MR 4K
Chattanooga, TN 37402

RE: TDEC Commissioner's Order OGC 15-1077
TVA Johnsonville Coal Fired Fossil Fuel Plant
Environmental Investigation Plan Revision 0 Comments

Dear Ms. Smelley:

The Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order OGC 15-0177 (the Order") to the Tennessee Valley Authority (TVA) that required TVA action at seven TVA Coal Fired Fossil Power Plants (active and inactive) located in Tennessee. The Order was signed on August 6, 2015 and included information about TVA's right to appeal the Order. TVA did not appeal the Order and it is now final.

The Order required TVA to perform environmental investigations and to take appropriate corrective action at seven TVA Coal Fossil Power Plants (CCR sites) in Tennessee. The Order is specific to Coal Combustion Residual (CCR) material. Paragraph VII. of the Order provides the sequence of events for environmental investigation at a TVA CCR site as presented below.

1. TVA and TDEC are required to schedule and conduct an initial meeting to discuss each CCR site. At each CCR site meeting, TVA provides the operational history of the CCR site, all geological and hydrogeological information currently available, results of environmental investigations and sampling, etc. This is basically a summary of TVA's current understanding of each CCR site.

2. TDEC reviews the information provided by TVA (historical information, geophysical properties of the site, operational history, etc.) at the on-site meeting and historical CCR site information provided by TVA. After review of the information provided by TVA, TDEC

sends a letter to TVA that sets the date for submission of the draft CCR site Environmental Investigation Plan (EIP) and informs TVA of any additional environmental activities it believes are necessary to complete the CCR site environmental investigation.

3. TVA submits a draft Environmental Investigation Plan for the CCR site. TDEC reviews the draft CCR site EIP and provides TVA with comments that identify opportunities to improve the environmental investigation of the CCR site EIP. This letter also sets a due date for submission of the revised CCR site EIP.

4. TVA submits a revised EIP for the CCR site to TDEC, with a schedule of onsite activities such as installation of ground water monitoring wells, installing soil/rock borings to determine subsurface geological features, methods that will be used to determine the location and amount of disposed CCR material, surface water and ground water monitoring, etc.

5. TDEC provides TVA with its response to the revised EIP. When TDEC finds the CCR site EIP to be complete, TDEC notifies TVA via letter.

6. TVA is required to issue a public notice for the CCR site EIP before it is implemented. The public has 30 days to submit its EIP comments to TDEC. If EIP comments are submitted to TDEC, then TDEC has 30 days to respond to the comments.

7. Once the public comment period has ended, TDEC may provide TVA with CCR site EIP comments as a result of the review of the public comments submitted to TDEC. TVA submits and TDEC approves/disapproves the schedule of activities for environmental investigation at the CCR site. Unless TDEC disapproves the CCR site EIP schedule of activities, TVA proceeds with the environmental investigation, collects and generates data, then prepares an Environmental Assessment Report (EAR).

8. The EAR is submitted to TDEC. TDEC evaluates the EAR and decides if TVA has generated enough environmental investigation data to:

   a. Determine the impact of CCR materials to public health and the environment.
   b. Provide a comprehensive picture of the areas where CCR material disposed.
   c. Assess the structural and seismic stability of the CCR disposal areas.
   d. Determine the extent of CCR constituents in ground water and discharges to surface water.
   e. Determine if CCR material is disposed below the ground water table.

TDEC also determines if there is enough information generated to prepare a comprehensive corrective action plan.

If TDEC determines the EAR is incomplete or deficient, then TDEC informs TVA of its concerns. TVA is then required to further investigate the CCR site, beginning with item 4. above.

<u>Johnsonville CCR site EIP Rev 0 Comments</u>

TVA submitted the EIP Rev 0 for TVA Johnsonville Coal Fired Fossil Power Plant (TVA JOF) on July 24, 2017. TDEC has completed its review of EIP Rev 0 and is providing comments listed in the attached **Table 1 TVA Johnsonville EIP Rev 0 Summary of TDEC Comments**.

Please address the attached comments and submit a revised plan (EIP Rev 1) with a cover letter summarizing TVA's response to each comment and subsequent modifications to TDEC by **January 12, 2018**.

TDEC's goal is to work with TVA to ensure the environmental investigation of the TVA JOF site is complete, accurate and timely. Should you have any questions, please do not hesitate to contact me via email at Robert.S.Wilkinson@tn.gov or phone at (615) 253-0689.

Sincerely,

Robert Wilkinson, PG, CHMM

CC:	Paul Pearman	Britton Dotson	James Clark
	Pat Flood	Scotty Sorrells	Rob Burnette
	Tisha Calabrese Benton	Angela Adams	Joseph E. Sanders
	Chuck Head	Peter Lemiszki	Jason Repsher
	Alan Spear		

TVA Johnsonville EIP Rev 0
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
All	All	All	All	All	General comment - TVA should include an applicability assessment of the TDEC General Guideline for Environmental Investigation Plans, TVA Fossil Plants when preparing the EIP. TDEC understands that not all aspects of the guidelines will be applicable at all TVA facilities, but each line item should be reviewed and assessed for applicability within the EIP. If an item is deemed not applicable to this facility, TVA should provide a written justification for exclusion within the EIP. Applicable items from the guidelines should be incorporated into the next revision of the EIP.
All	All	All	All	All	TDEC recommends conducting a leachability characterization study that includes an evaluation of CCR parameters from pore water and solid material samples from locations that would characterize the vertical and lateral distribution of leachability characteristics across the facility.
All	All	All	All	All	General comment - All monitor wells, geotechnical borings, and soil borings should be logged by a Tennessee licensed professional geologist.
All	All	All	All	All	General content comment - please give titles to sections that reflect the content of the section - "TDEC Information Request" is not an appropriate section title.
All	All	All	All	All	General content comment - EIP does not include the following: Water Use Survey and SAP, Sediment Assessment and SAP, Seep SAP, Ash Characterization (leachability) Assessment and SAP.
General Administrative	NA	NA	NA	NA	The document lacks a signature page that indicates the document has been read and that the various parties (e.g., QA consultant, Investigation Consultant field personal) understand the relevant requirements.
General Administrative	NA	NA	NA	NA	The document lacks an approval page, with all stakeholders listed.
General Administrative	NA	NA	NA	NA	The document lacks a revision log.
General Administrative	NA	NA	NA	NA	The TDEC will be notified immediately by the TVA of any problems related to successful completion of field efforts as outlined in this EIP.

Section Number	Section Title	Page	Paragraph	Line	Comment
General Administrative	NA	NA	NA	NA	Please provide the following TVA TI, "Monitoring Well and Piezometer Installation and Development" (ENV-TI-05.80.25).
Global SAPs	NA	NA	NA	NA	The SAPs lack a list of field equipment and critical spare parts (if applicable) related to the specific tasks described in each SAP.
Global SAPs	NA	NA	NA	NA	There needs to be a maintenance form created to document the routine checks and both the regular and special maintenance that will occur for each instrument. This form needs to include the nature of the maintenance the qualified person and dates.
Global SAPs	NA	NA	NA	NA	Are the sample sites and transects for stream sampling known to be in representative areas of leachate location/impact, or targeting maximum impact areas? If this hasn't been determined, tracking conductivity in the field to locate well mixed or maximum concentration plumes may be useful.
Global SAPs	NA	NA	NA	NA	Data analysis and any statistics isn't really mentioned. What will be done with the data, how analyzed, etc…? If statistics will be run, was any sort of power analysis done to see if sample sizes provide sufficient statistical power given expected variability in the data?
General Technical	NA	NA	NA	NA	Is there a plan to look at the data for trends when common leachate indicators are compared to the total amount of CCR metals in contaminated water samples. It is important to determine if there is a relationship because of the expected geochemical relationships between chloride, other leachate indicators, and the presence of CCR metals, otherwise only CCR metals can be used to reliably indicate leachate-groundwater interaction.

Section Number	Section Title	Page	Paragraph	Line	Comment
General Technical	NA	NA	NA	NA	Will Piper diagrams be used to compare the hydrochemical facies of EIP groundwater samples? And if so please identify what comparison(s) will be made (e.g., west ash pond versus east ash pond, groundwater discharge to McKellar Lake versus groundwater recharge from McKellar Lake, contaminated wells versus background wells, etc.)?
General Technical	NA	NA	NA	NA	The TVA Johnsonville CCR Surface Impoundment is in an unusual setting. The active CCR impoundment was constructed within the confines of Kentucky Lake. The structure appears to the casual eye to be an island. Should the initial ground water monitoring wells constructed at the perimeter have CCR constituents at levels greater than background or Maximum Contaminant Limits (MCL), then TVA must provide TDEC with a groundwater monitoring plan that extends beyond the waste boundary of the surface impoundment. This will be a challenge given the location of the surface impoundment.
General Technical	NA	NA	NA	NA	TVA has should have completed the CCR groundwater monitoring around the perimeter of the active CCR Surface Impoundment at TVA Johnsonville. The groundwater data from this sampling effort should be available for review. TVA shall submit the groundwater monitoring data it has collected from the monitoring wells around the active Johnsonville surface impoundment to TDEC. This data shall be submitted in two tables. The first table shall present the raw data provided by the laboratory to TVA for each groundwater monitoring event by well, constituent and date of sampling. The second table shall present the groundwater data for each monitoring well by well, sampling date and constituent after TVA has completed quality assurance/quality control review of the results. For both tables, TVA shall provide the sampling results in Parts per Billion (µg/L) and shall identify each result that is above either the CCR constituent MCL or background levels for constituents without MCLs.

Section Number	Section Title	Page	Paragraph	Line	Comment
General Technical	NA	NA	NA	NA	Assuming TVA has received the results of groundwater monitoring at the CCR monitoring wells required by the EPA CCR regulations and the results from the groundwater monitoring demonstrate that there are CCR constituents above either the CCR MCLs or above background levels at the waste boundary, TVA shall amend the Johnsonville EIP and include the location of additional groundwater monitoring wells to determine the horizontal and vertical extent of CCR constituents in groundwater. If TVA cannot extend the groundwater monitoring well network due to the location of the active Johnsonville Surface Impoundment, then TVA shall propose an alternative strategy to determine the extent of CCR contamination vertically and horizontally beyond the waste boundary of the surface impoundment.
General Technical	NA	NA	NA	NA	The active Johnsonville CCR surface impoundment was constructed within Kentucky Lake in the late 1940s and early 1950s. TDEC does not have the physical characteristics of the materials used to construct the impoundment nor the permeability of the dike structure upon completion. At the TVA Johnsonville site, the Tennessee River flows from the south to the north. To determine if the river is influencing the movement of groundwater within the active CCR surface impoundment, TVA shall propose a dye study to determine if the river is influencing ground water movement. TVA shall include in its amended Johnsonville EIP a groundwater dye study to determine the direction of groundwater flow below the active Johnsonville CCR surface impoundment.

TVA Johnsonville EIP Rev 0
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
General Technical	NA	NA	NA	NA	From review of TVA documents, it appears that TVA will no longer burn coal to produce electricity at Johnsonville after January 1, 2018. TVA shall include in its revised Johnsonville EIP a plan to monitor water levels within the CCR surface impoundment monthly to determine the change in water levels in the surface impoundment. Once the water levels in the active CCR surface impoundment reach asymptotic levels, TVA shall notify TDEC and shall report to TDEC the amount and location of CCR materials remaining in the active CCR surface impoundment that are below the static water levels within the surface impoundment.
2.1	EIP Development and Structure	4	6	1	Please provide a minimum frequency that TVA will be providing progress reports to TDEC.
2.1.5	Revising the EIP to address TDEC and public comments	4	3	All	TVA should provide TDEC with a better understanding of the submittal of progress reports/status updates and include these submittals in the schedule provided in Appendix A.
2.2	Proposed Schedule	All	All	All	Monthly schedule updates will be provided to TDEC depicting progress for all EIP activities. TVA should include explanations for lagging or incomplete EIP tasks.
2.2	Proposed Schedule	All	All	All	Proposed schedule is considered draft at this time, not final.
2.3	Quality Assurance Project Plan	5	1	1	Suggest using common abbreviations for clarity, Appendix C uses JOF QAPP instead of JOF Quality Plan.

Section Number	Section Title	Page	Paragraph	Line	Comment
2.3	Quality Assurance Project Plan	6	2	4	Please include as an appendix to the EIP the referenced "Data Management Plan".
3.1	3.1.1	8	1	1	TVA states that it has existing ground water monitoring wells located at the TVA Johnsonville site. TVA shall include the location, description and construction methods for each well in the revised Johnsonville EIP submitted to TDEC in response to TDEC's comments. TVA shall also include the sampling results from each groundwater monitoring well including sampling date, sample results and identifying whether the levels of CCR constituents reported exceed either the MCL levels for CCR constituents or background levels for CCR constituents. Well location shall be identified on a TVA Johnsonville facility map, Results shall be reported in a table by monitoring well, CCR constituent and sampling date. Results shall be reported in µg/L. The wells reported shall include wells TVA installed at Johnsonville as required by the EPA CCR regulations.
3.1.1	TDEC General Request No. 1	8	2	6	Based on previous historical documents, the general assumption is that although the groundwater gradient is probably very small on the island there is a high probability that a groundwater mound exists beneath the ash pond and that groundwater flows radially out to Kentucky Lake. Therefore, wells on the perimeter of the ash pond will not represent background conditions. This is bolstered by the fact that three of the perimeter wells have had one or more exceedances for at least one CCR pollutant in the previous 7 years.
3.1.1	TDEC General Request No. 1	8	2	6	A monitoring well or piezometer should be installed near the former location of JS-16 (Report WR28-2-30-101) in order to determine the groundwater flow rate and groundwater flow direction, the current distribution of wells does not allow for that determination.

TVA Johnsonville EIP Rev 0
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
3.1.1	TDEC General Request No. 1	8	2	6	This section calls JOF-115 an alternate potential background well, whereas Appendix E does not indicate that it is an alternate. This well should be installed as indicates on Exhibit 2 and Appendix E and not be an alternate.
3.1.1	TDEC General Request #1	9	2		Figure 2 Displays a pipe and riser running through the bottom of dikes out to Kentucky Lake. What purpose does the pipe serve? The figure mentioned a inspection with a CCTV Camera. Could TVA share the inspection findings?
3.1.2	TDEC General Request No. 2	12	All	All	TVA's assertion that Ash Disposal Area 1 (Ponds A, B, and C) that were reclaimed, retired, and located on Chemours property are "*beyond the scope of the TDEC Order* " is incorrect. These areas must be included in the EIP process and investigated. This includes all aspects of the EIP process.

Section Number	Section Title	Page	Paragraph	Line	Comment
3.1	3.1.2	12	2	1	TVA maintains that it is not responsible for CCR material that it discharged in historic Surface Impoundments A, B and C. TVA originally owned property where ponds A, B and C are located but sold it to DuPont in 1956, retaining the right to discharge CCR waste water into the ponds for an additional 15 years. TVA maintains that it did not discharge CCR containing wastewater into these ponds after 1970. TVA maintains that the Commissioner's Order does not include investigation of CCR disposal sites outside its current property boundaries, even if TVA performed the disposal activities. TDEC does not agree with TVA's position. TVA did own property at the TVA Johnsonville Plant that was used for disposal of CCR materials and then sold a portion of the property. Change in ownership of the property will require TVA to obtain permission to investigate and remediate areas of CCR disposal on property it previously owned. The Commissioner's Order requires TVA to investigate and remediate all locations where TVA disposed of CCR material. As stated in the Commissioner's Order on page 4: Scope of the Order VI. This Order shall apply to all "CCR disposal areas" at the coal-power plant sites listed below that TVA operates or has operated in Tennessee (hereinafter sites or plants). "CCR disposal areas" include all areas where CCR disposal has occurred, including without limitation, all permitted landfills, all "non-registered" landfills (landfills that existed before they were subject to regulation), and all current and former surface water impoundments that contain CCR. • Allen Fossil Plant • Cumberland Fossil Plant • Johnsonville Fossil Plant • Kingston Fossil Plant • Bull Run Fossil Plant • John Sevier Fossil Plant • Watts Bar Plant

Section Number	Section Title	Page	Paragraph	Line	Comment
3.1	3.1.3	13	2	5	TVA again states it does not intend to include in its TVA JOF EIP the investigation of CCR material disposed of by TVA on property it previously owned but since sold. The Commissioner's Order requires TVA to take this action. While TVA no longer owns property adjacent to the TVA JOF, the CCR disposal activity occurred when TVA owned the property. TDEC will assist TVA in obtaining access to the adjacent property if necessary. TVA shall describe the strategy it will use to gain access to the adjacent TVA JOF property owned by DuPont and now subsequent owner
3.1	3.1.3	13	3	1	TVA plans to construct a 3 Dimensional Model of the CCR disposal areas; Coal Yard, Active Ash Pond 2, South Rail Loop Area 4, DuPont Road, Dredge Cell, and Ash Disposal Area 1 using existing data. TVA states that installing new soil borings where a protective cover of clay and/or synthetic material will compromise the integrity of the cap. Given that these locations have been closed and the historic record was not developed with the intent of determining the amount and location of disposed CCR material, new information is needed to develop a 3 Dimensional model of the disposal areas. There are methods available to install soil borings through final caps that allow installation of borings and subsequent repair of the final cover. Further, the borings may be converted into piezometers that can be used to determine whether there is CCR material in groundwater.
3.1.5	TDEC General Request #5	15	1	all	TVA should characterize the geology and hydrology beneath and at a minimum 150 meters beyond the limits of CCR fill in the Coal Yard. TVA should conduct the investigation in anticipation of designing and installing an adequate groundwater monitoring system for the CCR structural fill area.
3.2.1	TDEC Groundwater Request #1	16	2	3	Provide TDEC with an updated ground water potentiometric surface map, identify the current ground water surface elevation below the landfills and surface impoundment and indicate an estimate of the amount of CCR material that is below the current ground water potentiometric surface.

Section Number	Section Title	Page	Paragraph	Line	Comment
3.2.2	TDEC General Request #2	16			How does TVA propose to adequately monitor groundwater at Ash Disposal Area 1 with no separation between property owners to the North? Please explain how one can infer that groundwater primarily flows east to west when the adjacent river flows North?
3.2.2	TDEC General Request #2	16			Can TVA adequately monitor groundwater at Ash Disposal Area 1 with no downgradient monitoring wells to the direct north between the two property owners?
3.2.2	TDEC General Request #2	16			How will TVA demonstrate groundwater quality in this area without a representative downgradient monitoring points between the two property owners?
3.2.2	TDEC General Request #2	16			Will any of the proposed monitoring wells at Ash Disposal Area 1 & 2 be installed over CCR waste or through the ash pond bottoms?
3.2.2	TDEC Groundwater Request #2	16	2	4	Since groundwater flow is currently unknown, based on the initial round of water level data the wells may not be indicative of upgradient or downgradient conditions and therefore additional wells may be required. TVA shall ensure that the ground water monitoring locations (existing and proposed) in the EIP will accurately determine groundwater flow and direction.
3.2.3	TDEC Groundwater Request No. 3	17	All	All	TDEC request's interim presentations of groundwater data generated during EIP activities on a per event basis.
3.2.3	TDEC Groundwater Request #3	17	2	1	The groundwater protection standard or MCL for arsenic was exceeded multiple times prior to 2002 at the JOF. Arsenic levels do not appear to have exceeded the MCL since then; please provide an explanation for the decrease of arsenic in ground water.

Section Number	Section Title	Page	Paragraph	Line	Comment
3.2.3	TDEC Groundwater Request #3	17	2	1	The groundwater protection standard or MCL for cadmium was exceeded multiple times prior to 2001 and then again in 2013-2016 at the JOF; please provide an explanation for the gap and reoccurrence of cadmium ground water.
3.2.3	TDEC Groundwater Request #3	17	2	1	The groundwater protection standard or MCL for nickel was exceeded multiple times prior to 1997 and then again in 2011-2016 at the JOF; please provide an explanation for the gap and reoccurrence of nickel ground water.
3.2.	3.2.3	17	3	1	TVA shall summit all CCR data collected over the last year to fulfill the EPA CCR regulations for ground water monitoring. This information shall include a map with location of the groundwater monitoring wells, all sample results by well, date, CCR constituent and amount of CCR constituent. Should CCR constituents from sampling these wells exceed EPA CCR Rule Appendix 3 or 4 levels, TVA shall include in its ground water monitoring well installation plan, additional wells to determine the extent CCR constituent migration at the TVA JOF site.
3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends installing additional monitoring points south of JOF-114 to characterize groundwater flow and quality along the western boundary of the Coal Yard. An additional upgradient monitoring well should also be installed along the southeastern boundary.
3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends observation well JOF-105 be added as a groundwater quality monitoring well to characterize groundwater flow and quality southwest of the DuPont Dredge Cell. If this is not feasible, a new well should be installed along the southwestern boundary of the DuPont Dredge Cell for this purpose.
3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends an additional monitoring well be installed along the northeastern boundary of the South Rail Loop Area 4 to adequately characterize groundwater quality and flow.

Section Number	Section Title	Page	Paragraph	Line	Comment
3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends observation well JOF-102 be added as a groundwater quality monitoring well to characterize groundwater flow and quality south of the South Rail Loop Area 4. If this is not feasible, a new well should be installed along the southern boundary of the South Rail Loop Area 4 for this purpose.
3.3	3.3.5	24	1	1	This section discusses how to determine the horizontal hydraulic conductivity of the perimeter dike for Ash Pond 2. TVA proposes to perform slug testing in existing piezometers and groundwater monitoring wells to determine dike horizontal permeability. This is specifically mentioned as an appropriate test method because of the potential variability of the materials used to construct the dike. Would measuring piezometer and groundwater monitoring well recharge rates provide better information, assuming the piezometers and monitoring wells can be pumped dry? Another thought, if slug testing is the best method of testing horizontal permeability, would it be appropriate to use dye and monitor for its occurrence at a corresponding point on the river side of the dike, providing data that could help determine hydraulic conductivity towards the river?
3.3.5	TDEC Active Ash Pond 2 Request No. 5	25	3	All	TVA states in this paragraph that active Ash Pond 2 will be closed and capped as a result of a 2011 agreement with the EPA. One of the purposes of the EIP process is the fully investigate the site and develop a CARA plan that will include the methods TVA will employ to remove and/or close in place CCR material at the site. TDEC recommends any closure activities at the site be completed after the EIP process is complete and an appropriate remedy has been selected for the site.
3.4.2	Background Soil SAP	27	1	1	Statistics play a major role in determining background concentrations and based on chosen method will effect the sample design and data analysis. Please specify how the background soil will be evaluated and what statistical method will be employed to determine what background levels are for the CCR parameters.

Section Number	Section Title	Page	Paragraph	Line	Comment
3.4	3.4.2	27	2	1	Background Soil SAP. TVA presents their idea for identifying points to sample for background concentrations of CCR materials in soil at the TVA JOF site in Appendix L. TDEC shall review Appendix L. once it is in final form, consider TVA's recommendation and select the locations for soil background sample collection.
3.4.2	Background Soil SAP	27	3	2	It does not appear based on Exhibit 6 or the discussion in the text that the 12 proposed locations are related to any potential background groundwater monitoring wells (existing or planned). Is this accurate? And if so TVA should consider including additional borings to be correlated to potential background monitoring wells.
3.4.2	Background Soil SAP	27	3	4	It was stated that the proposed sampling locations were evaluated for past placement of CCR material and were selected based on access and current hydrogeologic knowledge. Are these sample locations at a similar elevation to JOF ground surfaces near the ash ponds? Are they located on the same geologic units present at beneath the ash ponds? Are these proposed sample locations in similar depositional environments as the ash ponds?
3.4.2	Background Soil SAP	27	5	7	Will a background concentration be determined for each soil type? Please explain how many samples from each soil type will be considered a valid test population for statistical evaluation.
3.4.2	Background Soil SAP	27	5	7	If the soil is fine sand and silt the sample should be biased to sampling the interface between sand lenses and silt since these lenses are of the conduits for contaminant movement. In clays the inorganics will tend to adsorb and samples should be collected from soil fractures or areas that show oxidation.

Section Number	Section Title	Page	Paragraph	Line	Comment
3.4	3.4.2	28	2	1	Hydrogeological and Groundwater Investigation SAPs - TVA proposes to install two down gradient monitoring wells on the western edge of the northern half of the Coal Yard. TVA states the well locations are down gradient of the Coal Yard. These locations maybe appropriate, however, at other TVA fossil plants the coal yards are sprayed regularly to reduce release of particulate matter to the air. TVA shall report to TDEC if it routinely sprays the coal yard for dust suppression. If so, does the continual spraying artificially increase the ground water level, causing a mounding effect that is large enough to modify normal ground water flow and direction?
5.0	References	33	NA	NA	ASTM D5084 was referenced in text but not noted here.
5.0	References	33	NA	NA	"Stantec Consulting Services Inc. (Stantec). 2011b." should this be 2011 or is there a missing 2011a?
5.0	References	33	NA	NA	Stantec 2012 referenced in text but not noted here.
5.0	References	33	NA	NA	Stantec Consulting Services Inc. (Stantec). 2016b. Not reference in preceding sections
Appendix A	Schedule				Please update

Section Number	Section Title	Page	Paragraph	Line	Comment
QAPP	16	39	3	1	The TVA Quality Assurance Project Plan provides great detail in the methods to be used to ensure that data, particularly analytical data will produced and reviewed. TDEC appreciates the importance of this effort because analytical data will be used to make investigation and corrective action decisions. Poor quality data leads to poor environmental decisions. TVA shall present all data to TDEC in an Excel spreadsheet format. Sample collection point, analytical method, sample data and analysis date will be included for each report. For soil permeability and ground water flow rates, data sall be reported in cm/sec, soil and tissue analytical data shall be reported in µg/kg, water and groundwater data shall be reported in µg/L. For analytical samples, the initial laboratory result and the final analytical result shall be presented for each sample. Any data qualifiers shall be noted for each data point. For each analytical parameter, TVA shall specify if the analytical method used reached the analytical method quantitation limit for each analyte in each sampling media. If the analytical method used for a sample or set of samples was not able to reach the method quantitation limit, then TVA shall denote this in the sample report and the reason the method quantitation limit was not achieved.
Appendix C, Section 9.1.2	QAPP	23	4	9	Some of the requirements in the QAPP are written as should. The QAPP must be written as what will be done. If multiple coolers are needed, one COC Record ~~should~~ will accompany each cooler that contains the samples identified on the COC.
Appendix C, Section10.0	QAPP	26	1	4	Detectability was not mentioned in the quality objectives and criteria for analytical data
Appendix C, Section 11.1	QAPP	29	4	6	At least 10% of the screening data ~~should~~ will be confirmed using appropriate analytical methods and QA/QC procedures and criteria associated with definitive data.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix C, Section 11.1	QAPP	30	2	2	Based on the procedure outlined in ENV-TI-05.80.46 (Section 3.3.3, bullet [4]) it appears that the pH instrument will be calibrated to the 25 C^0 certified buffer strength, rather than the temperature-adjusted buffer strength. Is this accurate?
Appendix C, Section 13.1	QAPP	36	2	2	Based on the QAPP and ENV-TI-05.80.46 the DO calibration is an air saturated water calibration which is time consuming and could introduce error if not done properly. Is this the method the field teams are actually using? Most field applications of DO that are not long-term, continuous monitoring applications utilize the water saturated air calibration method. Please clarify which calibration method the sampling teams will be utilizing.
Appendix C, Section 13.1	QAPP	37	1	2	Field pH meters used for collecting data will have to meet the calibration requirements of Method 9040C , which is 0.05 pH units of the bracketing buffer solution values. The QAPP references SESDPROC-100-R3, January 2013 and the TVA TI ENV-TI-05.80.46 which only require calibration to 0.1 SU.
Appendix C, Section 13.1	QAPP	37	2	4	Maintenance ~~should~~ will be performed when the instrument will not adequately calibrate. Maintenance of field equipment ~~should~~ will be noted in an instrument logbook or field notebook.
Appendix C, Section 17.0	QAPP	47	3	2	This audit report ~~should~~ will include a list of observed field activities, a list of reviewed documents, and any observed deficiencies.
Appendix C, Section 19.5	QAPP	54	1	4	By providing specific protocols for obtaining and analyzing samples, data sets ~~should~~ will be comparable regardless of who collects the sample or who performs the sample analysis.
QAPP	Appendix E, H & I				All soil, solid material and tissue sampling results, except samples for $Radium^{226}$ and $Radium^{228}$, shall be reported in Parts per Billion, µg/kg.

Section Number	Section Title	Page	Paragraph	Line	Comment
QAPP	Appendix F & G				All water and groundwater soil sampling results, except samples for $Radium^{226}$ and $Radium^{228}$, shall be reported in Parts per Billion, µg/L.
Appendix C, QAPP Appendix A	QAPP Appendix A.1	A-3	1	3	In the event that certain required information is not included on a particular form, the laboratory ~~should~~ will provide additional documentation (e.g., preparation logs or analytical run logs) to ensure that the minimum required level of documentation is supplied.
Appendix C, QAPP Appendix A	QAPP Appendix A.2	A-14	1	3	In the event that certain required information is not included on a particular form, the laboratory ~~should~~ will provide additional documentation (e.g., preparation logs or analytical run logs) to ensure that the minimum required level of documentation is supplied.
Appendix C, QAPP Appendix D	QAPP Appendix D	D-2	Table A		Sample matrix codes do not have nomenclature for laboratory supplied deionized water.
Appendix E, Section 1.0	Hydrogeological Investigation SAP	1	2	3	The hydrogeological SAP purpose is to characterize the groundwater flow direction, install monitoring wells to provide locations to evaluate horizontal and vertical extent of CCR constituents and measure horizontal and vertical groundwater flow gradients within the alluvial aquifer.
Appendix E, Section 2.0	Hydrogeological Investigation SAP	2	1	3	The objectives are to characterize the groundwater flow direction, to install monitoring wells to provide locations to evaluate horizontal and vertical extent of CCR constituents and measure horizontal and vertical groundwater flow gradients within the alluvial aquifer.
Appendix E, Section 4.0	Monitoring Well Locations	4	3	12	TVA proposes JOF-112 as a potential background monitoring well. This well may not be suitable as groundwater quality may be influenced by the DuPont Dredge Cell located to the east. TDEC recommends installing potential background monitoring wells up gradient of existing coal ash disposal areas.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix E, Section 4.0	Monitoring Well Locations	4	3	10	TVA proposes JOF-115 as a potential background monitoring well. This well may not be suitable as groundwater quality may be influenced by the South Rail Loop Area 4 located to the northeast. TDEC recommends installing potential background monitoring wells up gradient of existing coal ash disposal areas. JOF-101 should be considered for a possible background location.
Appendix E, Section 5.1	Hydrogeological Investigation SAP	6	3	1	There are no observation wells proposed.
Appendix E, Section 5.1	Hydrogeological Investigation SAP	7	2	1	Potable water should be used for drilling, installation, and development of all environmental monitoring wells and piezometers. Non potable water may be used for core holes, geotechnical borings, or other boreholes in which monitoring wells are not installed.
Appendix E, Section 5.2	Hydrogeological Investigation SAP	7	2	2	The elevation of the established and documented point on the top of each well casing will be correlated to Mean Sea Level
Appendix E, Section 5.2.6	Hydrogeological Investigation SAP	10	2	1	Distribution of cuttings and discharge of water ~~should~~ will be performed in a manner as to not create a safety hazard.
Appendix E, Section 5.2.7.1	Hydrogeological Investigation SAP	11	2	12	The annular grout shall consist of a mixture of Portland cement and 4%-6% powdered bentonite. A grout density of 13.5 to 14.1 lbs./gal shall be used.
Appendix E, Section 5.2.7.2	Hydrogeological Investigation SAP	12	1	1	Monitoring well development should not begin until a minimum of 24 hours following completion of the well.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix E, Section 5.2.7.2	Hydrogeological Investigation SAP	12	1	12	Why is the target turbidity for development 10 NTU when the groundwater stabilization criteria listed for turbidity in ENV-TI-05.80.42 is less than 5 NTUs?
Appendix E, Section 6.0	Hydrogeological Investigation SAP	14	1	3	There are no observation wells proposed.
Appendix E, Section 9.0	Hydrogeological Investigation SAP	18	1	14	"Stantec Consulting Services Inc. (Stantec). 2017." not cited in body of SAP
Appendix E, Attachment A	Hydrogeological Investigation SAP		Figure 3		Well pump placement should be at the midpoint of the screen, if the screen is fully submerged, otherwise the pump should be placed at the midpoint of the saturated interval. It is unclear by this figure that the pump is placed correctly.
Appendix E, Attachment A	Hydrogeological Investigation SAP		Figure 3		Water encountered during drilling should be shown on stratigraphy log adjacent to monitoring well construction log.
Appendix F, Section 4.0	Sampling Locations	5	1	All	Why wouldn't TVA sample all available groundwater monitoring wells as part of the EIP?
Appendix F, Section 4.2	Sampling Frequency	6	1	All	TDEC recommends increased sampling frequency to capture a statistically significant data set
Appendix F	Groundwater Investigation SAP				Statistical methods to be used for evaluating groundwater monitoring data are not developed in this EIP. TVA must include a discussion of the statistical procedure to be used in the EIP.
Appendix F, Section 2.0	Groundwater Investigation SAP, Objectives	2	1	3	Objectives need to include a comprehensive evaluation of groundwater flow direction(s), velocities and gradients; and an evaluation of groundwater quality (geochemical and CCR parameters).

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix F, Section 2.0	Groundwater Investigation SAP, Objectives	2	1	6	The Groundwater Investigation SAP indicates determining direction and gradient only, however TDEC requires the groundwater flow direction(s), velocities and gradients each time groundwater is sampled.
Appendix F, Section 4.0	Groundwater Investigation SAP, Sampling Locations	4	1	3	TVA states that monitoring wells that are being sampled as part of other programs will not be sampled as part of this SAP. TDEC recommends all applicable groundwater monitoring wells be sampled as part of the EIP and the data provided to TDEC for review. Or monitoring wells should be installed to fill gaps in characterization.
Appendix F, Section 4.1	Groundwater Investigation SAP, Sampling Scope	4	2	1	Have monitoring wells B-11 and B-12 been replaced as requested by TDEC in correspondence dated July 22, 2016? It was noted that these two wells had become less reliable due to potential impact from surface water and must be replaced with new monitoring wells. TVA must replace B-11 and B-12 and sample both the existing B-11 and B-12 and their replacements.
Appendix F, Section 4.1	Groundwater Investigation SAP, Sampling Scope	4	6	3	"*submitted for laboratory analysis of parameters listed in Section* ~~*5.6.2*~~ 5.2.6."
Appendix F, Section 4.2	Groundwater Investigation SAP, Sampling Frequency	6	1	1	When installing new groundwater monitoring networks, groundwater quality data from at least eight events is needed, in most cases, to fully assess and compare up gradient versus downgradient groundwater quality. Four quarterly events are not adequate to determine statistical significance or determine groundwater fluctuation (reversals) caused by the rise in pool elevation of Kentucky Lake.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix F, Section 5.2.1	Groundwater Investigation SAP, Groundwater Level Measurements	8	2	3	There is a discussion of the fluctuations in groundwater elevation at the TVA JOF site. TVA shall explain whether the changes are connected to Kentucky Lake levels, seasonal variations or other factors. Discuss if these ground water elevation variations impact ground water below the surface impoundment and the landfills.
Appendix F, Section 5.2.2	Groundwater Investigation SAP, Well Purging	8	2	1	Will barometric pressure readings be recorded? What will be the frequency and source of the barometric pressure readings? Will ambient air temperature be measured? Will a correlation between a NIST thermometer and the temperature on the multi parameter probe be made and recorded?
Appendix F, Section 5.2.2	Groundwater Investigation SAP, Well Purging	8	2	2	Indicate if specific conductance is measured in mS/cm or µS/cm.
Appendix F, Section 5.2.2	Groundwater Investigation SAP, Well Purging	8	2	4	According to TVA's TI document ENV-TI-05.80.42 the turbidity is required to be below 5 NTUs. If the final turbidity after sample collection is greater than 5NTU is there any additional requirements sampling?
Appendix F, Section 5.2.5.1	Groundwater Investigation SAP, Groundwater Sampling	11	2	3	This should be 5NTU according to ENV-TI-05.80.42
Appendix F, Table 5	Groundwater Investigation SAP	15	Table 5		Field pH meters used for collecting data will have to meet the calibration requirements of Method C , which is 0.05 pH units of the bracketing buffer solution values. There is not a hold time associated with the field measurement of pH by Method 9040C.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix F, Section 5.2.8	Groundwater Investigation SAP	16	4	1	Distribution of cuttings and discharge of water ~~should~~ will be performed in a manner as to not create a safety hazard.
Appendix F, Section 6.2	Groundwater Investigation SAP	17	1	1	If the tubing used to collect the filter blank is not certified clean tubing then a tubing blank would be required at the same rate of collection as a filter blank and for the same analytes.
Appendix F, Section 6.2	Groundwater Investigation SAP	17	3	1	If an analyte is not amenable to the MS/MSD procedure it should be collected as a lab duplicate (e.g., TSS and radium) as indicated in QAPP.
Appendix H, Section 5.2.7	Material Quantity SAP	13	4	1	Distribution of cuttings and discharge of water ~~should~~ will also be performed in a manner as not to create a safety hazard.
Appendix J	All	All	All	All	Does existing boring data from within all ash disposal areas provide enough information to characterize the geology underlying each cell (permeability, material type/description, ect.) to demonstrate that the ash is contained and separated from groundwater?
Appendix J, Section 4.0	Hydraulic Conductivity Testing SAP	4	3	4	If the 2016 Shelby tube samples are not suitable for laboratory hydraulic conductivity testing then it will be necessary to use exploratory borings to collect replacement undisturbed samples from the dike fill, hydraulic fill, CCR, and alluvium.
Appendix J, Section 5.1	Hydraulic Conductivity Testing SAP	5	all		This section does not seem to reflect the objectives for the SAP. Potable water is not appropriate for slug testing.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix J, Section 5.2	Hydraulic Conductivity Testing SAP	6	1	1	Slug tests need to be performed in all active piezometers and monitoring wells on the perimeter of Active Ash Pond #2 as indicated in Section 3.3.5. This also includes all proposed monitoring wells (JOF-106 through JOF-115) as indicated in Section 5.2.7.3 of the Hydrogeological Investigation SAP.
Appendix J, Section 5.2	Hydraulic Conductivity Testing SAP	6	1	2	Slug tests need to be performed in dike fill, hydraulic fill, CCR, and alluvium as indicated in Section 3.3.5
Appendix J, Section 5.2.3	Hydraulic Conductivity Testing SAP	7	1	5	piezometers and monitoring wells.
Appendix J, Section 5.2.3	Hydraulic Conductivity Testing SAP	7	2	3	piezometers or monitoring well.
Appendix J, Section 5.2.4 and 5.2.5	Hydraulic Conductivity Testing SAP	7&8	all		These samples were already collected in 2016 by Geocomp? Have they been stored as indicated (i.e., IAW D4220-95)? What is the appropriate "hold time" for the samples? Are these sections here to guide collection of replacement shelby tube samples if the 2016 shelby tube samples are not suitable for laboratory hydraulic conductivity testing.
Appendix J, Section 5.2.6	Hydraulic Conductivity Testing SAP	8	1	1	This refers to the undisturbed samples that were previously collected in 2016 by Geocomp? The testing will need to characterize the in-situ hydraulic conductivity of dike fill, hydraulic fill, CCR, and alluvium.
Appendix J, Section 5.2.6	Hydraulic Conductivity Testing SAP	8	2	4	If the 2016 Shelby tube samples are not suitable for laboratory hydraulic conductivity testing then it will be necessary to use exploratory borings to collect replacement undisturbed samples from the dike fill, hydraulic fill, CCR, and alluvium.
Appendix J, Section 6.0	Hydraulic Conductivity Testing SAP	9	1	2	QA/QC requirements are specific to slug testing and the collection and analysis of the undisturbed soil samples.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix J, Section 8.0	Hydraulic Conductivity Testing SAP	12	1	6	If the 2016 Shelby tube samples are not suitable for laboratory hydraulic conductivity testing then it will be necessary to use exploratory borings to collect replacement undisturbed samples from the dike fill, hydraulic fill, CCR, and alluvium.
Appendix J, Section 9.0	Hydraulic Conductivity Testing SAP	13	1	1	Need ASTM D4220-95 and D5084 references
Appendix L, Section 2.0	Background Soil SAP	2	2	10	Soil samples will also analyzed for percent ash.
Appendix L, Section 3.0	Background Soil SAP	3	1	4	Field teams should consist of (at a minimum) an experienced TN licensed professional geologist.
Appendix L, Section 5.2.1.1	Background Soil SAP	7	3	11	Will the mid-point for sampling aliquot be the vertical depth midpoint or the mid-point based on recovery? What is the contingency if recovery is poor?
Appendix L, Section 5.2.1.1	Background Soil SAP	7	3	16	Grab samples only. The collection of composite soil samples is not acceptable to determine that CCR constituents are not present because the evidence of a release may be diluted.
Appendix L, Section 5.2.1.1	Background Soil SAP	8	1	1	Borehole should be filled with cement-bentonite grout mixture using a tremie pipe to within approximately six inches of the surface. The top six inches should be restored to match the existing surface.
Appendix L, Section 5.2.1.2	Background Soil SAP	8	1	3	Soil color will be determined using a Munsell soil color chart.
Appendix L, Section 5.2.1.2	Background Soil SAP	8	1	3	Soil will be logged following the visual-manual procedures of the American Society of Testing and Materials (ASTM) Standard D2488-09a

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix L, Section 5.2.1.2	Background Soil SAP	8	1	5	Soil should be logged to include soil consistency or density, size, shape and angularity of particles, plasticity (for fine-grained soil)
Appendix L, Section 5.2.5	Background Soil SAP	12	Table 4		A pH field test kit should be employed to help identify if soil pH is in a range to mobilize CCR contaminants (specifically target sample aliquots and horizon changes). For example several metals are easily leached from acidic soil, however selenium is mobilized under alkaline conditions. Also, due the short hold time, which will create a situation where the analytical result will not be within the 15 min holding time, please consider a field method measurement of pH for comparison.
Appendix L, Section 5.2.7	Background Soil SAP	13	4	1	Some of the requirements in the Background Soil Sampling SAP are written as should. The SAP must be written as what will be done. This indicates the requirements on what will be acceptable. If the procedure cannot be followed, identify in the QAPP or QA/QC section of SAP how things will be documented that don't follow the QAPP /SAP requirements. Distribution of cuttings and discharge of water ~~should~~ will also be performed in a manner as not to create a safety hazard.
Appendix M	Surface Stream SAP	All	All	All	TDEC recommends collecting water column samples (top, middle, and bottom) at each sampling location. Effort should be made to co-locate water column samples with sediment samples collected as part of the EIP as well as the already identified sampling locations. TDEC recommends adjusting water column sample locations to include transects at each location that are perpendicular to flow and include right descending bank, center of channel, and left descending bank in order to characterize the stream/river profile.
Appendix M	Surface Stream SAP	All	All	All	TDEC reccomends gathering data on some water quality conditions that would influence the toxicity of some metals, i.e., water hardness for metals with hardness dependent standards.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix M	Surface Stream SAP	All	All	All	TDEC reccomends trace-clean (e.g., 'clean hands/dirty hands) methods be used for sample collection
Appendix M	Surface Stream SAP	All	All	All	Please explain why being within a meter of the bottom is sufficient to represent "epibenthic" conditions.
Appendix M	Surface Stream SAP	All	All	All	TDEC reccomends conducting sampling away from and upstream of the boat and motor.
Appendix M	Surface Stream SAP	All	All	All	Please confirm that detection limits < TDEC water quality standards for constituents.
Appendix M	Surface Stream SAP	All	All	All	Please confirm that sampling teams will change tubes on peristaltic pumps between sample sites.
Appendix M	Surface Stream SAP	All	All	All	TDEC reccomends a metals grade nitric acid cleaning of sampling equipment between sample collection sites.
Appendix N	Benthic SAP	All	All	All	A ponar grab sample is not a quantitative sample.
Appendix N	Benthic SAP	All	All	All	What metrics will TVA use for community composition? Will stats be run, if so, what ones?
Appendix N	Benthic SAP	All	All	All	Will all mayfly samples be mayflies of the same species? Can TVA get sufficient numbers, especially off of vegetation (50 to 75 cited), to get tissue mass sufficient for meaningful detection limits?
Appendix O	Fish Tissue SAP	All	All	All	This assessment is for ecological, not human health assessments, so why are filet data being used for all non-gizzard shad fish? Did TVA consider whole-body data?
Appendix O	Fish Tissue SAP	All	All	All	Will TVA present the data as lipid-normalized values, as wet weight or dry weight?
Appendix O	Fish Tissue SAP	All	All	All	Please clarify how TVA will assess possible correlations with potential fish health.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix O	Fish Tissue SAP	All	All	All	For a given species, will “adults” all be in a specific size range, or at least have the smallest be within 75% of the length of the largest?
Appendix O	Fish Tissue SAP	All	All	All	Checking gill nets after sitting all night could result in some decomposed fish. Not using such fish needs addressed.
Appendix O	Fish Tissue SAP	All	All	All	No indication of detection limits is provided.
Appendix O	Fish Tissue SAP	All	All	All	Will TVA account for differences in male/female ratios in the various samples?
Appendix O	Fish Tissue SAP				Several species of fish are targeted. The plan should focus on fish that are popular with local fishers.
Appendix O	Fish Tissue SAP				How will sample integrity be maintained?
Appendix O	Fish Tissue SAP				It does not appear that DQOs have been identified in either the SAP or QAPP for the fish tissue sample collection activities. The text should explain relevant DQOs assuming that they would be primarily related to sample handling issues. One exception involves the measurement of sample location surface water pH. DQOs for pH will require that meters are calibrated to a known standard in accordance with manufacturer’s specifications.
Appendix O, Section 3.0	Fish Tissue SAP	3	1	5	Field teams should consist of (at a minimum) one experienced fisheries biologist, one field technician, and a quality control specialist, all of whom must have experience with the array of fisheries sampling equipment to be used.

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix O, Section 5.2.1.2	Fish Tissue SAP	8	3	1	The text should explain how why only muscle and ovary sampling was chosen and does not appear to include the following four types of fish tissue: liver, muscle, ovary and testes.
Appendix O, Section 5.2.1.2	Fish Tissue SAP	8	2	all	The sampled fish should be of similar size so that the smallest individual in a composite is no less than 75% of the total length of the largest individual
Appendix O, Section 5.2.4.1	Fish Tissue SAP	10	2	5	Since the fish tissue samples are required to be maintained at -10 degrees C, wet ice in resealable bags may not meet that requirement. It is suggested to pack the samples on dry ice, and that the samples arrive at the sample preparation laboratory within less than 24 hours from the time of sample collection. TVA shall document that the fish tissue samples were maintained at -10^{o} C from collection to arrival at the laboratory. Should sample delivery require more than 24 hours, TVA shall document the reason for late delivery and any adverse ipacts to the tissue samples.
Appendix O	Fish Tissue SAP	15	Table 5		Please confirm the appropriate method for Mercury analysis (i.e., Method 1631, Revision B with Appendix A or Method 7473)

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1	All	All	All	All	All	General comment - TVA should include an applicability assessment of the TDEC General Guideline for Environmental Investigation Plans, TVA Fossil Plants when preparing the EIP. TDEC understands that not all aspects of the guidelines will be applicable at all TVA facilities, but each line item should be reviewed and assessed for applicability within the EIP. If an item is deemed not applicable to this facility, TVA should provide a written justification for exclusion within the EIP. Applicable items from the guidelines should be incorporated into the next revision of the EIP.	Comment is acknowledged, and the corresponding change has been made in the document.
2	All	All	All	All	All	TDEC recommends conducting a leachability characterization study that includes an evaluation of CCR parameters from pore water and solid material samples from locations that would characterize the vertical and lateral distribution of leachability characteristics across the facility.	Comment acknowledged - This revision of the JOF EIP will include a Material Characteristics SAP to evaluate leachability.
3	All	All	All	All	All	General comment - All monitor wells, geotechnical borings, and soil borings should be logged by a Tennessee licensed professional geologist.	TVA proposes that for environmental investigation wells and soil borings, a TN-licensed professional geologist will be present and will log the borings. For geotechnical investigation borings and piezometer installations, a TN-licensed professional geologist or professional engineer will be present and will log the borings. This approach has been used at current investigations at other TVA sites in TN.
4	All	All	All	All	All	General content comment - please give titles to sections that reflect the content of the section - "TDEC Information Request" is not an appropriate section title.	Comment is acknowledged. The next revision of the EIP will include section headers that describe the content of the section
5	All	All	All	All	All	General content comment - EIP does not include the following: Water Use Survey and SAP, Sediment Assessment and SAP, Seep SAP, Ash Characterization (leachability) Assessment and SAP.	Comment is acknowledged. TVA has included a Water Use SAP, a Benthic SAP (containing sediment sampling), a Seep SAP, and a CCR Material Characteristics SAP along with other SAPs in this revision of the EIP.
6	General Administrative	NA	NA	NA	NA	The document lacks a signature page that indicates the document has been read and that the various parties (e.g., QA consultant, Investigation Consultant field personal) understand the relevant requirements.	Comment is acknowledged, and the corresponding change has been made in the document.
7	General Administrative	NA	NA	NA	NA	The document lacks an approval page, with all stakeholders listed.	Comment is acknowledged, and the corresponding change has been made in the document.
8	General Administrative	NA	NA	NA	NA	The document lacks a revision log.	Comment is acknowledged, and the corresponding change has been made in the document.
9	General Administrative	NA	NA	NA	NA	The TDEC will be notified immediately by the TVA of any problems related to successful completion of field efforts as outlined in this EIP.	Comment is acknowledged, and the corresponding change has been made in the document.
10	General Administrative	NA	NA	NA	NA	Please provide the following TVA TI, "Monitoring Well and Piezometer Installation and Development" (ENV-TI-05.80.25).	Comment is acknowledged. The TI was submitted to TDEC on November 9th, 2017.
11	Global SAPs	NA	NA	NA	NA	The SAPs lack a list of field equipment and critical spare parts (if applicable) related to the specific tasks described in each SAP.	Comment is acknowledged, and the corresponding change has been made in the document. The SAPs have been revised to include a list of field equipment as an Attachment. The QAPP has been revised to state that spare parts will be the responsibility of the contracted equipment provider.

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12	Global SAPs	NA	NA	NA	NA	There needs to be a maintenance form created to document the routine checks and both the regular and special maintenance that will occur for each instrument. This form needs to include the nature of the maintenance the qualified person and dates.	Comment is acknowledged, and the corresponding change has been made in the document. The QAPP has been revised to state "field equipment will be maintained under service contract for rapid instrument repair or provision of backup instruments in the case of instrument failure". The contracted equipment provider will be responsible for equipment maintenance.
13	Global SAPs	NA	NA	NA	NA	Are the sample sites and transects for stream sampling known to be in representative areas of leachate location/impact, or targeting maximum impact areas? If this hasn't been determined, tracking conductivity in the field to locate well mixed or maximum concentration plumes may be useful.	Comment is acknowledged, sampling locations were based on historic seep locations and to achieve good representation of water quality around the facility. Additional information (including leachate location/impacts) will be evaluated to determine if proposed sampling locations are still appropriate.
14	Global SAPs	NA	NA	NA	NA	Data analysis and any statistics isn't really mentioned. What will be done with the data, how analyzed, etc…? If statistics will be run, was any sort of power analysis done to see if sample sizes provide sufficient statistical power given expected variability in the data?	There are multiple statistical methods available to calculate background concentrations. TVA proposes to utilize Background Threshold Values (BTVs) as the method to statistically evaluate and quantify site specific background concentrations for CCR parameters. BTVs are calculated using sampling data collected from un-impacted site-specific reference areas and represent an upper threshold of background concentration(s). The choice of BTV (Upper Confidence Limit, Upper Threshold Limit, Upper Prediction Limits) will be determined based on characteristics of the data (e.g. sample size, statistical distribution). All statistical analyses will be conducted utilizing the latest version of USEPA ProUCL software (currently version 5.1.0) and consistent with ProUCL Technical Guidance Document (USEPA 2015). ProUCL Version 5.1 Technical Guide. Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. EPA/600/R-07/041).
15	General Technical	NA	NA	NA	NA	Is there a plan to look at the data for trends when common leachate indicators are compared to the total amount of CCR metals in contaminated water samples. It is important to determine if there is a relationship because of the expected geochemical relationships between chloride, other leachate indicators, and the presence of CCR metals, otherwise only CCR metals can be used to reliably indicate leachate-groundwater interaction.	Following collection of the leachate data from the proposed work in the EI, the data will be evaluated for trends and additional assessment will be performed as necessary.
16	General Technical	NA	NA	NA	NA	Will Piper diagrams be used to compare the hydrochemical facies of EIP groundwater samples? And if so please identify what comparison(s) will be made (e.g., west ash pond versus east ash pond, groundwater discharge to McKellar Lake versus groundwater recharge from McKellar Lake, contaminated wells versus background wells, etc.)?	Piper diagrams will be used to classify groundwater samples according to their major ionic composition. Groundwater sample results from background and downgradient monitoring wells will be included in the evaluation. Additional Piper diagram comparisons of individual CCR units or geological formations may be included based on the results of the hydrogeological investigation.
17	General Technical	NA	NA	NA	NA	The TVA Johnsonville CCR Surface Impoundment is in an unusual setting. The active CCR impoundment was constructed within the confines of Kentucky Lake. The structure appears to the casual eye to be an island. Should the initial ground water monitoring wells constructed at the perimeter have CCR constituents at levels greater than background or Maximum Contaminant Limits (MCL), then TVA must provide TDEC with a groundwater monitoring plan that extends beyond the waste boundary of the surface impoundment. This will be a challenge given the location of the surface impoundment.	The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater flow and constituent levels. Based on the results of the initial phase of work, TVA will work with TDEC to develop a mutually agreeable plan.

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18	General Technical	NA	NA	NA	NA	TVA has should have completed the CCR groundwater monitoring around the perimeter of the active CCR Surface Impoundment at TVA Johnsonville. The groundwater data from this sampling effort should be available for review. TVA shall submit the groundwater monitoring data it has collected from the monitoring wells around the active Johnsonville surface impoundment to TDEC. This data shall be submitted in two tables. The first table shall present the raw data provided by the laboratory to TVA for each groundwater monitoring event by well, constituent and date of sampling. The second table shall present the groundwater data for each monitoring well by well, sampling date and constituent after TVA has completed quality assurance/quality control review of the results. For both tables, TVA shall provide the sampling results in Parts per Billion (µg/L) and shall identify each result that is above either the CCR constituent MCL or background levels for constituents without MCLs.	CCR Rule Annual Groundwater Monitoring Reports will be provided to TDEC each year in January. This information will also be provided in the requested table format in the EAR. Data generated during the environmental investigation will be managed per the Data Management Plan and can be accessed in accordance with the plan. Any MCL exceedances are being reported to TDEC within 14 days, as required. TVA has prepared this EIP and associated plans to conduct an environmental investigation of JOF per the TDEC Order. The reporting requirement for the investigation as stated in the Order is to provide summaries and conclusions in the EAR. If corrective actions or compliance monitoring are required based on the conclusions in the EAR, then those activities will follow the EAR under the CARA Plan as required by the Order. If conditions are detected during the investigation that would warrant more immediate action under the CCR Rule, the pertinent data and monitoring points would be considered for incorporation into that program.
19	General Technical	NA	NA	NA	NA	Assuming TVA has received the results of groundwater monitoring at the CCR monitoring wells required by the EPA CCR regulations and the results from the groundwater monitoring demonstrate that there are CCR constituents above either the CCR MCLs or above background levels at the waste boundary, TVA shall amend the Johnsonville EIP and include the location of additional groundwater monitoring wells to determine the horizontal and vertical extent of CCR constituents in groundwater. If TVA cannot extend the groundwater monitoring well network due to the location of the active Johnsonville Surface Impoundment, then TVA shall propose an alternative strategy to determine the extent of CCR contamination vertically and horizontally beyond the waste boundary of the surface impoundment.	New groundwater monitoring wells and surface water sampling are proposed as part of this EIP. Preliminary results from the CCR groundwater monitoring were used in preparation of the EIP. The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater flow and constituent levels. Based on the results of the initial phase of work, TVA will work with TDEC to develop a mutually agreeable plan. Results from CCR groundwater monitoring will be evaluated in accordance with the QAPP and incorporated into the EAR. CCR Rule Annual Groundwater Monitoring Reports will also be provided to TDEC each year in January. Data generated during the environmental investigation will be managed per the Data Management Plan and can be accessed in accordance with the plan. Any MCL exceedances are being reported to TDEC within 14 days, as required. TVA has prepared this EIP and associated plans to conduct an environmental investigation of JOF per the TDEC Order. The reporting requirement for the investigation as stated in the Order is to provide summaries and conclusions in the EAR. If corrective actions or compliance monitoring are required based on the conclusions in the EAR, then those activities will follow the EAR under the CARA Plan as required by the Order. If conditions are detected during the investigation that would warrant more immediate action under the CCR Rule, the pertinent data and monitoring points would be considered for incorporation into that program.

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20	General Technical	NA	NA	NA	NA	The active Johnsonville CCR surface impoundment was constructed within Kentucky Lake in the late 1940s and early 1950s. TDEC does not have the physical characteristics of the materials used to construct the impoundment nor the permeability of the dike structure upon completion. At the TVA Johnsonville site, the Tennessee River flows from the south to the north. To determine if the river is influencing the movement of groundwater within the active CCR surface impoundment, TVA shall propose a dye study to determine if the river is influencing ground water movement. TVA shall include in its amended Johnsonville EIP a groundwater dye study to determine the direction of groundwater flow below the active Johnsonville CCR surface impoundment.	TVA understands that TDEC would like to understand more information about the physical characteristics and permeability of dike materials. An alternative plan for the evaluation of groundwater movement has been proposed in this EIP, including hydraulic conductivity testing on wells where this information is lacking. Groundwater flow for Ash Disposal Area 2 will be evaluated using new and existing hydraulic conductivity data, gauging data from recently installed monitoring wells and surface water elevations from the gauging station. The results of the evaluation will be provided in the EAR.
21	General Technical	NA	NA	NA	NA	From review of TVA documents, it appears that TVA will no longer burn coal to produce electricity at Johnsonville after January 1, 2018. TVA shall include in its revised Johnsonville EIP a plan to monitor water levels within the CCR surface impoundment monthly to determine the change in water levels in the surface impoundment. Once the water levels in the active CCR surface impoundment reach asymptotic levels, TVA shall notify TDEC and shall report to TDEC the amount and location of CCR materials remaining in the active CCR surface impoundment that are below the static water levels within the surface impoundment.	As part of the closure process for Active Ash Pond 2, water levels in the surface impoundment will be monitored as decanting occurs. Similarly, piezometers will be monitored to observe changes in the phreatic levels in response to decanting and closure. This information will be provided to TDEC as part of the closure process. Per the Material Quantity SAP, piezometer data will be utilized to help develop CCR quantities above the below the phreatic surface.
22	2.1	EIP Development and Structure	4	6	1	Please provide a minimum frequency that TVA will be providing progress reports to TDEC.	Monthly progress reports and schedule updates will be provided to TDEC. The corresponding change has been made in the document.
23	2.1.5	Revising the EIP to address TDEC and public comments	4	3	All	TVA should provide TDEC with a better understanding of the submittal of progress reports/status updates and include these submittals in the schedule provided in Appendix A.	Comment is acknowledged; the corresponding change has been made in the document
24	2.2	Proposed Schedule	All	All	All	Monthly schedule updates will be provided to TDEC depicting progress for all EIP activities. TVA should include explanations for lagging or incomplete EIP tasks.	Comment is acknowledged; the corresponding change has been made in the document
25	2.2	Proposed Schedule	All	All	All	Proposed schedule is considered draft at this time, not final.	Comment is acknowledged.
26	2.3	Quality Assurance Project Plan	5	1	1	Suggest using common abbreviations for clarity, Appendix C uses JOF QAPP instead of JOF Quality Plan.	Comment is acknowledged, and the corresponding changes have been made in the document.
27	2.3	Quality Assurance Project Plan	6	2	4	Please include as an appendix to the EIP the referenced "Data Management Plan".	The Data Management Plan for the TDEC Order environmental investigations has been provided to TDEC as a stand-alone document on November 22nd, 2017. Site specific updates to the Data Management Plan, if applicable, will be included in each site specific QAPP.

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28	3.1	3.1.1	8	1	1	TVA states that it has existing ground water monitoring wells located at the TVA Johnsonville site. TVA shall include the location, description and construction methods for each well in the revised Johnsonville EIP submitted to TDEC in response to TDEC's comments. TVA shall also include the sampling results from each groundwater monitoring well including sampling date, sample results and identifying whether the levels of CCR constituents reported exceed either the MCL levels for CCR constituents or background levels for CCR constituents. Well location shall be identified on a TVA Johnsonville facility map, Results shall be reported in a table by monitoring well, CCR constituent and sampling date. Results shall be reported in µg/L. The wells reported shall include wells TVA installed at Johnsonville as required by the EPA CCR regulations.	The location, description and construction methods for existing groundwater wells and historical groundwater analytical data have been included in the revised EIP. Future sampling results and comparisons to background levels, which have not been calculated, will be included in the EAR.
29	3.1.1	TDEC General Request No. 1	8	2	6	Based on previous historical documents, the general assumption is that although the groundwater gradient is probably very small on the island there is a high probability that a groundwater mound exists beneath the ash pond and that groundwater flows radially out to Kentucky Lake. Therefore, wells on the perimeter of the ash pond will not represent background conditions. This is bolstered by the fact that three of the perimeter wells have had one or more exceedances for at least one CCR pollutant in the previous 7 years.	New locations are proposed for background monitoring water wells as part of the EIP. The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater background levels. Based on the results of the initial phase of work, additional investigations may be proposed to further identify background levels, if CCR constituents are detected in groundwater at concentrations indicating impacts from CCR units. Based on current information, a background monitoring well (JOF-107) is proposed to be installed on the southern end of Active Ash Pond 2. If results from JOF-107 indicate that this well is not suitable as a background well, alternate background monitoring well JOF-115 will be installed on TVA property southeast of the unit and south of U.S. Highway 70.
30	3.1.1	TDEC General Request No. 1	8	2	6	A monitoring well or piezometer should be installed near the former location of JS-16 (Report WR28-2-30-101) in order to determine the groundwater flow rate and groundwater flow direction, the current distribution of wells does not allow for that determination.	The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater flow rate and direction. A nested vibrating wire piezometer is planned for installation in the area near the former location of JS-16 as part of the decanting project that TVA will submit to TDEC under separate cover. Information from this piezometer will be used to enhance TVA's understanding of groundwater flow rate and direction.
31	3.1.1	TDEC General Request No. 1	8	2	6	This section calls JOF-115 an alternate potential background well, whereas Appendix E does not indicate that it is an alternate. This well should be installed as indicates on Exhibit 2 and Appendix E and not be an alternate.	JOF-115 is proposed to be installed as an alternate background well if results from proposed background well JOF-107 indicate that JOF-107 is not an appropriate location for a background well. JOF-115 will be installed, if necessary, after the initial phase of investigation activities. Appendix E has been revised to show JOF-115 as a proposed alternate background well.

Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments
32	3.1.1	TDEC General Request No. 1	9	2		Figure 2 Displays a pipe and riser running through the bottom of dikes out to Kentucky Lake. What purpose does the pipe serve? The figure mentioned a inspection with a CCTV Camera. Could TVA share the inspection findings?	Although the purpose of the figure was to discuss wave protection around the unit perimeter, the pipe shown was formerly part of the south spillway structure for Active Ash Pond 2. This spillway (along with several others) were closed (Stantec 2011) and replaced by new spillways. As part of the closure project, the pipes and riser structures were cleaned and then inspected via CCTV camera. Then the pipes and risers were grouted-in-place. The drawings for the spillway closure project were provided to TDEC as part of the Investigation Conference data transmittal. The requested CCTV videos will be provided to TDEC under separate cover, along with a supporting memo that provides context from the spillway closure project.
33	3.1.2	TDEC General Request No. 2	12	All	All	TVA's assertion that Ash Disposal Area 1 (Ponds A, B, and C) that were reclaimed, retired, and located on Chemours property are "beyond the scope of the TDEC Order " is incorrect. These areas must be included in the EIP process and investigated. This includes all aspects of the EIP process.	The TDEC Order requires the investigation of active and inactive CCR disposal areas at TVA fossil plant sites. This does not include the investigation of offsite property not owned by TVA. In particular, at this location, the unit in question has been owned by a neighboring chemical plant since the early 1950s. TVA began placing CCR in the unit during the last approximately six months of TVA's ownership and continued sending CCR to the unit until 1970. It is TVA's understanding that, during this time period, the property owner also disposed of CCR in this unit. Thus, during the past 60 years, entities other than TVA have disposed of CCR and likely non-CCR waste in the offsite unit. As a result, the TVA and non-TVA waste were and are intermingled in the unit in a way that makes it likely impossible to distinguish the TVA contributions and impacts for investigation purposes. For this reason, using the TDEC Order process, with TVA as the sole investigating entity, is inappropriate and would reach an inequitable result because it would require TVA to engage in an investigation and corrective action process to address a third-party's unit with potentially significant non-TVA contributions. This is a unique situation that is different from all other "disposal areas" being addressed under the TDEC Order. If TDEC desires remediation of this offsite unit, TDEC has other authorities available to it to cause such remediation and that would properly allow the direct involvement of the property owner and all entities responsible for solid waste disposal in the unit. Given the history of this unit, a process that allows multiple parties to be involved in the investigation and remediation process seems more appropriate and to better reflect the actual usage of the unit.

Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments
34	3.1	3.1.2	12	2	1	TVA maintains that it is not responsible for CCR material that it discharged in historic Surface Impoundments A, B and C. TVA originally owned property where ponds A, B and C are located but sold it to DuPont in 1956, retaining the right to discharge CCR waste water into the ponds for an additional 15 years. TVA maintains that it did not discharge CCR containing wastewater into these ponds after 1970. TVA maintains that the Commissioner's Order does not include investigation of CCR disposal sites outside its current property boundaries, even if TVA performed the disposal activities. TDEC does not agree with TVA's position. TVA did own property at the TVA Johnsonville Plant that was used for disposal of CCR materials and then sold a portion of the property. Change in ownership of the property will require TVA to obtain permission to investigate and remediate areas of CCR disposal on property it previously owned. The Commissioner's Order requires TVA to investigate and remediate all locations where TVA disposed of CCR material. As stated in the Commissioner's Order on page 4: Scope of the Order VI. This Order shall apply to all "CCR disposal areas" at the coal-power plant sites listed below that TVA operates or has operated in Tennessee (hereinafter sites or plants). "CCR disposal areas" include all areas where CCR disposal has occurred, including without limitation, all permitted landfills, all "non-registered" landfills (landfills that existed before they were subject to regulation), and all current and former surface water impoundments that contain CCR. • Allen Fossil Plant • Cumberland Fossil Plant • Johnsonville Fossil Plant • Kingston Fossil Plant • Bull Run Fossil Plant • John Sevier Fossil Plant • Watts Bar Plant	The TDEC Order requires the investigation of active and inactive CCR disposal areas at TVA fossil plant sites. This does not include the investigation of offsite property not owned by TVA. In particular, at this location, the unit in question has been owned by a neighboring chemical plant since the early 1950s. TVA began placing CCR in the unit during the last approximately six months of TVA's ownership and continued sending CCR to the unit until 1970. It is TVA's understanding that, during this time period, the property owner also disposed of CCR in this unit. Thus, during the past 60 years, entities other than TVA have disposed of CCR and likely non-CCR waste in the offsite unit. As a result, the TVA and non-TVA waste were and are intermingled in the unit in a way that makes it likely impossible to distinguish the TVA contributions and impacts for investigation purposes. For this reason, using the TDEC Order process, with TVA as the sole investigating entity, is inappropriate and would reach an inequitable result because it would require TVA to engage in an investigation and corrective action process to address a third-party's unit with potentially significant non-TVA contributions. This is a unique situation that is different from all other "disposal areas" being addressed under the TDEC Order. If TDEC desires remediation of this offsite unit, TDEC has other authorities available to it to cause such remediation and that would properly allow the direct involvement of the property owner and all entities responsible for solid waste disposal in the unit. Given the history of this unit, a process that allows multiple parties to be involved in the investigation and remediation process seems more appropriate and to better reflect the actual usage of the unit.

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments
35	3.1	3.1.3	13	2	5	TVA again states it does not intend to include in its TVA JOF EIP the investigation of CCR material disposed of by TVA on property it previously owned but since sold. The Commissioner's Order requires TVA to take this action. While TVA no longer owns property adjacent to the TVA JOF, the CCR disposal activity occurred when TVA owned the property. TDEC will assist TVA in obtaining access to the adjacent property if necessary. TVA shall describe the strategy it will use to gain access to the adjacent TVA JOF property owned by DuPont and now subsequent owner	The TDEC Order requires the investigation of active and inactive CCR disposal areas at TVA fossil plant sites. This does not include the investigation of offsite property not owned by TVA. In particular, at this location, the unit in question has been owned by a neighboring chemical plant since the early 1950s. TVA began placing CCR in the unit during the last approximately six months of TVA's ownership and continued sending CCR to the unit until 1970. It is TVA's understanding that, during this time period, the property owner also disposed of CCR in this unit. Thus, during the past 60 years, entities other than TVA have disposed of CCR and likely non-CCR waste in the offsite unit. As a result, the TVA and non-TVA waste were and are intermingled in the unit in a way that makes it likely impossible to distinguish the TVA contributions and impacts for investigation purposes. For this reason, using the TDEC Order process, with TVA as the sole investigating entity, is inappropriate and would reach an inequitable result because it would require TVA to engage in an investigation and corrective action process to address a third-party's unit with potentially significant non-TVA contributions. This is a unique situation that is different from all other "disposal areas" being addressed under the TDEC Order. If TDEC desires remediation of this offsite unit, TDEC has other authorities available to it to cause such remediation and that would properly allow the direct involvement of the property owner and all entities responsible for solid waste disposal in the unit. Given the history of this unit, a process that allows multiple parties to be involved in the investigation and remediation process seems more appropriate and to better reflect the actual usage of the unit.
36	3.1	3.1.3	13	3	1	TVA plans to construct a 3 Dimensional Model of the CCR disposal areas; Coal Yard, Active Ash Pond 2, South Rail Loop Area 4, DuPont Road, Dredge Cell, and Ash Disposal Area 1 using existing data. TVA states that installing new soil borings where a protective cover of clay and/or synthetic material will compromise the integrity of the cap. Given that these locations have been closed and the historic record was not developed with the intent of determining the amount and location of disposed CCR material, new information is needed to develop a 3 Dimensional model of the disposal areas. There are methods available to install soil borings through final caps that allow installation of borings and subsequent repair of the final cover. Further, the borings may be converted into piezometers that can be used to determine whether there is CCR material in groundwater.	The proposed 3-D model is not a preliminary model. It is based on a thorough evaluation of site-specific data regarding the base, sides, and surface elevations of CCR. To the extent that information is developed during the environmental investigation that affects CCR volume calculations, revisions to the 3-D model will be included in the EAR. Corrective actions based on this 3-D model or any other data found in the EAR will be found in the CARA Plan according to Part VII.A.f of the Order. The historical borings, plus the proposed exploratory borings are sufficient to address this information request without having to drill through and then repair areas with geosynthetics in the final cover. Borings are proposed in select areas with soil-only final cover, which can be repaired (i.e., backfilled) relatively simply. Results of proposed borings can be applied to adjacent areas that are covered with geosynthetics.
37	3.1.5	TDEC General Request #5	15	1	all	TVA should characterize the geology and hydrology beneath and at a minimum 150 meters beyond the limits of CCR fill in the Coal Yard. TVA should conduct the investigation in anticipation of designing and installing an adequate groundwater monitoring system for the CCR structural fill area.	Comment acknowledged. TVA plans to characterize the geology and hydrogeology beneath the Coal Yard as part of this EIP.
38	3.2.1	TDEC Groundwater Request #1	16	2	3	Provide TDEC with an updated ground water potentiometric surface map, identify the current ground water surface elevation below the landfills and surface impoundment and indicate an estimate of the amount of CCR material that is below the current ground water potentiometric surface.	Comment acknowledged; The requested information will be evaluated as part of the EIP activities and will be presented in the EAR

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39	3.2.2	TDEC General Request #2	16			How does TVA propose to adequately monitor groundwater at Ash Disposal Area 1 with no separation between property owners to the North? Please explain how one can infer that groundwater primarily flows east to west when the adjacent river flows North?	Comment acknowledged; The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater flow and direction. Based on the results of the initial phase of work, additional wells may be proposed. Based on current information, groundwater flows from east to west within Ash Disposal Area 1. Groundwater data collected as part of the proposed investigation activities will be used to evaluate groundwater flow direction and the results will be provided in the EAR.
40	3.2.2	TDEC General Request #2	16			Can TVA adequately monitor groundwater at Ash Disposal Area 1 with no downgradient monitoring wells to the direct north between the two property owners?	Comment acknowledged; The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater flow and direction. Based on the results of the initial phase of work, additional wells may be proposed. Based on current information, groundwater flows from east to west within Ash Disposal Area 1. Groundwater data collected as part of the proposed investigation activities will be used to evaluate groundwater flow direction and the results will be provided in the EAR.
41	3.2.2	TDEC General Request #2	16			How will TVA demonstrate groundwater quality in this area without a representative downgradient monitoring points between the two property owners?	Comment acknowledged; The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater quality. Based on the results of the initial phase of work, additional wells may be proposed. Based on current information, groundwater flows from east to west within Ash Disposal Area 1. Groundwater data collected as part of the proposed investigation activities will be used to evaluate groundwater quality and flow direction and the results will be provided in the EAR.
42	3.2.2	TDEC General Request #2	16			Will any of the proposed monitoring wells at Ash Disposal Area 1 & 2 be installed over CCR waste or through the ash pond bottoms?	Three of the proposed wells will be installed in dikes that contain ash fill in Ash Disposal Area 1, but no wells are proposed to be installed in a CCR unit. The proposed wells that will be installed in the dikes are proposed to be screened below the ash fill in the native unconsolidated materials above bedrock.
43	3.2.2	TDEC General Request #2	16	2	4	Since groundwater flow is currently unknown, based on the initial round of water level data the wells may not be indicative of upgradient or downgradient conditions and therefore additional wells may be required. TVA shall ensure that the ground water monitoring locations (existing and proposed) in the EIP will accurately determine groundwater flow and direction.	The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater flow and direction. Based on the results of the initial phase of work, additional investigations may be proposed to further evaluate groundwater flow and direction.
44	3.2.3	TDEC Groundwater Request No. 3	17	All	All	TDEC request's interim presentations of groundwater data generated during EIP activities on a per event basis.	Data generated during the environmental investigation will be managed per the Data Management Plan and can be accessed in accordance with the plan. Results from sampling events will be evaluated in accordance with the QAPP and incorporated in the EAR.
45	3.2.3	TDEC Groundwater Request No. 3	17	2	1	The groundwater protection standard or MCL for arsenic was exceeded multiple times prior to 2002 at the JOF. Arsenic levels do not appear to have exceeded the MCL since then; please provide an explanation for the decrease of arsenic in ground water.	An evaluation of historical and current arsenic concentrations in groundwater will be provided in the EAR.
46	3.2.3	TDEC Groundwater Request No. 3	17	2	1	The groundwater protection standard or MCL for cadmium was exceeded multiple times prior to 2001 and then again in 2013-2016 at the JOF; please provide an explanation for the gap and reoccurrence of cadmium ground water.	An evaluation of historical and current cadmium concentrations in groundwater will be provided in the EAR.

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47	3.2.3	TDEC Groundwater Request No. 3	17	2	1	The groundwater protection standard or MCL for nickel was exceeded multiple times prior to 1997 and then again in 2011-2016 at the JOF; please provide an explanation for the gap and reoccurrence of nickel ground water.	An evaluation of historical and current nickel concentrations in groundwater will be provided in the EAR.
48	3.2.	3.2.3	17	3	1	TVA shall summit all CCR data collected over the last year to fulfill the EPA CCR regulations for ground water monitoring. This information shall include a map with location of the groundwater monitoring wells, all sample results by well, date, CCR constituent and amount of CCR constituent. Should CCR constituents from sampling these wells exceed EPA CCR Rule Appendix 3 or 4 levels, TVA shall include in its ground water monitoring well installation plan, additional wells to determine the extent CCR constituent migration at the TVA JOF site.	CCR Rule Annual Groundwater Monitoring Reports will be provided to TDEC each year in January. Existing data has been provided to TDEC, including any MCL exceedances, reports with tables, and lab reports. In addition, data generated during the environmental investigation will be managed per the Data Management Plan and can be accessed in accordance with the plan. Any MCL exceedances are being reported to TDEC within 14 days, as required. TVA has included additional groundwater monitoring wells in this EIP and intends to conduct an environmental investigation of JOF per the TDEC Order. The reporting requirement for the investigation as stated in the Order is to provide summaries and conclusions in the EAR. If additional investigation, corrective actions or compliance monitoring are required based on the conclusions in the EAR, then those activities will follow the EAR under the CARA Plan as required by the Order. If conditions are detected during the investigation that would warrant more immediate action under the CCR Rule, the pertinent data and monitoring points would be considered for incorporation into that program.
49	3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends installing additional monitoring points south of JOF-114 to characterize groundwater flow and quality along the western boundary of the Coal Yard. An additional upgradient monitoring well should also be installed along the southeastern boundary.	The proposed coal yard closure plan includes consolidation of CCR material in the northern portion of the coal yard. TVA believes that the proposed monitoring network is adequate for the intended area. Additionally, groundwater may not be present in the unconsolidated materials above bedrock south of JOF-114. The results of the initial phase of work will be evaluated and if data gaps exist, additional wells may be proposed.
50	3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends observation well JOF-105 be added as a groundwater quality monitoring well to characterize groundwater flow and quality southwest of the DuPont Dredge Cell. If this is not feasible, a new well should be installed along the southwestern boundary of the DuPont Dredge Cell for this purpose.	Well JOF-105 has recently been installed and is currently being evaluated in cooperation with the Nashville TDEC field office. This well will be added to the groundwater network if deemed appropriate.
51	3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends an additional monitoring well be installed along the northeastern boundary of the South Rail Loop Area 4 to adequately characterize groundwater quality and flow.	Monitoring wells B-9 and JOF-101 are currently located east of South Rail Loop Area 4 as background locations. The area northeast of the South Rail Loop Area 4 would be expected to be in an upgradient location; therefore, an additional well in that location in not needed at this time. Nested vibrating wire piezometers are planned for installation in the South Rail Loop Area 4 along the northeastern boundary as part of the Geotechnical Stability SAP. Data collected from the existing monitoring well network and the planned piezometers will be evaluated to investigate groundwater quality and flow direction. Based on the results of the initial phase of work, additional investigations may be proposed to further evaluate groundwater quality and flow.

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52	3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends observation well JOF-102 be added as a groundwater quality monitoring well to characterize groundwater flow and quality south of the South Rail Loop Area 4. If this is not feasible, a new well should be installed along the southern boundary of the South Rail Loop Area 4 for this purpose.	Well JOF-102 has recently been installed and is currently being evaluated in cooperation with the TDEC field office. This well will be added to the groundwater network if deemed appropriate.
53	3.3	3.3.5	24	1	1	This section discusses how to determine the horizontal hydraulic conductivity of the perimeter dike for Ash Pond 2. TVA proposes to perform slug testing in existing piezometers and groundwater monitoring wells to determine dike horizontal permeability. This is specifically mentioned as an appropriate test method because of the potential variability of the materials used to construct the dike. Would measuring piezometer and groundwater monitoring well recharge rates provide better information, assuming the piezometers and monitoring wells can be pumped dry? Another thought, if slug testing is the best method of testing horizontal permeability, would it be appropriate to use dye and monitor for its occurrence at a corresponding point on the river side of the dike, providing data that could help determine hydraulic conductivity towards the river?	Comment is acknowledged; various methods of obtaining hydraulic conductivity were considered during EIP development, and the current plan of field slug testing and laboratory testing is judged to be appropriate for this initial phase. Both proposed methods provide direct, quantitative measurements of hydraulic conductivity in the materials of interest. Depending on the results, subsequent phases of work using other methods may be warranted.
54	3.3.5	TDEC Active Ash Pond 2 Request No. 5	25	3	All	TVA states in this paragraph that active Ash Pond 2 will be closed and capped as a result of a 2011 agreement with the EPA. One of the purposes of the EIP process is the fully investigate the site and develop a CARA plan that will include the methods TVA will employ to remove and/or close in place CCR material at the site. TDEC recommends any closure activities at the site be completed after the EIP process is complete and an appropriate remedy has been selected for the site.	On April 14, 2011, TVA entered into a Federal Facilities Compliance Agreement (FFCA) with EPA, and a parallel Consent Decree (CD) with the States of Alabama, North Carolina, and Tennessee, the Commonwealth of Kentucky, and three environmental advocacy groups. The purpose of these agreements was to resolve disputes arising under the Clean Air Act. Under the FFCA and CD, TVA was required to retire all ten units at the Johnsonville Fossil Plant by December 31, 2017. Consistent with these requirements, all ten units are now retired. TVA may need to close Active Ash Pond 2 as required by the EPA CCR Rule before the CARA plan required by the Order can be development and/or implemented.
55	3.4.2	Background Soil SAP	27	1	1	Statistics play a major role in determining background concentrations and based on chosen method will effect the sample design and data analysis. Please specify how the background soil will be evaluated and what statistical method will be employed to determine what background levels are for the CCR parameters.	There are multiple statistical methods available to calculate background concentrations. TVA proposes to utilize Background Threshold Values (BTVs) as the method to statistically evaluate and quantify site specific background concentrations for CCR parameters. BTVs are calculated using sampling data collected from un-impacted site-specific reference areas and represent an upper threshold of background concentration(s). The choice of BTV (Upper Confidence Limit, Upper Threshold Limit, Upper Prediction Limits) will be determined based on characteristics of the data (e.g. sample size, statistical distribution). All statistical analyses will be conducted utilizing the latest version of USEPA ProUCL software (currently version 5.1.0) and consistent with ProUCL Technical Guidance Document (USEPA 2015. ProUCL Version 5.1 Technical Guide. Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. EPA/600/R-07/041).
56	3.4	3.4.2	27	2	1	Background Soil SAP. TVA presents their idea for identifying points to sample for background concentrations of CCR materials in soil at the TVA JOF site in Appendix L. TDEC shall review Appendix L. once it is in final form, consider TVA's recommendation and select the locations for soil background sample collection.	Comment is acknowledged.

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57	3.4.2	Background Soil SAP	27	3	2	It does not appear based on Exhibit 6 or the discussion in the text that the 12 proposed locations are related to any potential background groundwater monitoring wells (existing or planned). Is this accurate? And if so TVA should consider including additional borings to be correlated to potential background monitoring wells.	Comment is acknowledged. The Background Soil SAP's objective is to characterize naturally occurring background soils on the TVA property. Two proposed background soil borings, BG-05 and BG-06, are located adjacent to existing background groundwater monitoring wells B-9 and JOF-101, respectively. Soil will also be sampled from the well screen interval of proposed background monitoring wells. Potential background groundwater will be addressed by monitoring of upgradient groundwater monitoring wells under the Hydrogeological Investigation SAP.
58	3.4.2	Background Soil SAP	27	3	4	It was stated that the proposed sampling locations were evaluated for past placement of CCR material and were selected based on access and current hydrogeologic knowledge. Are these sample locations at a similar elevation to JOF ground surfaces near the ash ponds? Are they located on the same geologic units present at beneath the ash ponds? Are these proposed sample locations in similar depositional environments as the ash ponds?	Comment is acknowledged. Background soil samples will be collected from the proposed locations from encountered geographic strata similar to the geological units and conditions as encountered near groundwater surfaces and under the ash ponds.
59	3.4.2	Background Soil SAP	27	5	7	Will a background concentration be determined for each soil type? Please explain how many samples from each soil type will be considered a valid test population for statistical evaluation.	TVA proposes to collect a minimum of 12 background samples from each soil horizon or geographic strata for the purpose of establishing background concentrations of CCR parameters. Twelve samples is consistent with other State's guidance (Ohio) and consistent with the findings presented in Gilbert, 1987. Twelve samples also exceeds the recommended number of samples for several other States (n=4 for Wisconsin and Alabama). If TDEC has specific regulatory guidance on the number of samples required, please provide that guidance to TVA.
60	3.4.2	Background Soil SAP	27	5	7	If the soil is fine sand and silt the sample should be biased to sampling the interface between sand lenses and silt since these lenses are of the conduits for contaminant movement. In clays the inorganics will tend to adsorb and samples should be collected from soil fractures or areas that show oxidation.	Samples will be taken at lithologic changes identified by the PG in the field according to the procedures identified in the Soil SAP(s).
61	3.4	3.4.2	28	2	1	Hydrogeological and Groundwater Investigation SAPs - TVA proposes to install two down gradient monitoring wells on the western edge of the northern half of the Coal Yard. TVA states the well locations are down gradient of the Coal Yard. These locations maybe appropriate, however, at other TVA fossil plants the coal yards are sprayed regularly to reduce release of particulate matter to the air. TVA shall report to TDEC if it routinely sprays the coal yard for dust suppression. If so, does the continual spraying artificially increase the ground water level, causing a mounding effect that is large enough to modify normal ground water flow and direction?	Comment is acknowledged; TVA will review the quantity of water used for dust suppression and evaluate the potential for infiltration of a portion of the water applied to the coal pile. If needed based on that evaluation, TVA will investigate the potential effect on groundwater levels attributable to infiltration of suppression water.
62	5.0	References	33	NA	NA	ASTM D5084 was referenced in text but not noted here.	ASTM standards are commonly understood industry standards and typically are not required to be listed in the reference section. Further, because we plan to follow the version(s) in effect at the time of implementation, we should not make reference to a particular version of the standard that could be outdated at the time of implementation.
63	5.0	References	33	NA	NA	"Stantec Consulting Services Inc. (Stantec). 2011b." should this be 2011 or is there a missing 2011a?	Comment is acknowledged, and the corresponding change has been made in the document.
64	5.0	References	33	NA	NA	Stantec 2012 referenced in text but not noted here.	Comment is acknowledged, and the corresponding change has been made in the document.

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65	5.0	References	33	NA	NA	Stantec Consulting Services Inc. (Stantec). 2016b. Not reference in preceding sections	Comment is acknowledged, and the corresponding change has been made in the document.
66	Appendix A	Schedule				Please update	Comment is acknowledged, and the corresponding change has been made in the document.
67	QAPP	16	39	3	1	The TVA Quality Assurance Project Plan provides great detail in the methods to be used to ensure that data, particularly analytical data will produced and reviewed. TDEC appreciates the importance of this effort because analytical data will be used to make investigation and corrective action decisions. Poor quality data leads to poor environmental decisions. TVA shall present all data to TDEC in an Excel spreadsheet format. Sample collection point, analytical method, sample data and analysis date will be included for each report. For soil permeability and ground water flow rates, data sall be reported in cm/sec, soil and tissue analytical data shall be reported in µg/kg, water and groundwater data shall be reported in µg/L. For analytical samples, the initial laboratory result and the final analytical result shall be presented for each sample. Any data qualifiers shall be noted for each data point. For each analytical parameter, TVA shall specify if the analytical method used reached the analytical method quantitation limit for each analyte in each sampling media. If the analytical method used for a sample or set of samples was not able to reach the method quantitation limit, then TVA shall denote this in the sample report and the reason the method quantitation limit was not achieved.	Data generated during the environmental investigation will be managed per the Data Management Plan and can be accessed in accordance with the plan. Access to this data will include the ability to view data in the requested units and formatting.
68	Appendix C, Section 9.1.2	QAPP	23	4	9	Some of the requirements in the QAPP are written as should. The QAPP must be written as what will be done. If multiple coolers are needed, one COC Record ~~should~~ will accompany each cooler that contains the samples identified on the COC.	"Should" will be replaced with "will."
69	Appendix C, Section10.0	QAPP	26	1	4	Detectability was not mentioned in the quality objectives and criteria for analytical data	Section 10.0 will be updated to indicate that analytical methods will be selected based on the ability to detect constituents of concern at reporting limits. The reporting limits will be sufficient to meet project requirements and quality objectives for precision, accuracy, and sensitivity.
70	Appendix C, Section 11.1	QAPP	29	4	6	At least 10% of the screening data ~~should~~ will be confirmed using appropriate analytical methods and QA/QC procedur es and criteria associated with definitive data.	"Should" will be replaced with "will."
71	Appendix C, Section 11.1	QAPP	30	2	2	Based on the procedure outlined in ENV-TI-05.80.46 (Section 3.3.3, bullet [4]) it appears that the pH instrument will be calibrated to the 25 C^{0} certified buffer strength, rather than the temperature-adjusted buffer strength. Is this accurate?	Section 11.1 will be updated to indicate that buffer temperature will be accounted for during pH meter calibration.
72	Appendix C, Section 13.1	QAPP	36	2	2	Based on the QAPP and ENV-TI-05.80.46 the DO calibration is an air saturated water calibration which is time consuming and could introduce error if not done properly. Is this the method the field teams are actually using? Most field applications of DO that are not long-term, continuous monitoring applications utilize the water saturated air calibration method. Please clarify which calibration method the sampling teams will be utilizing.	TVA TI ENV-TI-05.80.46 was drafted to be used by multiple programs within TVA and therefore was not intended to encompass detailed requirements for the wide variety of water quality meters available for use. Section 3.3.4 of ENV-TI-05.80.46 references both air-saturated water and water-saturated air for calibration. Section 13.1 will be updated to indicate that a 1-point water-saturated air method for calibration will be implemented following the manufacturer’s recommendations for this procedure.

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73	Appendix C, Section 13.1	QAPP	37	1	2	Field pH meters used for collecting data will have to meet the calibration requirements of Method 9040C , which is 0.05 pH units of the bracketing buffer solution values. The QAPP references SESDPROC-100-R3, January 2013 and the TVA TI ENV-TI-05.80.46 which only require calibration to 0.1 SU.	TVA disagrees with the need to calibrate field pH meters according to the acceptance criteria published in SW-846 Method 9040C. The referenced acceptance criteria of +/- 0.1 pH units (EPA Region 4 SESDPROC-100-R3, January 2013) have been established for regulatory applications by EPA Region 4 Science and Ecosystem Support Division and are appropriate for pH readings under the JOF EI.
74	Appendix C, Section 13.1	QAPP	37	2	4	Maintenance ~~should~~ will be performed when the instrument will not adequately calibrate. Mainte nance of field equipment ~~should~~ will be noted in an instrument logbook or field not ebook.	"Should" will be replaced with "will."
75	Appendix C, Section 17.0	QAPP	47	3	2	This audit report ~~should~~ will include a list of observed field activities, a list of reviewed documents, an d any observed deficiencies.	"Should" will be replaced with "will."
76	Appendix C, Section 19.5	QAPP	54	1	4	By providing specific protocols for obtaining and analyzing samples, data sets ~~should~~ will be comparable regardless of who collects the sample or who performs th e sample analysis.	"Should" will be replaced with "will."
77	QAPP	Appendix E, H & I				All soil, solid material and tissue sampling results, except samples for Radium^{226} and Radium^{228}, shall be reported in Parts per Billion, µg/kg.	Comment is acknowledged, and the corresponding change has been made in the text.
78	QAPP	Appendix F & G				All water and groundwater soil sampling results, except samples for Radium^{226} and Radium^{228}, shall be reported in Parts per Billion, µg/L.	Comment is acknowledged, and the corresponding change has been made in the text.
79	Appendix C, QAPP Appendix A	QAPP Appendix A.1	A-3	1	3	In the event that certain required information is not included on a particular form, the laboratory should will provide additional documentation (e.g., preparation logs or analytical run logs) to ensure that the minimum required level of documentation is supplied.	"Should" will be replaced with "will."
80	Appendix C, QAPP Appendix A	QAPP Appendix A.2	A-14	1	3	In the event that certain required information is not included on a particular form, the laboratory should will provide additional documentation (e.g., preparation logs or analytical run logs) to ensure that the minimum required level of documentation is supplied.	"Should" will be replaced with "will."
81	Appendix C, QAPP Appendix D	QAPP Appendix D	D-2	Table A		Sample matrix codes do not have nomenclature for laboratory supplied deionized water.	Table A presents sample nomenclature and includes field QC samples collected using deionized water, which are differentiated for normal samples by "Sample Type". The sample IDs for field QC samples are intentionally reflective of the associated investigatory samples; the matrix code on the COC Record for field QC samples collected using laboratory-supplied deionized water will be "AQ" .
82	Appendix E, Section 1.0	Hydrogeological Investigation SAP	1	2	3	The hydrogeological SAP purpose is to characterize the groundwater flow direction, install monitoring wells to provide locations to evaluate horizontal and vertical extent of CCR constituents and measure horizontal and vertical groundwater flow gradients within the alluvial aquifer.	TVA agrees that the purpose of the hydrgeological investigation is to characterize the hydrogeology of JOF and provide locations to collect groundwater samples for analysis of CCR constituents.

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments
83	Appendix E, Section 2.0	Hydrogeological Investigation SAP	2	1	3	The objectives are to characterize the groundwater flow direction, to install monitoring wells to provide locations to evaluate horizontal and vertical extent of CCR constituents and measure horizontal and vertical groundwater flow gradients within the alluvial aquifer.	TVA agrees that the objectives of the hydrgeological investigation are to characterize the hydrogeology of JOF and provide locations to collect groundwater samples for analysis of CCR constituents.
84	Appendix E, Section 4.0	Monitoring Well Locations	4	3	12	TVA proposes JOF-112 as a potential background monitoring well. This well may not be suitable as groundwater quality may be influenced by the DuPont Dredge Cell located to the east. TDEC recommends installing potential background monitoring wells up gradient of existing coal ash disposal areas.	To be able to evaluate impacts of individual CCR units, background monitoring wells need to be installed between various units or other potential sources of CCR constituents. Background monitoring wells for the DuPont Road Dredge Cell may also be evaluated as background for the Coal Yard. For these reasons, TVA believes that the proposed location for JOF-112 is appropriate. The proposed scope of work is consistent with an initial phase needed to evaluate groundwater. Based on the results of the initial phase of work, results will be evaluated and changes to the monitoring well network proposed as necessary.
85	Appendix E, Section 4.0	Monitoring Well Locations	4	3	10	TVA proposes JOF-115 as a potential background monitoring well. This well may not be suitable as groundwater quality may be influenced by the South Rail Loop Area 4 located to the northeast. TDEC recommends installing potential background monitoring wells up gradient of existing coal ash disposal areas. JOF-101 should be considered for a possible background location.	Monitoring well JOF-101 was specifically cited as not being in an appropriate location to serve as a background monitoring well for Active Ash Pond 2. TVA has attempted to meet TDEC requirements by proposing to install monitoring well JOF-107. If, after evaluation of groundwater quality data a determination is made that JOF-107 is not an appropriate background location, TVA proposes to install JOF-115. To be able to evaluate impacts of individual CCR units, background monitoring wells need to be installed between various units or other potential sources of CCR constituents. TVA believes that the proposed location for JOF-115 is appropriate. If an alternate to location JOF-115 is deemed necessary at a later time, then TVA will propose an alternate location and provide to TDEC for review. The proposed scope of work is consistent with an initial phase needed to evaluate groundwater. Based on the results of the initial phase of work, results will be evaluated and changes to the monitoring well network proposed, as necessary.
86	Appendix E, Section 5.1	Hydrogeological Investigation SAP	6	3	1	There are no observation wells proposed.	Comment is acknowledged, and the corresponding change will be noted in the document. The reference to proposed observation wells will be removed from the SAP.
87	Appendix E, Section 5.1	Hydrogeological Investigation SAP	7	2	1	Potable water should be used for drilling, installation, and development of all environmental monitoring wells and piezometers. Non potable water may be used for core holes, geotechnical borings, or other boreholes in which monitoring wells are not installed.	Potable water will be used for well installation activities. This reference has been added to the text.
88	Appendix E, Section 5.2	Hydrogeological Investigation SAP	7	2	2	The elevation of the established and documented point on the top of each well casing will be correlated to Mean Sea Level	In order to align with existing data, the top of each well casing will be surveyed and correlated to the vertical datum used by the Plant.
89	Appendix E, Section 5.2.6	Hydrogeological Investigation SAP	10	2	1	Distribution of cuttings and discharge of water ~~should~~ will be performed in a manner as to not create a safety hazard.	"Should" will be replaced with "will."
90	Appendix E, Section 5.2.7.1	Hydrogeological Investigation SAP	11	2	12	The annular grout shall consist of a mixture of Portland cement and 4%-6% powdered bentonite. A grout density of 13.5 to 14.1 lbs./gal shall be used.	Comment acknowledged. Cement may or may not be used depending on groundwater conditions due to potential interference with pH readings.

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91	Appendix E, Section 5.2.7.2	Hydrogeological Investigation SAP	12	1	1	Monitoring well development should not begin until a minimum of 24 hours following completion of the well.	TVA TI procedures will be followed and include this requirement.
92	Appendix E, Section 5.2.7.2	Hydrogeological Investigation SAP	12	1	12	Why is the target turbidity for development 10 NTU when the groundwater stabilization criteria listed for turbidity in ENV-TI-05.80.42 is less than 5 NTUs?	The referenced criteria in ENV-TI-05.80.42 (Rev 0001, effective date 3/31/2017) is less than or equal to 10 NTU, not 5. Ten NTUs is standard practice, and TVA has not identified benefits from sampling to 5 NTUs versus 10 NTUs. It is possible an older version of this TI may have had different criteria.
93	Appendix E, Section 6.0	Hydrogeological Investigation SAP	14	1	3	There are no observation wells proposed.	Comment is acknowledged, and the corresponding change will be noted in the document. The reference to proposed observation wells will be removed from the SAP.
94	Appendix E, Section 9.0	Hydrogeological Investigation SAP	18	1	14	"Stantec Consulting Services Inc. (Stantec). 2017." not cited in body of SAP	Comment is acknowledged, and the corresponding change has been made in the text.
95	Appendix E, Attachment A	Hydrogeological Investigation SAP		Figure 3		Well pump placement should be at the midpoint of the screen, if the screen is fully submerged, otherwise the pump should be placed at the midpoint of the saturated interval. It is unclear by this figure that the pump is placed correctly.	Figure 3 was revised to show the approximate placement of the well pump to be the midpoint of the screen or saturated interval.
96	Appendix E, Attachment A	Hydrogeological Investigation SAP		Figure 3		Water encountered during drilling should be shown on stratigraphy log adjacent to monitoring well construction log.	A note showing water encountered during drilling has been added to the referenced Figure 3 and will be included on boring logs.
97	Appendix F, Section 4.0	Sampling Locations	5	1	All	Why wouldn't TVA sample all available groundwater monitoring wells as part of the EIP?	Data collected from monitoring wells from other programs will be used as applicable to the TDEC Order. However, duplicate samples will not be collected as part of the Environmental Investigation if samples have already been or will be collected as part of another program at the same time as proposed in the EI sampling schedule. The data collected for other programs will be utilized in the EAR.
98	Appendix F, Section 4.2	Sampling Frequency	6	1	All	TDEC recommends increased sampling frequency to capture a statistically significant data set	Bi-monthly sampling (6 events) for one year is proposed. According to USEPA Project Summary document "Sampling Frequency for Ground-Water Quality Monitoring" dated September 1989, quarterly and bi-monthly groundwater sampling frequencies are sufficient for major, non-reactive chemical constituents. However, more frequent sampling intervals are not recommended due to potential autocorrelation issues.
99	Appendix F	Groundwater Investigation SAP				Statistical methods to be used for evaluating groundwater monitoring data are not developed in this EIP. TVA must include a discussion of the statistical procedure to be used in the EIP.	There are multiple statistical methods available to calculate background concentrations. TVA proposes to utilize Background Threshold Values (BTVs) as the method to statistically evaluate and quantify site specific background concentrations for CCR parameters. BTVs are calculated using sampling data collected from un-impacted site-specific reference areas and represent an upper threshold of background concentration(s). The choice of BTV (Upper Confidence Limit, Upper Threshold Limit, Upper Prediction Limits) will be determined based on characteristics of the data (e.g. sample size, statistical distribution).
100	Appendix F, Section 2.0	Groundwater Investigation SAP, Objectives	2	1	3	Objectives need to include a comprehensive evaluation of groundwater flow direction(s), velocities and gradients; and an evaluation of groundwater quality (geochemical and CCR parameters).	TVA agrees that the purpose of the groundwater investigation is to characterize groundwater flow directions and rates and groundwater quality with respect to CCR constituents.

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101	Appendix F, Section 2.0	Groundwater Investigation SAP, Objectives	2	1	6	The Groundwater Investigation SAP indicates determining direction and gradient only, however TDEC requires the groundwater flow direction(s), velocities and gradients each time groundwater is sampled.	TVA agrees that the purpose of the groundwater investigation is to characterize groundwater flow directions and rates and groundwater quality with respect to CCR constituents.
102	Appendix F, Section 4.0	Groundwater Investigation SAP, Sampling Locations	4	1	3	TVA states that monitoring wells that are being sampled as part of other programs will not be sampled as part of this SAP. TDEC recommends all applicable groundwater monitoring wells be sampled as part of the EIP and the data provided to TDEC for review. Or monitoring wells should be installed to fill gaps in characterization.	Data collected from monitoring wells from other programs will be used as applicable to the TDEC Order. However, duplicate samples will not be collected as part of the Environmental Investigation if samples have already been or will be collected as part of another program at the same time as proposed in the EI sampling schedule. The data collected for other programs will be utilized in the EAR.
103	Appendix F, Section 4.1	Groundwater Investigation SAP, Sampling Scope	4	2	1	Have monitoring wells B-11 and B-12 been replaced as requested by TDEC in correspondence dated July 22, 2016? It was noted that these two wells had become less reliable due to potential impact from surface water and must be replaced with new monitoring wells. TVA must replace B-11 and B-12 and sample both the existing B-11 and B-12 and their replacements.	Based on current available records, B-11 and B-12 have not been replaced, but have been modified to limit the potential impact from surface water. TVA is working to replace these wells under a minor modification request.
104	Appendix F, Section 4.1	Groundwater Investigation SAP, Sampling Scope	4	6	3	"*submitted for laboratory analysis of parameters listed in Section* ~~5.6.2~~ 5.2.6."	Comment is acknowledged, and the corresponding changes have been made in the document.
105	Appendix F, Section 4.2	Groundwater Investigation SAP, Sampling Frequency	6	1	1	When installing new groundwater monitoring networks, groundwater quality data from at least eight events is needed, in most cases, to fully assess and compare up gradient versus downgradient groundwater quality. Four quarterly events are not adequate to determine statistical significance or determine groundwater fluctuation (reversals) caused by the rise in pool elevation of Kentucky Lake.	Bi-monthly sampling (6 events) for one year is proposed. According to USEPA Project Summary document "Sampling Frequency for Ground-Water Quality Monitoring" dated September 1989, quarterly and bi-monthly groundwater sampling frequencies are sufficient for major, non-reactive chemical constituents. However, more frequent sampling intervals are not recommended due to potential autocorrelation issues.
106	Appendix F, Section 5.2.1	Groundwater Investigation SAP, Groundwater Level Measurements	8	2	3	There is a discussion of the fluctuations in groundwater elevation at the TVA JOF site. TVA shall explain whether the changes are connected to Kentucky Lake levels, seasonal variations or other factors. Discuss if these ground water elevation variations impact ground water below the surface impoundment and the landfills.	TVA will evaluate fluctuations in groundwater levels below CCR units, including correlations with surface water body fluctuations, seasonal changes in groundwater levels, or other factors and include the results in the EAR.
107	Appendix F, Section 5.2.2	Groundwater Investigation SAP, Well Purging	8	2	1	Will barometric pressure readings be recorded? What will be the frequency and source of the barometric pressure readings? Will ambient air temperature be measured? Will a correlation between a NIST thermometer and the temperature on the multi parameter probe be made and recorded?	Barometric pressure readings will be recorded daily. TVA plans to use a multi-parameter sensor equipped with an NIST certified temperature sensor.
108	Appendix F, Section 5.2.2	Groundwater Investigation SAP, Well Purging	8	2	2	Indicate if specific conductance is measured in mS/cm or µS/cm.	Specific conductance will be measured and recorded in µS/cm in accordance with ENV-TI-05.80.42 (Rev 0001, effective date 3/31/2017). The corresponding clarification has been made in the document.

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109	Appendix F, Section 5.2.2	Groundwater Investigation SAP, Well Purging	8	2	4	According to TVA's TI document ENV-TI-05.80.42 the turbidity is required to be below 5 NTUs. If the final turbidity after sample collection is greater than 5NTU is there any additional requirements sampling?	The referenced criteria in ENV-TI-05.80.42 (Rev 0001, effective date 3/31/2017) is less than or equal to 10 NTU, not 5. Ten NTUs is standard practice, and TVA has not identified benefits from sampling to 5 NTUs versus 10 NTUs. Per the SAP, if final turbity readings indicate values above 10 NTUs, then laboratory filtered (dissolved) inorganic constituent samples will be collected in addition to unfiltered (total) inorganic constituent samples. Dissolved sample collection will be accomplished in accordance with ENV-TI-05.80.42.
110	Appendix F, Section 5.2.5.1	Groundwater Investigation SAP, Groundwater Sampling	11	2	3	This should be 5NTU according to ENV-TI-05.80.42	The referenced criteria in ENV-TI-05.80.42 (Rev 0001, effective date 3/31/2017) is less than or equal to 10 NTU, not 5. Ten NTUs is standard practice, and TVA has not identified benefits from sampling to 5 NTUs versus 10 NTUs. It is possible an older version of this TI may have had different criteria.
111	Appendix F, Table 5	Groundwater Investigation SAP	15	Table 5		Field pH meters used for collecting data will have to meet the calibration requirements of Method C , which is 0.05 pH units of the bracketing buffer solution values. There is not a hold time associated with the field measurement of pH by Method 9040C.	TVA disagrees with the need to calibrate field pH meters according to the acceptance criteria published in SW-846 Method 9040C. The referenced acceptance criteria of +/- 0.1 pH units (EPA Region 4 SESDPROC-100-R3, January 2013) have been established for regulatory applications by EPA Region 4 Science and Ecosystem Support Division and are appropriate for pH readings under the JOF EI.
112	Appendix F, Section 5.2.8	Groundwater Investigation SAP	16	4	1	Distribution of cuttings and discharge of water ~~should~~ will be performed in a manner as to not create a safety hazard.	"Should" will be replaced with "will."
113	Appendix F, Section 6.2	Groundwater Investigation SAP	17	1	1	If the tubing used to collect the filter blank is not certified clean tubing then a tubing blank would be required at the same rate of collection as a filter blank and for the same analytes.	TVA plans to use certified clean tubing when required for sampling. If the tubing used to collect the filter blank is not certified clean tubing, then a tubing blank will be collected at a frequency of one blank per lot.
114	Appendix F, Section 6.2	Groundwater Investigation SAP	17	3	1	If an analyte is not amenable to the MS/MSD procedure it should be collected as a lab duplicate (e.g., TSS and radium) as indicated in QAPP.	For parameters such as Total Suspended Solids and radium that are not amenable to the MS/MSD procedure, additional sample volume will be collected for laboratory duplicate analysis per the QAPP.
115	Appendix H, Section 5.2.7	Material Quantity SAP	13	4	1	Distribution of cuttings and discharge of water ~~should~~ will also be performed in a manner as not to create a safety hazard.	"Should" will be replaced with "will."
116	Appendix J	All	All	All	All	Does existing boring data from within all ash disposal areas provide enough information to characterize the geology underlying each cell (permeability, material type/description, ect.) to demonstrate that the ash is contained and separated from groundwater?	Comment acknowledged; Additional borings and laboratory testing will be performed per an added Exploratory Drilling SAP. Evaluation of results from characterization will be included in the EAR.

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117	Appendix J, Section 4.0	Hydraulic Conductivity Testing SAP	4	3	4	If the 2016 Shelby tube samples are not suitable for laboratory hydraulic conductivity testing then it will be necessary to use exploratory borings to collect replacement undisturbed samples from the dike fill, hydraulic fill, CCR, and alluvium.	Comment acknowledged; Additional borings and laboratory testing will be performed per an added Exploratory Drilling SAP, to supplement the testing of surplus 2016 Shelby tube samples. Even if one or more of the surplus undisturbed samples prove to be unsuitable for testing, the available historical data and the testing from proposed exploratory borings will be sufficient to address the information request. Testing of the surplus samples is proposed because the relative benefit is significant considering these samples already exist; but these samples are not vital to addressing the information request.
118	Appendix J, Section 5.1	Hydraulic Conductivity Testing SAP	5	all		This section does not seem to reflect the objectives for the SAP. Potable water is not appropriate for slug testing.	Comment acknowledged; a solid slug (e.g., PVC pipe filled with sand) will be used for slug test activities. The text will be clarified.
119	Appendix J, Section 5.2	Hydraulic Conductivity Testing SAP	6	1	1	Slug tests need to be performed in all active piezometers and monitoring wells on the perimeter of Active Ash Pond #2 as indicated in Section 3.3.5. This also includes all proposed monitoring wells (JOF-106 through JOF-115) as indicated in Section 5.2.7.3 of the Hydrogeological Investigation SAP.	Comment acknowledged; Slug testing is proposed in both the Exploratory Drilling SAP (existing piezometers, existing wells, and proposed temporary wells at Active Ash Pond 2) and the Hydrogeological Investigation SAP (proposed wells). Data from both efforts will be used to characterize the subsurface.
120	Appendix J, Section 5.2	Hydraulic Conductivity Testing SAP	6	1	2	Slug tests need to be performed in dike fill, hydraulic fill, CCR, and alluvium as indicated in Section 3.3.5	Comment acknowledged; the change has been made in the appropriate documents.
121	Appendix J, Section 5.2.3	Hydraulic Conductivity Testing SAP	7	1	5	piezometers and monitoring wells.	Comment is acknowledged, and corresponding change will be made to make SAP and EIP consistent.
122	Appendix J, Section 5.2.3	Hydraulic Conductivity Testing SAP	7	2	3	piezometers or monitoring well.	Comment is acknowledged, and corresponding change will be made to make SAP and EIP consistent.
123	Appendix J, Section 5.2.4 and 5.2.5	Hydraulic Conductivity Testing SAP	7&8	all		These samples were already collected in 2016 by Geocomp? Have they been stored as indicated (i.e., IAW D4220-95)? What is the appropriate "hold time" for the samples? Are these sections here to guide collection of replacement shelby tube samples if the 2016 shelby tube samples are not suitable for laboratory hydraulic conductivity testing.	Samples have been properly stored since being collected. Geotechnical samples do not have prescribed "hold times" similar to environmental samples. As stated in the SAP, samples will be visually evaluated before testing. These sections of the SAP guide shipping and handling of these tubes under the TDEC Order. As part of an expansion of this SAP to also cover proposed Exploratory Drilling, these sections will also address collection/storage/transport of supplemental Shelby tube samples.
124	Appendix J, Section 5.2.6	Hydraulic Conductivity Testing SAP	8	1	1	This refers to the undisturbed samples that were previously collected in 2016 by Geocomp? The testing will need to characterize the in-situ hydraulic conductivity of dike fill, hydraulic fill, CCR, and alluvium.	Comment acknowledged; Additional borings and laboratory testing will be performed per an added Exploratory Drilling SAP, to supplement the testing of surplus 2016 Shelby tube samples.

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125	Appendix J, Section 5.2.6	Hydraulic Conductivity Testing SAP	8	2	4	If the 2016 Shelby tube samples are not suitable for laboratory hydraulic conductivity testing then it will be necessary to use exploratory borings to collect replacement undisturbed samples from the dike fill, hydraulic fill, CCR, and alluvium.	Comment acknowledged; Additional borings and laboratory testing will be performed per an added Exploratory Drilling SAP, to supplement the testing of surplus 2016 Shelby tube samples. Even if one or more of the surplus undisturbed samples prove to be unsuitable for testing, the available historical data and the testing from proposed exploratory borings will be sufficient to address the information request. Testing of the surplus samples is proposed because the relative benefit is significant considering these samples already exist; but these samples are not vital to addressing the information request.
126	Appendix J, Section 6.0	Hydraulic Conductivity Testing SAP	9	1	2	QA/QC requirements are specific to slug testing and the collection and analysis of the undisturbed soil samples.	QA/QC requirements for the collection and analysis of the undisturbed soil samples have been defined in the Exploratory Drilling SAP
127	Appendix J, Section 8.0	Hydraulic Conductivity Testing SAP	12	1	6	If the 2016 Shelby tube samples are not suitable for laboratory hydraulic conductivity testing then it will be necessary to use exploratory borings to collect replacement undisturbed samples from the dike fill, hydraulic fill, CCR, and alluvium.	Comment acknowledged; Additional borings and laboratory testing will be performed per an added Exploratory Drilling SAP, to supplement the testing of surplus 2016 Shelby tube samples. Even if one or more of the surplus undisturbed samples prove to be unsuitable for testing, the available historical data and the testing from proposed exploratory borings will be sufficient to address the information request. Testing of the surplus samples is proposed because the relative benefit is significant considering these samples already exist; but these samples are not vital to addressing the information request.
128	Appendix J, Section 9.0	Hydraulic Conductivity Testing SAP	13	1	1	Need ASTM D4220-95 and D5084 references	ASTM standards are commonly understood industry standards and typically are not required to be listed in the reference section. Further, because the plan is to follow the version(s) in effect at the time of implementation, a reference to a particular version of the standard that could be outdated at the time of implementation should not be made.
129	Appendix L, Section 2.0	Background Soil SAP	2	2	10	Soil samples will also analyzed for percent ash.	Only surface samples (zero to six inches) will be analyzed for percent ash in addition to CCR Parameters. All other samples will only be analyzed for CCR Parameters.
130	Appendix L, Section 3.0	Background Soil SAP	3	1	4	Field teams should consist of (at a minimum) an experienced TN licensed professional geologist.	Comment is acknowledged, and the corresponding change has been made in the document.
131	Appendix L, Section 5.2.1.1	Background Soil SAP	7	3	11	Will the mid-point for sampling aliquot be the vertical depth midpoint or the mid-point based on recovery? What is the contingency if recovery is poor?	The mid-point for grab samples will be the mid-point based on recovery, except in the situation where a core interval includes a lithology change. In the event that soils are expected to be hard to retain during core retrieval, core catchers will be used to prevent loss of sample material. No composite samples are proposed.
132	Appendix L, Section 5.2.1.1	Background Soil SAP	7	3	16	Grab samples only. The collection of composite soil samples is not acceptable to determine that CCR constituents are not present because the evidence of a release may be diluted.	Comment is acknowledged, and the corresponding change has been made in the document.

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133	Appendix L, Section 5.2.1.1	Background Soil SAP	8	1	1	Borehole should be filled with cement-bentonite grout mixture using a tremie pipe to within approximately six inches of the surface. The top six inches should be restored to match the existing surface.	Comment is acknowledged, and the corresponding change has been made in the document.
134	Appendix L, Section 5.2.1.2	Background Soil SAP	8	1	3	Soil color will be determined using a Munsell soil color chart.	Comment is acknowledged, and the corresponding change has been made in the document.
135	Appendix L, Section 5.2.1.2	Background Soil SAP	8	1	3	Soil will be logged following the visual-manual procedures of the American Society of Testing and Materials (ASTM) Standard D2488-09a	Comment is acknowledged, and the corresponding change has been made in the document. Soils will be logged using ASTM Standard D2488.
136	Appendix L, Section 5.2.1.2	Background Soil SAP	8	1	5	Soil should be logged to include soil consistency or density, size, shape and angularity of particles, plasticity (for fine-grained soil)	Comment is acknowledged, and the corresponding change has been made in the document.
137	Appendix L, Section 5.2.5	Background Soil SAP	12	Table 4		A pH field test kit should be employed to help identify if soil pH is in a range to mobilize CCR contaminants (specifically target sample aliquots and horizon changes). For example several metals are easily leached from acidic soil, however selenium is mobilized under alkaline conditions. Also, due the short hold time, which will create a situation where the analytical result will not be within the 15 min holding time, please consider a field method measurement of pH for comparison.	Comment is acknowledged, and the corresponding change has been made in the document. Background soil samples will initially be tested in the field using pH field test kits in addition to having soil samples submitted for laboratory analysis of pH. However, this study is not an investigation to determine the presence of CCR "contaminants" or conduits of contaminant movement. The biasing of sample collections based on pH ranges likely to mobilize CCR contaminants is not warranted.
138	Appendix L, Section 5.2.7	Background Soil SAP	13	4	1	Some of the requirements in the Background Soil Sampling SAP are written as should. The SAP must be written as what will be done. This indicates the requirements on what will be acceptable. If the procedure cannot be followed, identify in the QAPP or QA/QC section of SAP how things will be documented that don't follow the QAPP /SAP requirements. Distribution of cuttings and discharge of water should will also be performed in a manner as not to create a safety hazard.	Comment is acknowledged, and the corresponding change has been made in the document.
139	Appendix M	Surface Stream SAP	All	All	All	TDEC recommends collecting water column samples (top, middle, and bottom) at each sampling location. Effort should be made to co-locate water column samples with sediment samples collected as part of the EIP as well as the already identified sampling locations. TDEC recommends adjusting water column sample locations to include transects at each location that are perpendicular to flow and include right descending bank, center of channel, and left descending bank in order to characterize the stream/river profile.	Comment acknowledged, the Surface Stream SAP will be revised to include sample transects, instead of point sampling locations, and surface stream samples will generally be co-located with sediment samples.
140	Appendix M	Surface Stream SAP	All	All	All	TDEC reccomends gathering data on some water quality conditions that would influence the toxicity of some metals, i.e., water hardness for metals with hardness dependent standards.	Comment is acknowledged, TVA will add magnesium to the analyte list for use in hardness calculation.
141	Appendix M	Surface Stream SAP	All	All	All	TDEC reccomends trace-clean (e.g., 'clean hands/dirty hands) methods be used for sample collection	Clean hands/dirty hands methodology is not necessary to achieve the reporting limits specified in the QAPP, which are sufficient to meet the TDEC water quality standards. Potential sample contamination arising from field activities is monitored through a variety of blanks (equipment blanks, field blanks, filter blanks, tubing blanks).

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142	Appendix M	Surface Stream SAP	All	All	All	Please explain why being within a meter of the bottom is sufficient to represent “epibenthic” conditions.	Comment is acknowledged. The depth to the lake bottom for collection of a samples, which represents "epibenthic" conditions, has been changed to within 0.5 m of the riverbed. The intent is to characterize constituent concentrations near the riverbed while ensuring that bottom sediments are not disturbed during sample collection. Moreover, flow velocities within the sampling reach typically are sufficient to induce mixing within the lower meter of the water column.
143	Appendix M	Surface Stream SAP	All	All	All	TDEC reccomends conducting sampling away from and upstream of the boat and motor.	Comment is acknowledged, and the corresponding change has been made in the document.
144	Appendix M	Surface Stream SAP	All	All	All	Please confirm that detection limits < TDEC water quality standards for constituents.	The reporting limits specified in the QAPP for surface stream sampling are sufficient to meet TDEC water quality standards. Please note the RL for nickel is 0.0100; this will be corrected in the revised EIP.
145	Appendix M	Surface Stream SAP	All	All	All	Please confirm that sampling teams will change tubes on peristaltic pumps between sample sites.	Tubing will be changed between sampling sites.
146	Appendix M	Surface Stream SAP	All	All	All	TDEC reccomends a metals grade nitric acid cleaning of sampling equipment between sample collection sites.	New, certified clean, single-use sampling equipment will be used at each location.
147	Appendix N	Benthic SAP	All	All	All	A ponar grab sample is not a quantitative sample.	The ponar grab sampler will be used to collect the sediment sample. Macroinvertebrates collected from the sediment will then be submitted to a laboratory for taxonomic analyses and the quantitative results will be provided in the EAR.
148	Appendix N	Benthic SAP	All	All	All	What metrics will TVA use for community composition? Will stats be run, if so, what ones?	The metrics developed by TVA for evaluating benthic community integrity as required by their current NPDES Discharge Permit will be utilized. The statistical methods used will be based on the evaluation of the data gathered during the EI and included in the EAR.
149	Appendix N	Benthic SAP	All	All	All	Will all mayfly samples be mayflies of the same species? Can TVA get sufficient numbers, especially off of vegetation (50 to 75 cited), to get tissue mass sufficient for meaningful detection limits?	The Mayfly SOP references collecting Hexagenia only. Therefore, mayflies collected would not necessarily be the same species, just the same genus. Per Section 4.3 of the Benthic SAP: “The timing of the sampling will need to be coordinated with local adult mayfly emergence. Efforts will be made to collect mayfly adults/nymphs within the designated areas, however other species may need to be evaluated and/or other locations added if an insufficient number of mayfly adults/nymphs are encountered within the designated areas at the time the proposed sampling is conducted.”

Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments
150	Appendix O	Fish Tissue SAP	All	All	All	This assessment is for ecological, not human health assessments, so why are filet data being used for all non-gizzard shad fish? Did TVA consider whole-body data?	The fish SAP is designed to sample tissues where CCR constituents may accumulate and to assess potential transfer of CCR constituents maternally. TVA proposes to follow relevant portions of the fish tissue sampling protocols implemented following the Kingston ash release. Muscle, liver, and ovary samples are not feasibly collected from shad because of their very small size. It is anticipated that analytical results from filet samples will be considered in both the ecological and human health risk assessments. Except for shad, the species of fish listed in the SAP are known to be caught and consumed by people.
151	Appendix O	Fish Tissue SAP	All	All	All	Will TVA present the data as lipid-normalized values, as wet weight or dry weight?	The data will be presented as wet weight or “as-is” basis.
152	Appendix O	Fish Tissue SAP	All	All	All	Please clarify how TVA will assess possible correlations with potential fish health.	The Fish SAP has been developed to evaluate whether tissues from fish in the immediate vicinity and downstream of JOF have higher concentrations of CCR-related contaminants than occur in fish from reference areas upstream of JOF. TVA’s approach to evaluating risks will be presented in the EAR and/or CARA Plan.
153	Appendix O	Fish Tissue SAP	All	All	All	For a given species, will “adults” all be in a specific size range, or at least have the smallest be within 75% of the length of the largest?	Comment is acknowledged, and the corresponding change has been made in the document.
154	Appendix O	Fish Tissue SAP	All	All	All	Checking gill nets after sitting all night could result in some decomposed fish. Not using such fish needs addressed.	Comment is acknowledged, and the corresponding change has been made in the document.
155	Appendix O	Fish Tissue SAP	All	All	All	No indication of detection limits is provided.	Target reporting limits for fish tissue samples are presented in Attachment I of the QAPP.
156	Appendix O	Fish Tissue SAP	All	All	All	Will TVA account for differences in male/female ratios in the various samples?	If possible, female fish will be collected at the sampling reaches in order to be able to obtain ovaries for sampling. Once samples are collected, if deemed necessary, differences in male/female ratios will be accounted for.
157	Appendix O	Fish Tissue SAP				Several species of fish are targeted. The plan should focus on fish that are popular with local fishers.	The Fish SAP has been developed to evaluate whether tissues from fish in the immediate vicinity and downstream of JOF have higher concentrations of CCR-related contaminants than occur in fish from reference areas upstream of JOF. The concentrations of CCR constituents in filets of commonly consumed sport fish will be used in the human health risk assessment. TVA’s approach to evaluating risks will be presented in the EAR. The species being collected (bluegill, redear sunfish, largemouth bass, and catfish) are sportfish that are popular with fishermen throughout the Tennessee and Cumberland River Valleys (and the entire southeastern US). They also span a range of trophic guilds which is beneficial in evaluating ecological risks as well as human health risks. The concentrations of CCR constituents in filets of commonly consumed sport fish will be used in the human health risk assessment.

Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments
158	Appendix O	Fish Tissue SAP				How will sample integrity be maintained?	QA/QC procedures for the fish sampling activities are included in the referenced TVA SOPs and Tis. Additional language will be added to the SAP, referencing the QA/QC procedures.
159	Appendix O	Fish Tissue SAP				It does not appear that DQOs have been identified in either the SAP or QAPP for the fish tissue sample collection activities. The text should explain relevant DQOs assuming that they would be primarily related to sample handling issues. One exception involves the measurement of sample location surface water pH. DQOs for pH will require that meters are calibrated to a known standard in accordance with manufacturer's specifications.	Relevant DQOs for collection, preparation, and transfer of fish tissue samples to the analytical laboratory have been addressed in the Fish Tissue SAP and QAPP.
160	Appendix O, Section 3.0	Fish Tissue SAP	3	1	5	Field teams should consist of (at a minimum) one experienced fisheries biologist, one field technician, and a quality control specialist, all of whom must have experience with the array of fisheries sampling equipment to be used.	Comment is acknowledged; TVA will add a requirement for the suggested team to be made up of a fisheries biologist, field technician and quality control specialist with fish sampling experience to the Fish Tissue SAP. TVA will specify in the SAP that the team will consist of personnel with expertise in fish sampling techniques and who have experience with the quality control requirements of the sampling protocols specified herein. The QAPP (Section 5) provides for training of field personnel to reinforce the procedures to be followed during the sampling activities.
161	Appendix O, Section 5.2.1.2	Fish Tissue SAP	8	3	1	The text should explain how why only muscle and ovary sampling was chosen and does not appear to include the following four types of fish tissue: liver, muscle, ovary and testes.	TVA will add liver sampling to the Fish Tissue SAP for the sampled species except shad which are being processed as whole body. Testes are not being included because the objective is to sample tissues where CCR constituents will accumulate and to assess potential transfer of CCR constituents maternally. TVA proposes to follow relevant portions of the fish tissue sampling protocols implemented following the Kingston ash release. Except for gizzard shad (which are very small fish), muscle, liver, and ovaries will be collected from composites of representative trophic level fish. Testes will not be collected.
162	Appendix O, Section 5.2.1.2	Fish Tissue SAP	8	2	all	The sampled fish should be of similar size so that the smallest individual in a composite is no less than 75% of the total length of the largest individual	Comment is acknowledged, and the corresponding change has been made in the document.
163	Appendix O, Section 5.2.4.1	Fish Tissue SAP	10	2	5	Since the fish tissue samples are required to be maintained at -10 degrees C, wet ice in resealable bags may not meet that requirement. It is suggested to pack the samples on dry ice, and that the samples arrive at the sample preparation laboratory within less than 24 hours from the time of sample collection. TVA shall document that the fish tissue samples were maintained at - 10^{o} C from collection to arrival at the laboratory. Should sample delivery require more than 24 hours, TVA shall document the reason for late delivery and any adverse impacts to the tissue samples.	Using dry ice in the field is difficult and can be hazardous. The analytical laboratory confirmed that the samples should be maintained at 6 degrees Celsius and can be stored and shipped to the laboratory on wet ice. The samples will be frozen once received at the laboratory.
164	Appendix O	Fish Tissue SAP	15	Table 5		Please confirm the appropriate method for Mercury analysis (i.e., Method 1631, Revision B with Appendix A or Method 7473)	Comment is acknowledged, and the corresponding change has been made in the document.

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Robert J. Martineau, Jr.
Commissioner

Bill Haslam
Governor

March 9, 2018

M. Susan Smelley
Director
Environmental Compliance and Operations
Tennessee Valley Authority
1101 Market Street, BR 4A-C
Chattanooga, TN 37402

RE: TDEC Commissioner's Order OGC 15-1077
TVA Johnsonville Coal Fired Fossil Fuel Plant
Environmental Investigation Plan Revision 1 Comments

Dear Ms. Smelley:

The Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order OGC 15-0177 (the Order") to the Tennessee Valley Authority (TVA) that required TVA action at seven TVA Coal Fired Fossil Power Plants (active and inactive) located in Tennessee. The Order was signed on August 6, 2015 and included information about TVA's right to appeal the Order. TVA did not appeal the Order and it is now final.

The Order required TVA to perform environmental investigations and to take appropriate corrective action at seven TVA Coal Fossil Power Plants (CCR sites) in Tennessee. The Order is specific to Coal Combustion Residual (CCR) material. Paragraph VII. of the Order provides the sequence of events for environmental investigation at a TVA CCR site as presented below.

1. TVA and TDEC are required to schedule and conduct an initial meeting to discuss each CCR site. At each CCR site meeting, TVA provides the operational history of the CCR site, all geological and hydrogeological information currently available, results of environmental investigations and sampling, etc. This is basically a summary of TVA's current understanding of each CCR site.

2. TDEC reviews the information provided by TVA (historical information, geophysical properties of the site, operational history, etc.) at the on-site meeting and historical CCR site information provided by TVA. After review of the information provided by TVA, TDEC

sends a letter to TVA that sets the date for submission of the draft CCR site Environmental Investigation Plan (EIP) and informs TVA of any additional environmental activities it believes are necessary to complete the CCR site environmental investigation.

3. TVA submits a draft Environmental Investigation Plan for the CCR site. TDEC reviews the draft CCR site EIP and provides TVA with comments that identify opportunities to improve the environmental investigation of the CCR site EIP. This letter also sets a due date for submission of the revised CCR site EIP.

4. TVA submits a revised EIP for the CCR site to TDEC, with a schedule of onsite activities such as installation of ground water monitoring wells, installing soil/rock borings to determine subsurface geological features, methods that will be used to determine the location and amount of disposed CCR material, surface water and ground water monitoring, etc.

5. TDEC provides TVA with its response to the revised EIP. When TDEC finds the CCR site EIP to be complete, TDEC notifies TVA via letter.

6. TVA is required to issue a public notice for the CCR site EIP before it is implemented. The public has 30 days to submit its EIP comments to TDEC. If EIP comments are submitted to TDEC, then TDEC has 30 days to respond to the comments.

7. Once the public comment period has ended, TDEC may provide TVA with CCR site EIP comments as a result of the review of the public comments submitted to TDEC. TVA submits and TDEC approves/disapproves the schedule of activities for environmental investigation at the CCR site. Unless TDEC disapproves the CCR site EIP schedule of activities, TVA proceeds with the environmental investigation, collects and generates data, then prepares an Environmental Assessment Report (EAR).

8. The EAR is submitted to TDEC. TDEC evaluates the EAR and decides if TVA has generated enough environmental investigation data to:

    a. Determine the impact of CCR materials to public health and the environment.
    b. Provide a comprehensive picture of the areas where CCR material disposed.
    c. Assess the structural and seismic stability of the CCR disposal areas.
    d. Determine the extent of CCR constituents in ground water and discharges to surface water.
    e. Determine if CCR material is disposed below the ground water table.

TDEC also determines if there is enough information generated to prepare a comprehensive corrective action plan.

If TDEC determines the EAR is incomplete or deficient, then TDEC informs TVA of its concerns. TVA is then required to further investigate the CCR site, beginning with item 4. above.

<u>Johnsonville CCR site EIP Rev 1 Comments</u>

TVA submitted the EIP Rev 1 for TVA Johnsonville Coal Fired Fossil Power Plant (TVA JOF) on January 12, 2018. TDEC has completed its review of EIP Rev 1 and is providing comments listed in the attached **Table 1 TVA Johnsonville EIP Rev 1 Summary of TDEC Comments**.

Please address the attached comments and submit a revised plan (EIP Rev 2) with a cover letter summarizing TVA's response to each comment and subsequent modifications to TDEC by **May 11, 2018**.

TDEC's goal is to work with TVA to ensure the environmental investigation of the TVA JOF site is complete, accurate and timely. Should you have any questions, please do not hesitate to contact me via email at Robert.S.Wilkinson@tn.gov or phone at (615) 253-0689.

Sincerely,

Robert Wilkinson, P.G., CHMM

CC:	Bryan Wells	Britton Dotson	James Clark
	Pat Flood	Chuck Head	Rob Burnette
	Tisha Calabrese Benton	Angela Adams	Joseph E. Sanders
	Alan Spear	Peter Lemiszki	Jason Repsher
	Maggie Gilliland	Shawn Rudder	

Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments	JOF EIP Rev 1 TDEC Comment
New	General	General	NA	NA	NA			Current static pore water elevation for both pond 1 & 2 shall be provided in a table from borings or piezometers placed inside the impoundment.
New	General	General	NA	NA	NA			The elevations mentioned above shall be used for stability calculations for existing conditions.
New	General	General	NA	NA	NA			TVA shall provide proposed static pore water elevations for closure with stability calculations
New	General	General	NA	NA	NA			TVA shall provide a plan on how they will minimize mounding inside the impoundments after closure.
New	3.1.1	TDEC General Request	8	1	All			TVA discusses the construction materials used to construct Active Ash Pond 2. Given the construction material and the volume of CCR material disposed in Active Ash Pond 2, does TVA have any information about the release of water from the impoundment to the Tennessee River? TVA discusses the use of existing wells to determine this, however, given the size of the ash pond are the number of wells adequate? In regards to ground water monitoring are the existing wells currently monitored for Boron? Conversely, does TVA have any information that once the ash pond is closed that the level of water in the ash pond will stabilize to the same level of the river? Would a portion of the ash in the ash pond remain below the water level of the river after closure?
New	3.1.1	TDEC General Request	11	All	All			TVA discusses lowering the height of the current dikes for Active Ash Pond 2 from 390' to 380'. The 500 year flood surface water elevation is listed as 375'. This closure presupposes that TVA will be able to close in place. This should not be in the EIP. It should not be discussed until the Environmental Investigation has been completed. Approving the EIP with this language implies that TDEC agrees with closure in place as the corrective action at this site.
New	3.3.5	TDEC General Request	29	5	1			The language concerning filling and capping Active Ash Pond 2 shall be removed. The corrective action for this site shall be determined by the information gained during the environmental investigation at the TVA JOF site.
New	4.1.2	A.2 TDEC Site Information Request No. 2	All	All	All			TVA did not include any material characteristic sample locations from the Coal Yard, DuPont Dredge Cell, Ash Disposal Area 1, or South Rail Loop Area 4. TVA shall propose sample locations from within these units.
New	Appendix D, Exhibits	Exhibits No. 18	298/1076	NA	NA			The proposed temporary wells indicated on Exhibit 18 shall be converted to permeant piezometers with vibrating wires to monitor the phreatic surface during the post closure care period.
New	Appendix G	Water Use Survey Sampling	G-3	Table	NA			Why is TVA proposing to use EPA Method 200.8 for Boron with a detection limit of 0.08 mg/L versus EPA Method 200.7 which has a0.0038 mg/L detection limit? Is EPA Method 200.8 an approved method for Boron analysis in water?
New	Appendix H	Groundwater Investigative Sampling	H-3	Table	NA			Why is TVA proposing to use EPA Method 200.8 for Boron with a detection limit of 0.08 mg/L versus EPA Method 200.7 which has a0.0038 mg/L detection limit? Is EPA Method 200.8 an approved method for Boron analysis in water?
New	Appendix H - Material Quantity SAP	Attachment A - Figures	465/1076	NA	NA			The proposed temporary wells indicated on Figure 3 shall be converted to permeant piezometers with vibrating wires to monitor the phreatic surface during the post closure care period.
New	Appendix I	Groundwater Investigative Sampling	I-3	Table	NA			Why is TVA proposing to use EPA Method 200.8 for Boron with a detection limit of 0.08 mg/L versus EPA Method 200.7 which has a0.0038 mg/L detection limit? Is EPA Method 200.8 an approved method for Boron analysis in water?
New	Appendix J - Exploratory Drilling SAP	Attachment A - Figures	551/1076	NA	NA			The proposed temporary wells indicated on Figure 3 shall be converted to permeant piezometers with vibrating wires to monitor the phreatic surface during the post closure care period.
New	Appendix L	Material Quantity SAP	L-3	Table	NA			Why is TVA proposing to use EPA Method 6020 for Boron versus EPA Method 2010 which has a 0.0038 mg/L detection limit? Is EPA Method 6020C an approved method for Boron analysis in water?
New	Appendix P - Stability SAP	All	All	All	All			TVA shall verify through this investigation that inactive CCR landfill and/or surface Impoundments on site are no longer impounding water.
New	Appendix P - Stability SAP	4.0 Plant-Specific Stability Analysis Plan	913/1076	Table 1	NA			Stability Analysis for the Active Ash Pond 2 shall be performed using site-specific phreatic conditions obtained, in part, from site-specific piezometer data obtain in the site investigation. An analysis should included for the proposed cap-in-place closure design. Deformation tolerance shall be demonstrated to be appropriate for all components of the closure design.
New	Appendix P - Stability SAP	5.1.2 Phased Assessment and Acceptance Criteria	918/1072 & 922/1072	All	All			Provide rational for determining the acceptable (tolerable) displacement performance criteria. Provide documentation that justify the stated correlation of 3 feet to a factor of safety of 1.0.

TVA Johnsonville EIP Rev 1
Summary of Comments

Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments	JOF EIP Rev 1 TDEC Comment
New	Appendix P - Stability SAP	5.1.2 Phased Assessment and Acceptance Criteria	918/1076	NA	NA			TVA shall work with TDEC to define acceptable performance will need to be established as part of the of Phase 1 Assessment.
New	Appendix P - Stability SAP	5.1.3 Basis for Load Cases and Acceptance Criteria	920/1076	NA	NA			TVA embankment dam design guidance (TVA 2016) shall be removed from the list of documents used to determine acceptable criteria.
New	General	General	NA	NA	NA			Coordination of efforts to collect water, sediment, benthos, and fish from the same locations in some cases is worthwhile; however, it appears that there are not always common sample locations for all media. Could a map or matrix be provided indicating which media/sample types are collected at each sample site?
New	General	General	NA	NA	NA			With the exception of selenium and mercury, the CCR contaminants being analyzed don't readily bioaccumulate. Are there meaningful data on other sites to determine whether tissue concentrations are especially elevated for CCR constituents or will the data on upstream sites be the sole data used for these purposes? What effects endpoints (e.g., toxicity, fecundity, growth inhibition) are available in the literature by which to determine whether effects are likely occurring?
New	Appendix T	Surface Water SAP	NA	NA	NA			Will there be a comparison of chemical concentrations to conditions indicating possible environmental harm, for example water quality standards for receiving stream designated uses?
New	Appendix T	Surface Water SAP	12	Table 2	NA			TSS should be measured, it is needed for conversion of total metals concentrations to dissolved standards where applicable.
New	Appendix T	Surface Water SAP	All	All	NA			In what seasons or months are the sampling events going to be conducted and why?
New	5.2.4	Surface Water SAP	All	All	NA			Some detail is needed with respect to the transects being conducted at different sampling sites to identify the channel thalwag. For example, how many depth assessments will be made at each site and at what distance (or percent of stream width) along the transect?
New	5.2.4	Surface Water SAP	All	All	NA			Sampling will be conducted during seasonal mean flows and during flows of less than the 75th percentile. The mean would be below the 75th percentile, but you could be below the 75th percentile and be above the mean flow. Which condition will be the determining factor as to when sampling is conducted? Would a better approach be to conduct sampling when flows are between approximately the 25th and 75th percentile? You may want to consider sampling based on the median flow and some range around it.
New	Appendix Q	Benthic SAP	All	All	NA			None of the Boat Harbor or Cove samples' sediment sampling sites are being sampled for benthic macroinvertebrates, why is that?
New	2	Benthic SAP	All	All	NA			Are mayflies an appropriate choice for metals tissue analysis and what is the rationale for their use? In addition to being short-lived, they are not sediment-ingesting organisms. Would a crustacean or Corbicula be a better choice to assess metals uptake in benthos?
New	5.2.1.3	Benthic SAP	All	All	NA			What species will be targeted if sufficient mayflies are not available at a site, and will mayfly sampling and other species sampling be conducted? If so, is it meaningful to compare bioaccumulation data across species?
New	5.2.1.3	Benthic SAP	All	All	NA			You should also consider use of a collector-gatherer mayfly species since they would have the most exposure to sediments in their diet, burrowing mayflies would be best.
New	5.2.1.3	Benthic SAP	All	All	NA			By what means will mayfly tissue concentrations be normalized for comparison between sites?
New	5.2.1.3	Benthic SAP	All	All	NA			What is the purpose and use of developing depurated vs. non-depurated mayfly data?
New	5.2.1.3	Benthic SAP	All	All	NA			Would transport of mayflies on ice prior to depuration be a source of stress and thermal shock that would result in their death? What will be the depuration period and is it standard for such assessments?
New	5.2.5	Benthic SAP	All	All	NA			For sediment analysis, will acid volatile sulfide (AVS) analyses be conducted to compare to molar concentrations of metals known to be strongly bound by AVS?
New	5.2.5	Benthic SAP	All	All	NA			Will sediment contaminant concentrations be expressed on a dry weight basis?
New	2	Benthic SAP	All	All	NA			What is the basis of the 20 percent ash content as the value that triggers additional sediment analysis?

Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments	JOF EIP Rev 1 TDEC Comment
New	Appendix Q	Benthic SAP	All	All	NA			The sampling is often referred to as quantitative. A ponar sampler will penetrate to different depths based on substrate composition. How will identical sample sizes be ensured for appropriate site-to-site comparison?
New	Appendix Q	Benthic SAP	All	All	NA			How will you ensure that benthic community samples are collected from similar habitats/substrates so that any differences observed are due to contaminant concentrations and not habitat or substrate composition? Would sediment particle size analysis, photographs and notes related to habitat and substrate composition at each site assist in interpretation of benthic community composition data?
New	Appendix Q	Benthic SAP	All	All	NA			The bioavailability and toxicity of chemicals cannot be accurately predicted based on chemical data alone. Would toxicity testing be a better approach or a good supplement to the proposed approach to assess contaminant effects between sites? If so, the concentrations of natural toxicants such as ammonia and dissolved sulfide should also be determined to support data interpretation.
New	Table 5	Benthic SAP	All	All	NA			It may also be useful to include ammonia and dissolved sulfide analysis in the proposed plan to support interpretation of benthic community data.
New	Appendix U	Fish SAP	All	All	NA			It would be beneficial to do the tissue processing in the laboratory instead of the field. Removal of liver and ovary might be easier in the lab and/or better ensure lack of contamination during processing.
New	Appendix U	Fish SAP	All	All	NA			It is recommended to analyze individually any larger fish to supplement data obtained from the composite samples.
New	5.2.5	Fish SAP	All	All	NA			Is "gel ice" a potential source of contamination?
New	Appendix U	Fish SAP	All	All	NA			A single composite tissue sample will be collected in most cases. How will data analysis be conducted when sample size is n = 1?
New	5.2.4	Fish SAP	All	All	NA			How will you determine whether you have "unexpected" results and that the retained split sample should be analyzed given that only one (composite) sample will be collected from each site? As a trigger, it is recommended that you use TDEC fish tissue criteria as applicable for additional analysis. If fillet composite exceeds criteria, then individual fillets should be analyzed from retained sample.
2	All	All	All	All	All	TDEC recommends conducting a leachability characterization study that includes an evaluation of CCR parameters from pore water and solid material samples from locations that would characterize the vertical and lateral distribution of leachability characteristics across the facility.	Comment acknowledged - This revision of the JOF EIP will include a Material Characteristics SAP to evaluate leachability.	TVA did not include any material characteristic sample locations from the Coal Yard, DuPont Dredge Cell, Ash Disposal Area 1, or South Rail Loop Area 4. TVA shall propose sample locations from within these units.
20	General Technical	NA	NA	NA	NA	The active Johnsonville CCR surface impoundment was constructed within Kentucky Lake in the late 1940s and early 1950s. TDEC does not have the physical characteristics of the materials used to construct the impoundment nor the permeability of the dike structure upon completion. At the TVA Johnsonville site, the Tennessee River flows from the south to the north. To determine if the river is influencing the movement of groundwater within the active CCR surface impoundment, TVA shall propose a dye study to determine if the river is influencing ground water movement. TVA shall include in its amended Johnsonville EIP a groundwater dye study to determine the direction of groundwater flow below the active Johnsonville CCR surface impoundment.	TVA understands that TDEC would like to understand more information about the physical characteristics and permeability of dike materials. An alternative plan for the evaluation of groundwater movement has been proposed in this EIP, including hydraulic conductivity testing on wells where this information is lacking. Groundwater flow for Ash Disposal Area 2 will be evaluated using new and existing hydraulic conductivity data, gauging data from recently installed monitoring wells and surface water elevations from the gauging station. The results of the evaluation will be provided in the EAR.	TVA has not adequately responded to the comment. TVA shall propose the requested dye trace study. TVA has agreed to conduct an environmental investigation at the TVA JOF as required in the Commissioner's Order it received and did not appeal. It is TVA's responsibility to submit an Environmental Investigation Plan for TDEC's review and make changes to the EIP as requested by TDEC. When there are questions concerning any part of the EIP, TVA should discuss their concerns with TDEC and TDEC shall consider TVA's concerns. However, if TDEC and TVA disagree on any matter, TVA shall perform investigative activities as specified by TDEC.
28	3.1	3.1.1	8	1	1	TVA states that it has existing ground water monitoring wells located at the TVA Johnsonville site. TVA shall include the location, description and construction methods for each well in the revised Johnsonville EIP submitted to TDEC in response to TDEC's comments. TVA shall also include the sampling results from each groundwater monitoring well including sampling date, sample results and identifying whether the levels of CCR constituents reported exceed either the MCL levels for CCR constituents or background levels for CCR constituents. Well location shall be identified on a TVA Johnsonville facility map, Results shall be reported in a table by monitoring well, CCR constituent and sampling date. Results shall be reported in µg/L. The wells reported shall include wells TVA installed at Johnsonville as required by the EPA CCR regulations.	The location, description and construction methods for existing groundwater wells and historical groundwater analytical data have been included in the revised EIP. Future sampling results and comparisons to background levels, which have not been calculated, will be included in the EAR.	TVA's response is incomplete. It does not appear that Appendix E contains coordinates, description or construction methods for existing or historical groundwater wells. The groundwater data tables provided are very helpful. However, a few instances where it appears there may be some QC issues were noted most obviously on the groundwater elevation data (e.g., JOF-C2 (C-2) GW elevation on 12/4/1991 was 357.84 (21.00 feet below some unidentified reference point) while on 6/11/1992 the groundwater elevation was 373.23 (20.51 ft below some unidentified reference point) . This occurred multiple time in 1993, 1995 at the same location. Well TVA needs to make sure all datums are uniform between historic and current data sets so that comparisons can be drawn. It also appears there are discrepancies at JOF-B4 (B-4). Also if a well was measured and then remeasured the same day please determine which is the appropriate measurement and place an asterisk explaining the discrepancies on the erroneous measurement (e.g., JOF-B10 [89-B10] 3/10/1999). TVA needs to indicate if the measurement is below top of casing, ground elevation or some other reference point.

Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments	JOF EIP Rev 1 TDEC Comment
29	3.1.1	TDEC General Request No. 1	8	2	6	Based on previous historical documents, the general assumption is that although the groundwater gradient is probably very small on the island there is a high probability that a groundwater mound exists beneath the ash pond and that groundwater flows radially out to Kentucky Lake. Therefore, wells on the perimeter of the ash pond will not represent background conditions. This is bolstered by the fact that three of the perimeter wells have had one or more exceedances for at least one CCR pollutant in the previous 7 years.	New locations are proposed for background monitoring water wells as part of the EIP. The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater background levels. Based on the results of the initial phase of work, additional investigations may be proposed to further identify background levels, if CCR constituents are detected in groundwater at concentrations indicating impacts from CCR units. Based on current information, a background monitoring well (JOF-107) is proposed to be installed on the southern end of Active Ash Pond 2. If results from JOF-107 indicate that this well is not suitable as a background well, alternate background monitoring well JOF-115 will be installed on TVA property southeast of the unit and south of U.S. Highway 70.	TDEC understands that if results from JOF-107 installed on the southern end of Active Ash Pond 2 indicate that the well is not suitable as a background well, JOF-115 will be installed. However, JOF-107 will be retained as a downgradient monitoring well.
31	3.1.1	TDEC General Request No. 1	8	2	6	This section calls JOF-115 an alternate potential background well, whereas Appendix E does not indicate that it is an alternate. This well should be installed as indicates on Exhibit 2 and Appendix E and not be an alternate.	JOF-115 is proposed to be installed as an alternate background well if results from proposed background well JOF-107 indicate that JOF-107 is not an appropriate location for a background well. JOF-115 will be installed, if necessary, after the initial phase of investigation activities. Appendix E has been revised to show JOF-115 as a proposed alternate background well.	see response to comment #29
33	3.1.2	TDEC General Request No. 2	12	All	All	TVA's assertion that Ash Disposal Area 1 (Ponds A, B, and C) that were reclaimed, retired, and located on Chemours property are "beyond the scope of the TDEC Order " is incorrect. These areas must be included in the EIP process and investigated. This includes all aspects of the EIP process.	The TDEC Order requires the investigation of active and inactive CCR disposal areas at TVA fossil plant sites. This does not include the investigation of offsite property not owned by TVA. In particular, at this location, the unit in question has been owned by a neighboring chemical plant since the early 1950s. TVA began placing CCR in the unit during the last approximately six months of TVA's ownership and continued sending CCR to the unit until 1970. It is TVA's understanding that, during this time period, the property owner also disposed of CCR in this unit. Thus, during the past 60 years, entities other than TVA have disposed of CCR and likely non-CCR waste in the offsite unit. As a result, the TVA and non-TVA waste were and are intermingled in the unit in a way that makes it likely impossible to distinguish the TVA contributions and impacts for investigation purposes. For this reason, using the TDEC Order process, with TVA as the sole investigating entity, is inappropriate and would reach an inequitable result because it would require TVA to engage in an investigation and corrective action process to address a third-party's unit with potentially significant non-TVA contributions. This is a unique situation that is different from all other "disposal areas" being addressed under the TDEC Order. If TDEC desires remediation of this offsite unit, TDEC has other authorities available to it to cause such remediation and that would properly allow the direct involvement of the property owner and all entities responsible for solid waste disposal in the unit. Given the history of this unit, a process that allows multiple parties to be involved in the investigation and remediation process seems more appropriate and to better reflect the actual usage of the unit.	TDEC agrees that the investigation and remediation of Ash Disposal Area 1 (Ponds A, B, and C) that were reclaimed, retired, and located on Chemours property will require the participation of all entities responsible for disposal within the units. TDEC will review possible options and initiate additional investigation activities outside the Commissioner's Order. However, if during the course of the investigation at the JOF it is determined that contamination has migrated off-site, TVA is required by the Commissioner's Order to investigate the horizontal and vertical extent of the contamination regardless of location.
34	3.1	3.1.2	12	2	1	TVA maintains that it is not responsible for CCR material that it discharged in historic Surface Impoundments A, B and C. TVA originally owned property where ponds A, B and C are located but sold it to DuPont in 1956, retaining the right to discharge CCR waste water into the ponds for an additional 15 years. TVA maintains that it did not discharge CCR containing wastewater into these ponds after 1970. TVA maintains that the Commissioner's Order does not include investigation of CCR disposal sites outside its current property boundaries, even if TVA performed the disposal activities. TDEC does not agree with TVA's position. TVA did own property at the TVA Johnsonville Plant that was used for disposal of CCR materials and then sold a portion of the property. Change in ownership of the property will require TVA to obtain permission to investigate and remediate areas of CCR disposal on property it previously owned. The Commissioner's Order requires TVA to investigate and remediate all locations where TVA disposed of CCR material. As stated in the Commissioner's Order on page 4: Scope of the Order VI. This Order shall apply to all "CCR disposal areas" at the coal-power plant sites listed below that TVA operates or has operated in Tennessee (hereinafter sites or plants). "CCR disposal areas" include all areas where CCR disposal has occurred, including without limitation, all permitted landfills, all "non-registered" landfills (landfills that existed before they were subject to regulation), and all current and former surface water impoundments that contain CCR. • Allen Fossil Plant • Cumberland Fossil Plant • Johnsonville Fossil Plant • Kingston Fossil Plant • Bull Run Fossil Plant • John Sevier Fossil Plant • Watts Bar Plant	The TDEC Order requires the investigation of active and inactive CCR disposal areas at TVA fossil plant sites. This does not include the investigation of offsite property not owned by TVA. In particular, at this location, the unit in question has been owned by a neighboring chemical plant since the early 1950s. TVA began placing CCR in the unit during the last approximately six months of TVA's ownership and continued sending CCR to the unit until 1970. It is TVA's understanding that, during this time period, the property owner also disposed of CCR in this unit. Thus, during the past 60 years, entities other than TVA have disposed of CCR and likely non-CCR waste in the offsite unit. As a result, the TVA and non-TVA waste were and are intermingled in the unit in a way that makes it likely impossible to distinguish the TVA contributions and impacts for investigation purposes. For this reason, using the TDEC Order process, with TVA as the sole investigating entity, is inappropriate and would reach an inequitable result because it would require TVA to engage in an investigation and corrective action process to address a third-party's unit with potentially significant non-TVA contributions. This is a unique situation that is different from all other "disposal areas" being addressed under the TDEC Order. If TDEC desires remediation of this offsite unit, TDEC has other authorities available to it to cause such remediation and that would properly allow the direct involvement of the property owner and all entities responsible for solid waste disposal in the unit. Given the history of this unit, a process that allows multiple parties to be involved in the investigation and remediation process seems more appropriate and to better reflect the actual usage of the unit.	TDEC agrees that the investigation and remediation of Ash Disposal Area 1 (Ponds A, B, and C) that were reclaimed, retired, and located on Chemours property will require the participation of all entities responsible for disposal within the units. TDEC will review possible options and initiate additional investigation activities outside the Commissioner's Order. However, if during the course of the investigation at the JOF it is determined that contamination has migrated off-site, TVA is required by the Commissioner's Order to investigate the horizontal and vertical extent of the contamination regardless of location.

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35	3.1	3.1.3	13	2	5	TVA again states it does not intend to include in its TVA JOF EIP the investigation of CCR material disposed of by TVA on property it previously owned but since sold. The Commissioner's Order requires TVA to take this action. While TVA no longer owns property adjacent to the TVA JOF, the CCR disposal activity occurred when TVA owned the property. TDEC will assist TVA in obtaining access to the adjacent property if necessary. TVA shall describe the strategy it will use to gain access to the adjacent TVA JOF property owned by DuPont and now subsequent owner	The TDEC Order requires the investigation of active and inactive CCR disposal areas at TVA fossil plant sites. This does not include the investigation of offsite property not owned by TVA. In particular, at this location, the unit in question has been owned by a neighboring chemical plant since the early 1950s. TVA began placing CCR in the unit during the last approximately six months of TVA's ownership and continued sending CCR to the unit until 1970. It is TVA's understanding that, during this time period, the property owner also disposed of CCR in this unit. Thus, during the past 60 years, entities other than TVA have disposed of CCR and likely non-CCR waste in the offsite unit. As a result, the TVA and non-TVA waste were and are intermingled in the unit in a way that makes it likely impossible to distinguish the TVA contributions and impacts for investigation purposes. For this reason, using the TDEC Order process, with TVA as the sole investigating entity, is inappropriate and would reach an inequitable result because it would require TVA to engage in an investigation and corrective action process to address a third-party's unit with potentially significant non-TVA contributions. This is a unique situation that is different from all other "disposal areas" being addressed under the TDEC Order. If TDEC desires remediation of this offsite unit, TDEC has other authorities available to it to cause such remediation and that would properly allow the direct involvement of the property owner and all entities responsible for solid waste disposal in the unit. Given the history of this unit, a process that allows multiple parties to be involved in the investigation and remediation process seems more appropriate and to better reflect the actual usage of the unit.	TDEC agrees that the investigation and remediation of Ash Disposal Area 1 (Ponds A, B, and C) that were reclaimed, retired, and located on Chemours property will require the participation of all entities responsible for disposal within the units. TDEC will review possible options and initiate additional investigation activities outside the Commissioner's Order. However, if during the course of the investigation at the JOF it is determined that contamination has migrated off-site, TVA is required by the Commissioner's Order to investigate the horizontal and vertical extent of the contamination regardless of location.
36	3.1	3.1.3	13	3	1	TVA plans to construct a 3 Dimensional Model of the CCR disposal areas; Coal Yard, Active Ash Pond 2, South Rail Loop Area 4, DuPont Road, Dredge Cell, and Ash Disposal Area 1 using existing data. TVA states that installing new soil borings where a protective cover of clay and/or synthetic material will compromise the integrity of the cap. Given that these locations have been closed and the historic record was not developed with the intent of determining the amount and location of disposed CCR material, new information is needed to develop a 3 Dimensional model of the disposal areas. There are methods available to install soil borings through final caps that allow installation of borings and subsequent repair of the final cover. Further, the borings may be converted into piezometers that can be used to determine whether there is CCR material in groundwater.	The proposed 3-D model is not a preliminary model. It is based on a thorough evaluation of site-specific data regarding the base, sides, and surface elevations of CCR. To the extent that information is developed during the environmental investigation that affects CCR volume calculations, revisions to the 3-D model will be included in the EAR. Corrective actions based on this 3-D model or any other data found in the EAR will be found in the CARA Plan according to Part VII.A.f of the Order. The historical borings, plus the proposed exploratory borings are sufficient to address this information request without having to drill through and then repair areas with geosynthetics in the final cover. Borings are proposed in select areas with soil-only final cover, which can be repaired (i.e., backfilled) relatively simply. Results of proposed borings can be applied to adjacent areas that are covered with geosynthetics.	TVA has not adequately responded to the comment. TVA shall propose the requested borings. While using existing data is acceptable for developing the three-dimensional model, it is imperative to have data from within the landfill itself, especially within Active Ash Pond 2. These areas have been closed at risk and TVA shall install after TDEC's approval, additional borings within the footprints of the Coal Yard, Active Ash Pond 2, South Rail Loop Area 4, DuPont Road Dredge Cell, and Ash Disposal Area 1. At least one of these locations to a piezometer in order to determine the saturated portion of ash.TVA has agreed to conduct an environmental investigation at the TVA JOF as required in the Commissioner's Order it received and did not appeal. It is TVA's responsibility to submit an Environmental Investigation Plan for TDEC's review and make changes to the EIP as requested by TDEC. When there are questions concerning any part of the EIP, TVA should discuss their concerns with TDEC and TDEC shall consider TVA's concerns. However, if TDEC and TVA disagree on any matter, TVA shall perform investigative activities as specified by TDEC.
39	3.2.2	TDEC General Request #2	16			How does TVA propose to adequately monitor groundwater at Ash Disposal Area 1 with no separation between property owners to the North? Please explain how one can infer that groundwater primarily flows east to west when the adjacent river flows North?	Comment acknowledged; The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater flow and direction. Based on the results of the initial phase of work, additional wells may be proposed. Based on current information, groundwater flows from east to west within Ash Disposal Area 1. Groundwater data collected as part of the proposed investigation activities will be used to evaluate groundwater flow direction and the results will be provided in the EAR.	TDEC is unclear on how groundwater flow can be inferred for the area since there are no current monitoring points located adjacent to the disposal area. However, the four proposed well locations could provide preliminary information on groundwater flow in the area. TDEC requests an additional well installed in an intermediate position between proposed wells JOF-109 and JOF-110.
40	3.2.2	TDEC General Request #2	16			Can TVA adequately monitor groundwater at Ash Disposal Area 1 with no downgradient monitoring wells to the direct north between the two property owners?	Comment acknowledged; The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater flow and direction. Based on the results of the initial phase of work, additional wells may be proposed. Based on current information, groundwater flows from east to west within Ash Disposal Area 1. Groundwater data collected as part of the proposed investigation activities will be used to evaluate groundwater flow direction and the results will be provided in the EAR.	See response to Comment #39
41	3.2.2	TDEC General Request #2	16			How will TVA demonstrate groundwater quality in this area without a representative downgradient monitoring points between the two property owners?	Comment acknowledged; The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater quality. Based on the results of the initial phase of work, additional wells may be proposed. Based on current information, groundwater flows from east to west within Ash Disposal Area 1. Groundwater data collected as part of the proposed investigation activities will be used to evaluate groundwater quality and flow direction and the results will be provided in the EAR.	See response to Comment #39
49	3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends installing additional monitoring points south of JOF-114 to characterize groundwater flow and quality along the western boundary of the Coal Yard. An additional upgradient monitoring well should also be installed along the southeastern boundary.	The proposed coal yard closure plan includes consolidation of CCR material in the northern portion of the coal yard. TVA believes that the proposed monitoring network is adequate for the intended area. Additionally, groundwater may not be present in the unconsolidated materials above bedrock south of JOF-114. The results of the initial phase of work will be evaluated and if data gaps exist, additional wells may be proposed.	TVA has not adequately responded to the comment. TVA shall provide the proposed coal yard closure plan for review. TVA shall propose locations for the requested monitoring wells. Groundwater flow on the southwestern side of the Coal Yard is not fully characterized and requires a monitoring well to characterize groundwater flow and quality along the southwestern boundary of the Coal Yard. TVA has agreed to conduct an environmental investigation at the TVA JOF as required in the Commissioner's Order it received and did not appeal. It is TVA's responsibility to submit an Environmental Investigation Plan for TDEC's review and make changes to the EIP as requested by TDEC. When there are questions concerning any part of the EIP, TVA should discuss their concerns with TDEC and TDEC shall consider TVA's concerns. However, if TDEC and TVA disagree on any matter, TVA shall perform investigative activities as specified by TDEC.

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50	3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends observation well JOF-105 be added as a groundwater quality monitoring well to characterize groundwater flow and quality southwest of the DuPont Dredge Cell. If this is not feasible, a new well should be installed along the southwestern boundary of the DuPont Dredge Cell for this purpose.	Well JOF-105 has recently been installed and is currently being evaluated in cooperation with the Nashville TDEC field office. This well will be added to the groundwater network if deemed appropriate.	TVA will evaluate the well with the TDEC CCR Team. Please provide any well completion diagrams, well logs, soil, and groundwater data generated for JOF-105. If monitoring well JOF-105 is not an appropriate well to monitor the southwestern potential flow path then a new well will be required along the southwestern boundary of the DuPont Dredge Cell for this purpose.
51	3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends an additional monitoring well be installed along the northeastern boundary of the South Rail Loop Area 4 to adequately characterize groundwater quality and flow.	Monitoring wells B-9 and JOF-101 are currently located east of South Rail Loop Area 4 as background locations. The area northeast of the South Rail Loop Area 4 would be expected to be in an upgradient location; therefore, an additional well in that location in not needed at this time. Nested vibrating wire piezometers are planned for installation in the South Rail Loop Area 4 along the northeastern boundary as part of the Geotechnical Stability SAP. Data collected from the existing monitoring well network and the planned piezometers will be evaluated to investigate groundwater quality and flow direction. Based on the results of the initial phase of work, additional investigations may be proposed to further evaluate groundwater quality and flow.	In reviewing the provided groundwater data, there were no analytical results for well WP-4 however there were some limited physical data which did not seem to indicate elevated specific conductance and monitoring well B-9 (although more than 500 ft east of the landfill) has not shown any elevated metals concentrations for the past few years. This comment can be deferred pending the results of the initial phase of investigation.
52	3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends observation well JOF-102 be added as a groundwater quality monitoring well to characterize groundwater flow and quality south of the South Rail Loop Area 4. If this is not feasible, a new well should be installed along the southern boundary of the South Rail Loop Area 4 for this purpose.	Well JOF-102 has recently been installed and is currently being evaluated in cooperation with the TDEC field office. This well will be added to the groundwater network if deemed appropriate.	TVA will evaluate the well with the TDEC CCR Team. Please provide any well completion diagrams, well logs, soil, and groundwater data generated for JOF-102. If monitoring well JOF-102 is not an appropriate well to monitor the southern potential flow path then a new well will be required along the southern boundary of the South Rail Loop Area 4 for this purpose.
54	3.3.5	TDEC Active Ash Pond 2 Request No. 5	25	3	All	TVA states in this paragraph that active Ash Pond 2 will be closed and capped as a result of a 2011 agreement with the EPA. One of the purposes of the EIP process is the fully investigate the site and develop a CARA plan that will include the methods TVA will employ to remove and/or close in place CCR material at the site. TDEC recommends any closure activities at the site be completed after the EIP process is complete and an appropriate remedy has been selected for the site.	On April 14, 2011, TVA entered into a Federal Facilities Compliance Agreement (FFCA) with EPA, and a parallel Consent Decree (CD) with the States of Alabama, North Carolina, and Tennessee, the Commonwealth of Kentucky, and three environmental advocacy groups. The purpose of these agreements was to resolve disputes arising under the Clean Air Act. Under the FFCA and CD, TVA was required to retire all ten units at the Johnsonville Fossil Plant by December 31, 2017. Consistent with these requirements, all ten units are now retired. TVA may need to close Active Ash Pond 2 as required by the EPA CCR Rule before the CARA plan required by the Order can be development and/or implemented.	Any closure actions that occur prior to complete characterization of the site as part of the EIP process are considered "at risk". Based on the results of the EIP, TVA may be required to take other and further remedial action at the site.
59	3.4.2	Background Soil SAP	27	5	7	Will a background concentration be determined for each soil type? Please explain how many samples from each soil type will be considered a valid test population for statistical evaluation.	TVA proposes to collect a minimum of 12 background samples from each soil horizon or geographic strata for the purpose of establishing background concentrations of CCR parameters. Twelve samples is consistent with other State's guidance (Ohio) and consistent with the findings presented in Gilbert, 1987. Twelve samples also exceeds the recommended number of samples for several other States (n=4 for Wisconsin and Alabama). If TDEC has specific regulatory guidance on the number of samples required, please provide that guidance to TVA.	TVA should only develop background levels of constituents by totaling analytical results from soil samples from the same soil horizon. There should always be a minimum of 10 soil samples from the same soil horizon used to calculate the background levels of constituents. This may lead to different multiple background levels for a constituent within the profile of one boring.
68	Appendix C, Section 9.1.2	QAPP	23	4	9	Some of the requirements in the QAPP are written as should. The QAPP must be written as what will be done. If multiple coolers are needed, one COC Record ~~should~~ will accompany each cooler that contains the samples identified on the COC.	"Should" has been replaced with "will."	In keeping with verbiage used in previous EIPs. The word "will" will be replaced with "shall" where a TDEC regulation, rule or the Order is explicitly referenced. In all other uses, the word "will" can be interpreted by TDEC as having the same meaning as "shall" and reflect TVA's commitment to performing the specified task, action, activity, etc.
70	Appendix C, Section 11.1	QAPP	29	4	6	At least 10% of the screening data ~~should~~ will be confirmed using appropriate analytical methods and QA/QC procedures and cri teria associated with definitive data.	"Should" has been replaced with "will."	see response to Comment #68
73	Appendix C, Section 13.1	QAPP	37	1	2	Field pH meters used for collecting data will have to meet the calibration requirements of Method 9040C , which is 0.05 pH units of the bracketing buffer solution values. The QAPP references SESDPROC-100-R3, January 2013 and the TVA TI ENV-TI-05.80.46 which only require calibration to 0.1 SU.	TVA disagrees with the need to calibrate field pH meters according to the acceptance criteria published in SW-846 Method 9040C. The referenced acceptance criteria of +/- 0.1 pH units (EPA Region 4 SESDPROC-100-R3, January 2013) have been established for regulatory applications by EPA Region 4 Science and Ecosystem Support Division and are appropriate for pH readings under the JOF EI.	TVA will calibrate field pH meters to meet the requirements of 9040C.
74	Appendix C, Section 13.1	QAPP	37	2	4	Maintenance ~~should~~ will be performed when the instrument will not adequately calibrate. Maintenance of field equipment ~~should~~ will be noted in an instrument logbook or field notebook.	"Should" will be replaced with "will."	see response to Comment #68
75	Appendix C, Section 17.0	QAPP	47	3	2	This audit report ~~should~~ will include a list of observed field activities, a list of reviewed documents, and any obs erved deficiencies.	"Should" will be replaced with "will."	see response to Comment #68
76	Appendix C, Section 19.5	QAPP	54	1	4	By providing specific protocols for obtaining and analyzing samples, data sets ~~should~~ will be comparable regardless of who collects the sample or who performs the sample analysis.	"Should" will be replaced with "will."	see response to Comment #68
79	Appendix C, QAPP Appendix A	QAPP Appendix A.1	A-3	1	3	In the event that certain required information is not included on a particular form, the laboratory should will provide additional documentation (e.g., preparation logs or analytical run logs) to ensure that the minimum required level of documentation is supplied.	"Should" will be replaced with "will."	see response to Comment #68
80	Appendix C, QAPP Appendix A	QAPP Appendix A.2	A-14	1	3	In the event that certain required information is not included on a particular form, the laboratory should will provide additional documentation (e.g., preparation logs or analytical run logs) to ensure that the minimum required level of documentation is supplied.	"Should" will be replaced with "will."	see response to Comment #68

Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments	JOF EIP Rev 1 TDEC Comment
85	Appendix E, Section 4.0	Monitoring Well Locations	4	3	10	TVA proposes JOF-115 as a potential background monitoring well. This well may not be suitable as groundwater quality may be influenced by the South Rail Loop Area 4 located to the northeast. TDEC recommends installing potential background monitoring wells up gradient of existing coal ash disposal areas. JOF-101 should be considered for a possible background location.	Monitoring well JOF-101 was specifically cited as not being in an appropriate location to serve as a background monitoring well for Active Ash Pond 2. TVA has attempted to meet TDEC requirements by proposing to install monitoring well JOF-107. If, after evaluation of groundwater quality data a determination is made that JOF-107 is not an appropriate background location, TVA proposes to install JOF-115. To be able to evaluate impacts of individual CCR units, background monitoring wells need to be installed between various units or other potential sources of CCR constituents. TVA believes that the proposed location for JOF-115 is appropriate. If an alternate to location JOF-115 is deemed necessary at a later time, then TVA will propose an alternate location and provide to TDEC for review. The proposed scope of work is consistent with an initial phase needed to evaluate groundwater. Based on the results of the initial phase of work, results will be evaluated and changes to the monitoring well network proposed, as necessary.	Agreed, JOF 101 does no appear to be an appropriate background monitoring well location for Active Ash Pond 2. TDEC understands that if results from JOF-107 installed on the southern end of Active Ash Pond 2 indicate that the well is not suitable as a background well, JOF-115 will be installed. However, JOF-107 will be retained as a downgradient monitoring well.
88	Appendix E, Section 5.2	Hydrogeological Investigation SAP	7	2	2	The elevation of the established and documented point on the top of each well casing will be correlated to Mean Sea Level	In order to align with existing data, the top of each well casing will be surveyed and correlated to the vertical datum used by the Plant.	That is acceptable as long as a cross walk is provided that indicates what the Plant datum's equivalency is to MSL.
89	Appendix E, Section 5.2.6	Hydrogeological Investigation SAP	10	2	1	Distribution of cuttings and discharge of water ~~should~~ will be performed in a manner as to not create a safety hazard.	"Should" will be replaced with "will."	see response to Comment #68
111	Appendix F, Table 5	Groundwater Investigation SAP	15	Table 5		Field pH meters used for collecting data will have to meet the calibration requirements of Method C , which is 0.05 pH units of the bracketing buffer solution values. There is not a hold time associated with the field measurement of pH by Method 9040C.	TVA disagrees with the need to calibrate field pH meters according to the acceptance criteria published in SW-846 Method 9040C. The referenced acceptance criteria of +/- 0.1 pH units (EPA Region 4 SESDPROC-100-R3, January 2013) have been established for regulatory applications by EPA Region 4 Science and Ecosystem Support Division and are appropriate for pH readings under the JOF EI.	see response to Comment #73
112	Appendix F, Section 5.2.8	Groundwater Investigation SAP	16	4	1	Distribution of cuttings and discharge of water ~~should~~ will be performed in a manner as to not create a safety hazard.	"Should" will be replaced with "will."	see response to Comment #68
115	Appendix H, Section 5.2.7	Material Quantity SAP	13	4	1	Distribution of cuttings and discharge of water ~~should~~ will also be performed in a manner as not to create a safety hazard.	"Should" will be replaced with "will."	see response to Comment #68

Appendix B – Table 2

Summary of TDEC Comments & TVA Responses

May 11, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments	JOF EIP Rev 1 TDEC Comment	TVA Response to JOF EIP Rev 1 TDEC Comment
New (165)	General	General	NA	NA	NA			Current static pore water elevation for both pond 1 & 2 shall be provided in a table from borings or piezometers placed inside the impoundment.	Water levels from wells and piezometers, including those installed per the EIP, will be presented in the EAR.
New (166)	General	General	NA	NA	NA			The elevations mentioned above shall be used for stability calculations for existing conditions.	For proposed stability analyses, recent water levels, including those measured per the EIP (see response to Comment #165), will be considered. When existing stability analyses are to be leveraged, recent water levels will be compared to the modeled levels to confirm that the analyses are still suitable.
New (167)	General	General	NA	NA	NA			TVA shall provide proposed static pore water elevations for closure with stability calculations	TVA agrees to provide the results from the closure design analyses in the EAR (if analyses are available at the time of EAR issue). Documentation of the closure design will include discussion of the modeled pore water pressures (i.e., water levels).
New (168)	General	General	NA	NA	NA			TVA shall provide a plan on how they will minimize mounding inside the impoundments after closure.	In the proposed closure design (subject to TDEC approval), the CCR will be regraded to gentle slopes, and a final cap will be constructed. The final cap will have a low hydraulic conductivity and will be sloped to limit surface water infiltration. By limiting infiltration, the closure design will, over time, lead to lower phreatic levels and reduced pore water pressures within the unit.
New (169)	3.1.1	TDEC General Request	8	1	All			TVA discusses the construction materials used to construct Active Ash Pond 2. Given the construction material and the volume of CCR material disposed in Active Ash Pond 2, does TVA have any information about the release of water from the impoundment to the Tennessee River? TVA discusses the use of	Two additional monitoring wells are proposed (one on the northern tip and one on the southeastern corner of Ash Pond 2), which would increase the total number of monitoring wells to six. Existing monitoring wells JOF-10-AP1, JOF-10-AP3, JOF-103 and JOF-104 are currently being sampled for boron as part of CCR Rule

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								existing wells to determine this, however, given the size of the ash pond are the number of wells adequate? In regards to ground water monitoring are the existing wells currently monitored for Boron? Conversely, does TVA have any information that once the ash pond is closed that the level of water in the ash pond will stabilize to the same level of the river? Would a portion of the ash in the ash pond remain below the water level of the river after closure?	requirements as will the new proposed wells. As part of the Material Quantity SAP, the upper and lower surfaces of CCR in Active Ash Pond 2 will be modeled. In the EAR, the elevations of these surfaces will be compared to the water level of the river.
New (170)	3.1.1	TDEC General Request	11	All	All			TVA discusses lowering the height of the current dikes for Active Ash Pond 2 from 390' to 380'. The 500 year flood surface water elevation is listed as 375'. This closure presupposes that TVA will be able to close in place. This should not be in the EIP. It should not be discussed until the Environmental Investigation has been completed. Approving the EIP with this language implies that TDEC agrees with closure in place as the corrective action at this site.	Comment is acknowledged, and the text has been updated to clarify that the proposed closure design is subject to TDEC approval.
New (171)	3.3.5	TDEC General Request	29	5	1			The language concerning filling and capping Active Ash Pond 2 shall be removed. The corrective action for this site shall be determined by the information gained during the environmental investigation at the TVA JOF site.	Comment is acknowledged, and the text has been updated to clarify that the proposed closure design is subject to TDEC approval.
New (172)	4.1.2	A.2 TDEC Site Information Request No. 2	All	All	All			TVA did not include any material characteristic sample locations from the Coal Yard, DuPont Dredge Cell, Ash Disposal Area 1, or South Rail Loop Area 4. TVA shall propose sample locations from within these units.	To support CCR material characterization, borings with CCR sampling and temporary well installation have been added in Ash Disposal Area 1, Coal Yard, DuPont Road Dredge Cell, and South Rail Loop 4. The Exploratory Drilling SAP and the corresponding figures have been updated to show the location of these additional borings/wells.

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New (173)	Appendix D, Exhibits	Exhibits No. 18	298/1076	NA	NA			The proposed temporary wells indicated on Exhibit 18 shall be converted to permeant piezometers with vibrating wires to monitor the phreatic surface during the post closure care period.	As part of the upcoming decanting project, several borings with nested vibrating wire piezometers (VWPZ) will be installed within the interior of the Active Ash Pond 2 footprint. Each location will monitor pore water pressures in the CCR and foundation soils during decanting, closure, and post-closure. The spatial coverage provided by the VWPZs will provide post-closure data equal to or better than that requested herein.
New (174)	Appendix G	Water Use Survey Sampling	G-3	Table	NA			Why is TVA proposing to use EPA Method 200.8 for Boron with a detection limit of 0.08 mg/L versus EPA Method 200.7 which has a0.0038 mg/L detection limit? Is EPA Method 200.8 an approved method for Boron analysis in water?	EPA 200.8 is an approved method for boron analysis in water under 40 CFR Part 136.3. A single analytical method (ICP/MS) was proposed for all metals to avoid the need for multiple digestions/analyses to report the complete metals list. The detection limit for boron by EPA 200.8 is sufficient for investigation objectives.
New (175)	Appendix H	Groundwater Investigative Sampling	H-3	Table	NA			Why is TVA proposing to use EPA Method 200.8 for Boron with a detection limit of 0.08 mg/L versus EPA Method 200.7 which has a0.0038 mg/L detection limit? Is EPA Method 200.8 an approved method for Boron analysis in water?	EPA 200.8 is an approved method for boron analysis in water under 40 CFR Part 136.3. Please note that SW-846 methodology (i.e., 6020A) will be used for groundwater sampling.
New (176)	Appendix H - Material Quantity SAP	Attachment A - Figures	465/1076	NA	NA			The proposed temporary wells indicated on Figure 3 shall be converted to permeant piezometers with vibrating wires to monitor the phreatic surface during the post closure care period.	As part of the upcoming decanting project, several borings with nested vibrating wire piezometers (VWPZ) will be installed within the interior of the Active Ash Pond 2 footprint. Each location will monitor pore water pressures in the CCR and foundation soils during decanting, closure, and post-closure. The spatial coverage provided by the VWPZs will provide post-closure data equal to or better than that requested herein.

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New (177)	Appendix I	Groundwater Investigative Sampling	I-3	Table	NA			Why is TVA proposing to use EPA Method 200.8 for Boron with a detection limit of 0.08 mg/L versus EPA Method 200.7 which has a0.0038 mg/L detection limit? Is EPA Method 200.8 an approved method for Boron analysis in water?	EPA 200.8 is an approved method for boron analysis in water under 40 CFR Part 136.3. Please note that SW-846 methodology (i.e., 6020A) will be used for groundwater sampling.
New (178)	Appendix J - Exploratory Drilling SAP	Attachment A - Figures	551/1076	NA	NA			The proposed temporary wells indicated on Figure 3 shall be converted to permeant piezometers with vibrating wires to monitor the phreatic surface during the post closure care period.	As part of the upcoming decanting project, several borings with nested vibrating wire piezometers (VWPZ) will be installed within the interior of the Active Ash Pond 2 footprint. Each location will monitor pore water pressures in the CCR and foundation soils during decanting, closure, and post-closure. The spatial coverage provided by the VWPZs will provide post-closure data equal to or better than that requested herein.
New (179)	Appendix L	Material Quantity SAP	L-3	Table	NA			Why is TVA proposing to use EPA Method 6020 for Boron versus EPA Method 2010 which has a 0.0038 mg/L detection limit? Is EPA Method 6020C an approved method for Boron analysis in water?	A single analytical method (ICP/MS) was proposed for all metals to avoid the need for multiple digestions/analyses to report the complete metals list. The detection limit for boron by SW-846 6020A is sufficient for investigation objectives. SW-846 Method 6020A is a published guidance document for ICP/MS analyses of water samples or waste extracts or digests; EPA does not provide “approval” for SW-846 methods. Section 1.3 provides guidance for the determination of analytes not specifically listed in the method (e.g., boron). Boron analyses will be conducted by an analytical laboratory that has demonstrated method performance for boron by SW-846 6020A in accordance with SW-846 guidance.

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New (180)	Appendix P - Stability SAP	All	All	All	All			TVA shall verify through this investigation that inactive CCR landfill and/or surface Impoundments on site are no longer impounding water.	There is no impounded surface water within the boundaries of the closed units at Johnsonville. As part of a post-closure visual inspection, TVA will confirm that there is no impounded surface water within the boundaries of the closed units. The observations will be documented in inspection reports, which will be included in the EAR.
New (181)	Appendix P - Stability SAP	4.0 Plant-Specific Stability Analysis Plan	913/1076	Table 1	NA			Stability Analysis for the Active Ash Pond 2 shall be performed using site-specific phreatic conditions obtained, in part, from site-specific piezometer data obtain in the site investigation. An analysis should included for the proposed cap-in-place closure design. Deformation tolerance shall be demonstrated to be appropriate for all components of the closure design.	For proposed stability analyses, recent water levels, including those measured per the EIP (see response to Comment #165), will be considered. When existing stability analyses are to be leveraged, recent water levels will be compared to the modeled levels to confirm that the analyses are still suitable. As noted in Section 4.4.6 of the EIP, the closure design process for Active Ash Pond 2 is ongoing (and subject to TDEC approval), but static and seismic stability analyses have yet to be performed. The results from the closure design analyses will be provided in the EAR (if analyses are available at the time of EAR issue). Documentation of the closure design will include discussion of the modeled pore water pressures (i.e., water levels) and potential deformations (if any). If the closure design analyses are not available at the time of EAR issue, this documentation will be provided to TDEC as part of the closure process.
New (182)	Appendix P - Stability SAP	5.1.2 Phased Assessment and Acceptance Criteria	918/1072 & 922/1072	All	All			Provide rational for determining the acceptable (tolerable) displacement performance criteria. Provide documentation that justify the stated correlation of 3 feet to a factor of safety of 1.0.	Text will be added in Section 5.1.3.2.1 of the Stability SAP to explain the technical basis for this correlation.

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New (183)	Appendix P - Stability SAP	5.1.2 Phased Assessment and Acceptance Criteria	918/1076	NA	NA			TVA shall work with TDEC to define acceptable performance will need to be established as part of the of Phase 1 Assessment.	During the Phase 1 stability assessment, TVA will work with TDEC to define criteria for acceptable performance that would be utilized during a potential Phase 4 (the final phase) of the proposed phased stability assessment. The factors that contribute to defining acceptable performance will be site-specific and related to the consequences of the predicted deformations. As more site-specific information becomes available after Phase 1, TVA and TDEC may need to revisit the acceptable performance criteria in light of the additional information. The text will be clarified accordingly.
New (184)	Appendix P - Stability SAP	5.1.3 Basis for Load Cases and Acceptance Criteria	920/1076	NA	NA			TVA embankment dam design guidance (TVA 2016) shall be removed from the list of documents used to determine acceptable criteria.	TVA has a significant portfolio of embankment dams, and its design guidance is one of several relevant industry standards that were considered to help inform the proposed load cases and acceptance criteria. The proposed criteria in the Stability SAP do not rely solely on the TVA guidance document. Further, the TVA analysis load cases and acceptance criteria are based upon and generally consistent with other industry standards, such as the dam safety criteria of the U.S. Army Corps of Engineers and the Federal Energy Regulatory Commission. The text will be clarified to emphasize these similarities.

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New (185)	General	General	NA	NA	NA			Coordination of efforts to collect water, sediment, benthos, and fish from the same locations in some cases is worthwhile; however, it appears that there are not always common sample locations for all media. Could a map or matrix be provided indicating which media/sample types are collected at each sample site?	Comment is acknowledged and a matrix of co-located sample locations has been included in the relevant SAPs.
New (186)	General	General	NA	NA	NA			With the exception of selenium and mercury, the CCR contaminants being analyzed don't readily bioaccumulate. Are there meaningful data on other sites to determine whether tissue concentrations are especially elevated for CCR constituents or will the data on upstream sites be the sole data used for these purposes? What effects endpoints (e.g., toxicity, fecundity, growth inhibition) are available in the literature by which to determine whether effects are likely occurring?	TDEC's comment is acknowledged. Concentrations of CCR constituents in fish tissue and mayflies will be evaluated in the context of: location of organisms relative to the facility (upstream vs. adjacent and downstream); findings from other comparable studies conducted in Tennessee and other states; laboratory studies; and published/proposed tissue screening levels. Effects endpoints will be relevant to the species, populations, and communities expected to be present in the creeks and rivers where the facility is located.
New (187)	Appendix T	Surface Water SAP	NA	NA	NA			Will there be a comparison of chemical concentrations to conditions indicating possible environmental harm, for example water quality standards for receiving stream designated uses?	Appropriate screening levels and un-impacted background concentrations will be used to evaluate chemical concentrations in surface water, sediment, etc.
New (188)	Appendix T	Surface Water SAP	12	Table 2	NA			TSS should be measured, it is needed for conversion of total metals concentrations to dissolved standards where applicable.	The Surface Stream SAP currently specifies that TSS will be added to the list of constituents for this program. See asterisk at the bottom of Table 3 of the Surface Stream SAP.

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New (189)	Appendix T	Surface Water SAP	All	All	NA			In what seasons or months are the sampling events going to be conducted and why?	Targeting spring/summer and fall/winter sampling, but allowing field team some flexibility for when these events would occur. Seasonal sampling will allow for capture of temperature and pool level differences.
New (190)	5.2.4	Surface Water SAP	All	All	NA			Some detail is needed with respect to the transects being conducted at different sampling sites to identify the channel thalwag. For example, how many depth assessments will be made at each site and at what distance (or percent of stream width) along the transect?	Comment is acknowledged. The Surface Stream SAP has been modified to include depth measurement and thalweg identification procedures.
New (191)	5.2.4	Surface Water SAP	All	All	NA			Sampling will be conducted during seasonal mean flows and during flows of less than the 75th percentile. The mean would be below the 75th percentile, but you could be below the 75th percentile and be above the mean flow. Which condition will be the determining factor as to when sampling is conducted? Would a better approach be to conduct sampling when flows are between approximately the 25th and 75th percentile? You may want to consider sampling based on the median flow and some range around it.	Comment is acknowledged, and the corresponding changes have been made in the documents.
New (192)	Appendix Q	Benthic SAP	All	All	NA			None of the Boat Harbor or Cove samples' sediment sampling sites are being sampled for benthic macroinvertebrates, why is that?	The three proposed Boat Harbor sediment samples (SED-BH01, SED-BH02, SED-BH03) correspond with the three proposed Boat Harbor benthic macroinvertebrate samples (MAC-BH01, MAC-BH02, Mac-BH03). The three proposed Cove sediment samples (SED-CV01, SED-CV02, SED-CV03) correspond with the three proposed Cove benthic macroinvertebrate samples (MAC-CV01, MAC-CV02, Mac-CV03).

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New (193)	2	Benthic SAP	All	All	All			Are mayflies an appropriate choice for metals tissue analysis and what is the rationale for their use? In addition to being short-lived, they are not sediment-ingesting organisms. Would a crustacean or Corbicula be a better choice to assess metals uptake in benthos?	*Hexagenia* mayflies are relatively long-lived, widely distributed burrowing mayflies that are an important prey resource for higher trophic levels. Mayfly nymphs mature in the sediments and incidentally ingest sediments during feeding, making them susceptible to uptake and accumulation of pollutants present in sediments including metals. Mayfly nymphs are a widely-used organism in sediment bioaccumulation studies. TVA has conducted mayfly sampling for bioaccumulation evaluations at Kingston and Gallatin. Mayfly nymphs are prey items for bottom feeding fish and larger benthic macroinvertebrates. Mayfly adults are prey for insectivorous fish and birds. Thus, mayfly nymphs and adults represent the lowest levels of the aquatic/terrestrial foodchain.
New (194)	5.2.1.3	Benthic SAP	All	All	All			What species will be targeted if sufficient mayflies are not available at a site, and will mayfly sampling and other species sampling be conducted? If so, is it meaningful to compare bioaccumulation data across species?	Mayflies of the genus *Hexagenia* will be used as long as they are recoverable. Other locations may be added if insufficient *Hexagenia* are encountered within the designated areas. If sufficient *Hexagenia* are still not encountered, other organisms such as *Pleurocera* or *Corbicula* will be evaluated as a replacement based on their availability. Bioaccumulation data will not be compared directly across species.
New (195)	5.2.1.3	Benthic SAP	All	All	All			You should also consider use of a collector-gatherer mayfly species since they would have the most exposure to sediments in their diet, burrowing mayflies would be best.	*Hexagenia* are burrowing mayflies (nymphs dig into the sediment and filter feed on organic materials from within that burrow using a current created with their gills).
New (196)	5.2.1.3	Benthic SAP	All	All	NA			By what means will mayfly tissue concentrations be normalized for comparison between sites?	Mayfly tissues will be normalized based on drying specimens, grinding them together, and using a standard amount of dry weight in a mass spectrometer to analyze their chemical makeup.

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New (197)	5.2.1.3	Benthic SAP	All	All	NA			What is the purpose and use of developing depurated vs. non-depurated mayfly data?	Mayfly nymphs of the genus *Hexagenia* ingest sediment while feeding. Predators that feed on mayfly nymphs also ingest the sediment contained in the gut of the nymphs. Adult mayflies do not feed during their short lives on the wing and do not have functional guts. Fish, birds, and other predators that consume adult mayflies would also ingest any CCR constituents that bioaccumulated in tissues (not gut contents) during the nymphal stage. Gut contents are short-term consumed substances which may or may not be absorbed into the organism upon digestion. Purging the gut contents (depuration) prior to laboratory analysis informs evaluation of potential bioaccumulation of CCR metals in mayfly nymph tissues in the absence of metals in the gut contents.
New (198)	5.2.1.3	Benthic SAP	All	All	NA			Would transport of mayflies on ice prior to depuration be a source of stress and thermal shock that would result in their death? What will be the depuration period and is it standard for such assessments?	The TVA Kingston *Standard Operating Procedure for Mayfly Sampling* (TVA-KIF-SOP-29) referenced in Section 5.2.1.3 of the Benthic SAP outlines specific detailed procedures to minimize cold stress. The depuration period will be 48 hours. This is the standard period implemented at Kingston and Gallatin.
New (199)	5.2.5	Benthic SAP	All	All	NA			For sediment analysis, will acid volatile sulfide (AVS) analyses be conducted to compare to molar concentrations of metals known to be strongly bound by AVS?	Sediment analysis will be consistent with TVA SOPs, SAPs, and historical studies. Studies at Kingston showed AVS levels in the Vibecore samples were at or below detection limits, and Sequentially Extractable Metals concentrations were also low. With that limitation, assuming actual values were at the detection limits or as reported, AVS/SEM ratios were 0.90, 0.67, 0.63, and 1.10. Based on the results of the proposed sediment sampling, TVA will discuss the need for additional sampling, including

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									AVS/SEM, with TDEC.
New (200)	5.2.5	Benthic SAP	All	All	NA			Will sediment contaminant concentrations be expressed on a dry weight basis?	Sediment contaminant concentrations will be expressed on a dry weight basis.
New (201)	2	Benthic SAP	All	All	NA			What is the basis of the 20 percent ash content as the value that triggers additional sediment analysis	Based on previously conducted studies at Kingston, a threshold of 40% ash resulted in benthic impacts. TVA has therefore established 20% ash as a conservative Phase 1 sediment sample result to trigger subsequent Phase 2 activities.
New (202)	Appendix Q	Benthic SAP	All	All	NA			The sampling is often referred to as quantitative. A ponar sampler will penetrate to different depths based on substrate composition. How will identical sample sizes be ensured for appropriate site-to-site comparison?	Identical sample size is not required for comparison of the seven Reservoir Benthic Index (RBI) metrics listed below traditionally used by TVA to evaluate benthic macroinvertebrate populations: • Average number of taxa • Proportion of samples with long-lived organisms • Average number of *Ephemeroptera*, *Plecoptera*, and *Trichoptera* (EPT) taxa • Average proportion of oligochaete individuals • Average proportion of total abundance comprised by the two most abundant taxa • Average density excluding chironomids and oligochaete • Proportion of samples containing no organisms
New (203)	Appendix Q	Benthic SAP	All	All	NA			How will you ensure that benthic community samples are collected from similar habitats/substrates so that any differences observed are due to contaminant concentrations and not habitat or substrate composition? Would sediment particle size analysis, photographs	Habitats/substrates will be documented in the field; however, it is impossible to ensure that all benthic community samples will be collected from similar habitats/substrates while ensuring sample collection from representative areas of potential

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								and notes related to habitat and substrate composition at each site assist in interpretation of benthic community composition data?	contamination, background areas, etc. Reservoir Benthic Index (RBI) metrics will result in a benthic index score or very poor, poor, fair, good, or excellent independent of habitat/substrate, and qualitative assumptions regarding RBI scores can be inferred if habitats/substrates differ dramatically. In addition, benthic community samples are being collected from four historical sample transects which will allow evaluation of temporal trends. Sediment particle size analysis is not proposed as the current procedures, analyses, and metrics will adequately document habitat and community composition both temporally and spatially.
New (204)	Appendix Q	Benthic SAP	All	All	NA			The bioavailability and toxicity of chemicals cannot be accurately predicted based on chemical data alone. Would toxicity testing be a better approach or a good supplement to the proposed approach to assess contaminant effects between sites? If so, the concentrations of natural toxicants such as ammonia and dissolved sulfide should also be determined to support data interpretation.	Toxicity testing could be a good supplement to the proposed approach if there is evidence of adverse effects on aquatic ecology in adjacent water bodies. The proposed approach of evaluating bioaccumulation of CCR in fish and mayflies, and evaluating fish and benthic community structure for evidence of CCR impacts should be the first phase, since it focuses on whether there are any observable adverse ecological effects of bioaccumulation to levels that approach or exceed published toxicity thresholds. Based on the results of the proposed benthic sampling, TVA will discuss the need for additional sampling, including toxicity testing and ammonia/dissolved sulfide analysis, with TDEC.

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New (205)	Table 5	Benthic SAP	All	All	NA			It may also be useful to include ammonia and dissolved sulfide analysis in the proposed plan to support interpretation of benthic community data.	See response to 204 above
New (206)	Appendix U	Fish SAP	All	All	NA			It would be beneficial to do the tissue processing in the laboratory instead of the field. Removal of liver and ovary might be easier in the lab and/or better ensure lack of contamination during processing.	Comment is acknowledged, and the corresponding changes have been made in the documents. The appropriate quality assurance/quality control procedures will be in place to avoid potential contamination during process are as outlined in the Fish Tissue SAP and QAPP.
New (207)	Appendix U	Fish SAP	All	All	NA			It is recommended to analyze individually any larger fish to supplement data obtained from the composite samples.	Section 5.2.1.2 of the Fish Tissue SAP specifies that the smallest fish in a composite be no less than 75% of the total length of the largest fish in the composite which is standard protocol. The size of the fish is generally correlated with age and with length of potential exposure to chemicals in the environment. Thus, the body burden of CCR in an individual fish that is larger than the size range of the composite may not be comparable.
New (208)	5.2.5	Fish SAP	All	All	NA			Is "gel ice" a potential source of contamination?	Comment is acknowledged, and the corresponding changes have been made in the documents. Wet ice or dry ice will be used. Gel ice will not be used.

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New (209)	Appendix U	Fish SAP	All	All	NA			A single composite tissue sample will be collected in most cases. How will data analysis be conducted when sample size is n = 1?	As described in the SAP, multiple composite samples will be collected from areas upstream, adjacent to, and downstream of JOF. Tissue composites of each representative trophic level species will be collected for analysis of CCR constituents in whole body (shad), muscle tissue, liver, and ovaries. The approach for comparing analytical results between locations will be determined upon examination of the data.
New (210)	5.2.4	Fish SAP	All	All	NA			How will you determine whether you have “unexpected” results and that the retained split sample should be analyzed given that only one (composite) sample will be collected from each site? As a trigger, it is recommended that you use TDEC fish tissue criteria as applicable for additional analysis. If fillet composite exceeds criteria, then individual fillets should be analyzed from retained sample.	For the purpose of the Fish Tissue SAP, unexpected results could refer to any of the following: 1) elevated laboratory method detection limits in one or more samples; 2) elevated detection limits for one or more CCR analytes; 3) other issues identified by the analytical laboratory; and 4) results for one or more CCR analytes in a sample that are notably higher or lower than the range of results for the same analyte detected in all other composites from the same sampling reach, or the range of results from composites of the same trophic level fish across all sampling reaches from the same sampling event.
2	All	All	All	All	All	TDEC recommends conducting a leachability characterization study that includes an evaluation of CCR parameters from pore water and solid material samples from locations that would characterize the vertical and lateral distribution of leachability characteristics across the facility.	Comment acknowledged - This revision of the JOF EIP will include a Material Characteristics SAP to evaluate leachability.	TVA did not include any material characteristic sample locations from the Coal Yard, DuPont Dredge Cell, Ash Disposal Area 1, or South Rail Loop Area 4. TVA shall propose sample locations from within these units.	To support CCR material characterization, borings with CCR sampling and temporary well installation have been added in Ash Disposal Area 1, Coal Yard, DuPont Road Dredge Cell, and South Rail Loop 4. The Exploratory Drilling SAP and the corresponding figures have been updated to show the location of these additional borings/wells.

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20	General Technical	NA	NA	NA	NA	The active Johnsonville CCR surface impoundment was constructed within Kentucky Lake in the late 1940s and early 1950s. TDEC does not have the physical characteristics of the materials used to construct the impoundment nor the permeability of the dike structure upon completion. At the TVA Johnsonville site, the Tennessee River flows from the south to the north. To determine if the river is influencing the movement of groundwater within the active CCR surface impoundment, TVA shall propose a dye study to determine if the river is influencing ground water movement. TVA shall include in its amended Johnsonville EIP a groundwater dye study to determine the direction of groundwater flow below the active Johnsonville CCR surface impoundment.	TVA understands that TDEC would like to understand more information about the physical characteristics and permeability of dike materials. An alternative plan for the evaluation of groundwater movement has been proposed in this EIP, including hydraulic conductivity testing on wells where this information is lacking. Groundwater flow for Ash Disposal Area 2 will be evaluated using new and existing hydraulic conductivity data, gauging data from recently installed monitoring wells and surface water elevations from the gauging station. The results of the evaluation will be provided in the EAR.	TVA has not adequately responded to the comment. TVA shall propose the requested dye trace study. TVA has agreed to conduct an environmental investigation at the TVA JOF as required in the Commissioner's Order it received and did not appeal. It is TVA's responsibility to submit an Environmental Investigation Plan for TDEC's review and make changes to the EIP as requested by TDEC. When there are questions concerning any part of the EIP, TVA should discuss their concerns with TDEC and TDEC shall consider TVA's concerns. However, if TDEC and TVA disagree on any matter, TVA shall perform investigative activities as specified by TDEC.	Comment acknowledged, a dye trace study has been included as Appendix K in this revision of the EIP.

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28	3.1	3.1.1	8	1	1	TVA states that it has existing ground water monitoring wells located at the TVA Johnsonville site. TVA shall include the location, description and construction methods for each well in the revised Johnsonville EIP submitted to TDEC in response to TDEC's comments. TVA shall also include the sampling results from each groundwater monitoring well including sampling date, sample results and identifying whether the levels of CCR constituents reported exceed either the MCL levels for CCR constituents or background levels for CCR constituents. Well location shall be identified on a TVA Johnsonville facility map, Results shall be reported in a table by monitoring well, CCR constituent and sampling date. Results shall be reported in µg/L. The wells reported shall include wells TVA installed at Johnsonville as required by the EPA CCR regulations.	The location, description and construction methods for existing groundwater wells and historical groundwater analytical data have been included in the revised EIP. Future sampling results and comparisons to background levels, which have not been calculated, will be included in the EAR.	TVA's response is incomplete. It does not appear that Appendix E contains coordinates, description or construction methods for existing or historical groundwater wells. The groundwater data tables provided are very helpful. However, a few instances where it appears there may be some QC issues were noted most obviously on the groundwater elevation data (e.g., JOF-C2 (C-2) GW elevation on 12/4/1991 was 357.84 (21.00 feet below some unidentified reference point) while on 6/11/1992 the groundwater elevation was 373.23 (20.51 ft below some unidentified reference point) . This occurred multiple time in 1993, 1995 at the same location. Well TVA needs to make sure all datums are uniform between historic and current data sets so that comparisons can be drawn. It also appears there are discrepancies at JOF-B4 (B-4). Also if a well was measured and then remeasured the same day please determine which is the appropriate measurement and place an asterisk explaining the discrepancies on the erroneous measurement (e.g., JOF-B10 [89-B10] 3/10/1999). TVA needs to indicate if the measurement is below top of casing, ground elevation or some other reference point.	Available monitoring well coordinates, description and construction methods for existing and closed wells are included in table format in Appendix O. Historical well measurements were obtained from a groundwater database. The differences in groundwater elevations at the same location over time could potentially be related to well repairs and re-surveying the location, obstructions in the well, conversion of units and/or human error. Water levels and depths to the bottom of the monitoring wells were measured from the top of the well casings. Groundwater elevations for existing wells will be confirmed during the investigation and provided in interim monthly reports and the EAR.

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Summary of TDEC Comments & TVA Responses

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29	3.1.1	TDEC General Request No. 1	8	2	6	Based on previous historical documents, the general assumption is that although the groundwater gradient is probably very small on the island there is a high probability that a groundwater mound exists beneath the ash pond and that groundwater flows radially out to Kentucky Lake. Therefore, wells on the perimeter of the ash pond will not represent background conditions. This is bolstered by the fact that three of the perimeter wells have had one or more exceedances for at least one CCR pollutant in the previous 7 years.	New locations are proposed for background monitoring water wells as part of the EIP. The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater background levels. Based on the results of the initial phase of work, additional investigations may be proposed to further identify background levels, if CCR constituents are detected in groundwater at concentrations indicating impacts from CCR units.Based on current information, a background monitoring well (JOF-107) is proposed to be installed on the southern end of Active Ash Pond 2. If results from JOF-107 indicate that this well is not suitable as a background well, alternate background monitoring well JOF-115 will be installed on TVA property southeast of the unit and south of U.S. Highway 70.	TDEC understands that if results from JOF-107 installed on the southern end of Active Ash Pond 2 indicate that the well is not suitable as a background well, JOF-115 will be installed. However, JOF-107 will be retained as a downgradient monitoring well.	Comment is acknowledged. Please note that wells have been renumbered such that JOF-107 is now JOF-119 and JOF-115 is now JOF-120. If results from JOF-119 indicate that the well is not suitable as a background well, JOF-120 will be installed and JOF-119 will be retained as a downgradient monitoring well.
31	3.1.1	TDEC General Request No. 1	8	2	6	This section calls JOF-115 an alternate potential background well, whereas Appendix E does not indicate that it is an alternate. This well should be installed as indicates on Exhibit 2 and Appendix E and not be an alternate.	JOF-115 is proposed to be installed as an alternate background well if results from proposed background well JOF-107 indicate that JOF-107 is not an appropriate location for a background well. JOF-115 will be installed, if necessary, after the initial phase of investigation activities. Appendix E has been revised to show JOF-115 as a proposed alternate background well.	see response to comment #29	Refer to response to comment #29.

Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments	JOF EIP Rev 1 TDEC Comment	TVA Response to JOF EIP Rev 1 TDEC Comment
33	3.1.2	TDEC General Request No. 2	12	All	All	TVA's assertion that Ash Disposal Area 1 (Ponds A, B, and C) that were reclaimed, retired, and located on Chemours property are "beyond the scope of the TDEC Order " is incorrect. These areas must be included in the EIP process and investigated. This includes all aspects of the EIP process.	The TDEC Order requires the investigation of active and inactive CCR disposal areas at TVA fossil plant sites. This does not include the investigation of offsite property not owned by TVA. In particular, at this location, the unit in question has been owned by a neighboring chemical plant since the early 1950s. TVA began placing CCR in the unit during the last approximately six months of TVA's ownership and continued sending CCR to the unit until 1970. It is TVA's understanding that, during this time period, the property owner also disposed of CCR in this unit. Thus, during the past 60 years, entities other than TVA have disposed of CCR and likely non-CCR waste in the offsite unit. As a result, the TVA and non-TVA waste were and are intermingled in the unit in a way that makes it likely impossible to distinguish the TVA contributions and impacts for investigation purposes. For this reason, using the TDEC Order process, with TVA as the sole investigating entity, is inappropriate and would reach an inequitable result because it would require TVA to engage in an investigation and corrective action process to address a third-party's unit with potentially significant non-TVA contributions. This is a unique situation that is different from all other "disposal areas" being addressed under the TDEC Order. If TDEC desires remediation of this offsite unit, TDEC has other authorities available to it to cause such remediation and that would properly allow the direct involvement of the property owner and all entities responsible for solid waste disposal in the unit. Given the history of this unit, a process that allows multiple parties to be involved in the investigation and remediation	TDEC agrees that the investigation and remediation of Ash Disposal Area 1 (Ponds A, B, and C) that were reclaimed, retired, and located on Chemours property will require the participation of all entities responsible for disposal within the units. TDEC will review possible options and initiate additional investigation activities outside the Commissioner's Order. However, if during the course of the investigation at the JOF it is determined that contamination has migrated off-site, TVA is required by the Commissioner's Order to investigate the horizontal and vertical extent of the contamination regardless of location.	Comment noted. If, however, any contamination migrating from the JOF site cannot be sufficiently distinguished from contamination stemming from Ash Disposal Area 1 (Ponds A, B, and C), TVA respectfully suggests that such a situation could also trigger the need for the participation of all entities responsible for disposal on the Chemours Property in order to assure that all potential sources of contamination are appropriately considered.

Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments	JOF EIP Rev 1 TDEC Comment	TVA Response to JOF EIP Rev 1 TDEC Comment
							process seems more appropriate and to better reflect the actual usage of the unit.		
34	3.1	3.1.2	12	2	1	TVA maintains that it is not responsible for CCR material that it discharged in historic Surface Impoundments A, B and C. TVA originally owned property where ponds A, B and C are located but sold it to DuPont in 1956, retaining the right to discharge CCR waste water into the ponds for an additional 15 years. TVA maintains that it did not discharge CCR containing wastewater into these ponds after 1970. TVA maintains that the Commissioner's Order does not include investigation of CCR disposal sites outside its current property boundaries, even if TVA performed the disposal activities. TDEC does not agree with TVA's position. TVA did own property at the TVA Johnsonville Plant that was used for disposal of CCR materials and then sold a portion of the property. Change in ownership of the property will require TVA to obtain permission to investigate and remediate areas of CCR disposal on property it previously owned. The Commissioner's Order requires TVA to investigate and remediate all locations where TVA disposed of CCR material. As stated in the Commissioner's Order on page 4:Scope of the OrderVI. This Order shall apply to all "CCR disposal areas" at the coal-power plant sites listed below that TVA operates or has operated in Tennessee (hereinafter sites or plants). "CCR disposal areas" include all areas where CCR disposal has occurred, including without limitation, all permitted landfills, all "non-registered" landfills (landfills that existed before they were subject	The TDEC Order requires the investigation of active and inactive CCR disposal areas at TVA fossil plant sites. This does not include the investigation of offsite property not owned by TVA. In particular, at this location, the unit in question has been owned by a neighboring chemical plant since the early 1950s. TVA began placing CCR in the unit during the last approximately six months of TVA's ownership and continued sending CCR to the unit until 1970. It is TVA's understanding that, during this time period, the property owner also disposed of CCR in this unit. Thus, during the past 60 years, entities other than TVA have disposed of CCR and likely non-CCR waste in the offsite unit. As a result, the TVA and non-TVA waste were and are intermingled in the unit in a way that makes it likely impossible to distinguish the TVA contributions and impacts for investigation purposes. For this reason, using the TDEC Order process, with TVA as the sole investigating entity, is inappropriate and would reach an inequitable result because it would require TVA to engage in an investigation and corrective action process to address a third-party's unit with potentially significant non-TVA contributions. This is a unique situation that is different from all other "disposal areas" being addressed under the TDEC Order. If TDEC desires remediation of this offsite unit, TDEC has other authorities available to it to cause such remediation and that would properly allow the direct involvement of the property owner	TDEC agrees that the investigation and remediation of Ash Disposal Area 1 (Ponds A, B, and C) that were reclaimed, retired, and located on Chemours property will require the participation of all entities responsible for disposal within the units. TDEC will review possible options and initiate additional investigation activities outside the Commissioner's Order. However, if during the course of the investigation at the JOF it is determined that contamination has migrated off-site, TVA is required by the Commissioner's Order to investigate the horizontal and vertical extent of the contamination regardless of location.	Comment noted. If, however, any contamination migrating from the JOF site cannot be sufficiently distinguished from contamination stemming from Ash Disposal Area 1 (Ponds A, B, and C), TVA respectfully suggests that such a situation could also trigger the need for the participation of all entities responsible for disposal on the Chemours Property in order to assure that all potential sources of contamination are appropriately considered.

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						to regulation), and all current and former surface water impoundments that contain CCR. • Allen Fossil Plant • Cumberland Fossil Plant • Johnsonville Fossil Plant • Kingston Fossil Plant • Bull Run Fossil Plant • John Sevier Fossil Plant • Watts Bar Plant	and all entities responsible for solid waste disposal in the unit. Given the history of this unit, a process that allows multiple parties to be involved in the investigation and remediation process seems more appropriate and to better reflect the actual usage of the unit.		
35	3.1	3.1.3	13	2	5	TVA again states it does not intend to include in its TVA JOF EIP the investigation of CCR material disposed of by TVA on property it previously owned but since sold. The Commissioner's Order requires TVA to take this action. While TVA no longer owns property adjacent to the TVA JOF, the CCR disposal activity occurred when TVA owned the property. TDEC will assist TVA in obtaining access to the adjacent property if necessary. TVA shall describe the strategy it will use to gain access to the adjacent TVA JOF property owned by DuPont and now subsequent owner	The TDEC Order requires the investigation of active and inactive CCR disposal areas at TVA fossil plant sites. This does not include the investigation of offsite property not owned by TVA. In particular, at this location, the unit in question has been owned by a neighboring chemical plant since the early 1950s. TVA began placing CCR in the unit during the last approximately six months of TVA's ownership and continued sending CCR to the unit until 1970. It is TVA's understanding that, during this time period, the property owner also disposed of CCR in this unit. Thus, during the past 60 years, entities other than TVA have disposed of CCR and likely non-CCR waste in the offsite unit. As a result, the TVA and non-TVA waste were and are intermingled in the unit in a way that makes it likely impossible to distinguish the TVA contributions and impacts for investigation purposes. For this reason, using the TDEC Order process, with TVA as the sole investigating entity, is inappropriate and would reach an inequitable result because it would require TVA to engage in an investigation and corrective action process to address a third-party's unit with potentially significant non-TVA contributions. This is a unique situation that is different from all other "disposal areas" being addressed under the TDEC Order. If TDEC desires	TDEC agrees that the investigation and remediation of Ash Disposal Area 1 (Ponds A, B, and C) that were reclaimed, retired, and located on Chemours property will require the participation of all entities responsible for disposal within the units. TDEC will review possible options and initiate additional investigation activities outside the Commissioner's Order. However, if during the course of the investigation at the JOF it is determined that contamination has migrated off-site, TVA is required by the Commissioner's Order to investigate the horizontal and vertical extent of the contamination regardless of location.	Comment noted. If, however, any contamination migrating from the JOF site cannot be sufficiently distinguished from contamination stemming from Ash Disposal Area 1 (Ponds A, B, and C), TVA respectfully suggests that such a situation could also trigger the need for the participation of all entities responsible for disposal on the Chemours Property in order to assure that all potential sources of contamination are appropriately considered.

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							remediation of this offsite unit, TDEC has other authorities available to it to cause such remediation and that would properly allow the direct involvement of the property owner and all entities responsible for solid waste disposal in the unit. Given the history of this unit, a process that allows multiple parties to be involved in the investigation and remediation process seems more appropriate and to better reflect the actual usage of the unit.		
36	3.1	3.1.3	13	3	1	TVA plans to construct a 3 Dimensional Model of the CCR disposal areas; Coal Yard, Active Ash Pond 2, South Rail Loop Area 4, DuPont Road, Dredge Cell, and Ash Disposal Area 1 using existing data. TVA states that installing new soil borings where a protective cover of clay and/or synthetic material will compromise the integrity of the cap. Given that these locations have been closed and the historic record was not developed with the intent of determining the amount and location of disposed CCR material, new information is needed to develop a 3 Dimensional model of the disposal areas. There are methods available to install soil borings through final caps that allow installation of borings and subsequent repair of the final cover. Further, the borings may be converted into piezometers that can be used to determine whether there is CCR material in groundwater.	The proposed 3-D model is not a preliminary model. It is based on a thorough evaluation of site-specific data regarding the base, sides, and surface elevations of CCR. To the extent that information is developed during the environmental investigation that affects CCR volume calculations, revisions to the 3-D model will be included in the EAR. Corrective actions based on this 3-D model or any other data found in the EAR will be found in the CARA Plan according to Part VII.A.f of the Order. The historical borings, plus the proposed exploratory borings are sufficient to address this information request without having to drill through and then repair areas with geosynthetics in the final cover. Borings are proposed in select areas with soil-only final cover, which can be repaired (i.e., backfilled) relatively simply. Results of proposed borings can be applied to adjacent areas that are covered with geosynthetics.	TVA has not adequately responded to the comment. TVA shall propose the requested borings. While using existing data is acceptable for developing the three-dimensional model, it is imperative to have data from within the landfill itself, especially within Active Ash Pond 2. These areas have been closed at risk and TVA shall install after TDEC's approval, additional borings within the footprints of the Coal Yard, Active Ash Pond 2, South Rail Loop Area 4, DuPont Road Dredge Cell, and Ash Disposal Area 1. At least one of these locations to a piezometer in order to determine the saturated portion of ash.TVA has agreed to conduct an environmental investigation at the TVA JOF as required in the Commissioner's Order it received and did not appeal. It is TVA's responsibility to submit an Environmental Investigation Plan for TDEC's review and make changes to the EIP as requested by TDEC. When there are questions concerning any part of the EIP, TVA should discuss their concerns with TDEC and TDEC shall consider TVA's concerns. However, if TDEC and TVA disagree on any matter, TVA shall perform investigative activities as specified by TDEC.	The comment is acknowledged, and borings, piezometers, and/or temporary wells have been added to the Exploratory Drilling SAP as detailed herein. **Active Ash Pond 2, Coal Yard, DuPont Road Dredge Cell:** An extensive amount of subsurface data is already available within the interior of Active Ash Pond 2, Coal Yard, and DuPont Road Dredge Cell. Refer to the exhibits in Appendix D for existing boring locations with CCR thickness, uppermost foundation soil type, and/or top of rock data. In addition, the Exploratory Drilling SAP proposes several supplemental borings on the interior, which include installation of temporary wells. The temporary wells will allow water level measurements within the CCR. Finally, as discussed in the response to Comment 173, the ongoing decanting project for Active Ash Pond 2 includes several borings on the interior, which include installation of nested vibrating wire piezometers (VWPZ). All of this data will support 3-D model development. **South Rail Loop 4, Ash Disposal Area 1:** Existing borings are available (see Appendix D) within the interiors of South Rail Loop 4 and Ash Disposal

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									Area 1. However, to improve spatial coverage within the units, additional borings are proposed in the Exploratory Drilling SAP. Borings include installation of temporary wells and VWPZ to measure water levels within the CCR. All of this data will support 3-D model development.
39	3.2.2	TDEC General Request #2	16			How does TVA propose to adequately monitor groundwater at Ash Disposal Area 1 with no separation between property owners to the North? Please explain how one can infer that groundwater primarily flows east to west when the adjacent river flows North?	Comment acknowledged; The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater flow and direction. Based on the results of the initial phase of work, additional wells may be proposed. Based on current information, groundwater flows from east to west within Ash Disposal Area 1. Groundwater data collected as part of the proposed investigation activities will be used to evaluate groundwater flow direction and the results will be provided in the EAR.	TDEC is unclear on how groundwater flow can be inferred for the area since there are no current monitoring points located adjacent to the disposal area. However, the four proposed well locations could provide preliminary information on groundwater flow in the area. TDEC requests an additional well installed in an intermediate position between proposed wells JOF-109 and JOF-110.	To monitor and address groundwater flow, a vibrating wire piezometer will be installed between JOF-109 and JOF-110. A vibrating wire piezometer would provide additional information to help determine groundwater flow. This piezometer will have to be installed through ash as there is no subsurface divider between the ash on TVA property and the waste on Chemours' property.

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40	3.2.2	TDEC General Request #2	16			Can TVA adequately monitor groundwater at Ash Disposal Area 1 with no downgradient monitoring wells to the direct north between the two property owners?	Comment acknowledged; The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater flow and direction. Based on the results of the initial phase of work, additional wells may be proposed. Based on current information, groundwater flows from east to west within Ash Disposal Area 1. Groundwater data collected as part of the proposed investigation activities will be used to evaluate groundwater flow direction and the results will be provided in the EAR.	See response to Comment #39	Refer to response to comment #39.
41	3.2.2	TDEC General Request #2	16			How will TVA demonstrate groundwater quality in this area without a representative downgradient monitoring points between the two property owners?	Comment acknowledged; The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater quality. Based on the results of the initial phase of work, additional wells may be proposed. Based on current information, groundwater flows from east to west within Ash Disposal Area 1. Groundwater data collected as part of the proposed investigation activities will be used to evaluate groundwater quality and flow direction and the results will be provided in the EAR.	See response to Comment #39	Refer to response to comment #39

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49	3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends installing additional monitoring points south of JOF-114 to characterize groundwater flow and quality along the western boundary of the Coal Yard. An additional upgradient monitoring well should also be installed along the southeastern boundary.	The proposed coal yard closure plan includes consolidation of CCR material in the northern portion of the coal yard. TVA believes that the proposed monitoring network is adequate for the intended area. Additionally, groundwater may not be present in the unconsolidated materials above bedrock south of JOF-114. The results of the initial phase of work will be evaluated and if data gaps exist, additional wells may be proposed.	TVA has not adequately responded to the comment. TVA shall provide the proposed coal yard closure plan for review. TVA shall propose locations for the requested monitoring wells. Groundwater flow on the southwestern side of the Coal Yard is not fully characterized and requires a monitoring well to characterize groundwater flow and quality along the southwestern boundary of the Coal Yard. TVA has agreed to conduct an environmental investigation at the TVA JOF as required in the Commissioner's Order it received and did not appeal. It is TVA's responsibility to submit an Environmental Investigation Plan for TDEC's review and make changes to the EIP as requested by TDEC. When there are questions concerning any part of the EIP, TVA should discuss their concerns with TDEC and TDEC shall consider TVA's concerns. However, if TDEC and TVA disagree on any matter, TVA shall perform investigative activities as specified by TDEC.	A monitoring well will be installed along the southwestern boundary of the Coal Yard to satisfy this request.
50	3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends observation well JOF-105 be added as a groundwater quality monitoring well to characterize groundwater flow and quality southwest of the DuPont Dredge Cell. If this is not feasible, a new well should be installed along the southwestern boundary of the DuPont Dredge Cell for this purpose.	Well JOF-105 has recently been installed and is currently being evaluated in cooperation with the Nashville TDEC field office. This well will be added to the groundwater network if deemed appropriate.	TVA will evaluate the well with the TDEC CCR Team. Please provide any well completion diagrams, well logs, soil, and groundwater data generated for JOF-105. If monitoring well JOF-105 is not an appropriate well to monitor the southwestern potential flow path then a new well will be required along the southwestern boundary of the DuPont Dredge Cell for this purpose.	The soil boring log, well completion diagram, well development form, and groundwater data for well JOF-105 have been added to Appendix P – Groundwater Monitoring Data. TVA will determine a path forward in cooperation with TDEC.

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51	3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends an additional monitoring well be installed along the northeastern boundary of the South Rail Loop Area 4 to adequately characterize groundwater quality and flow.	Monitoring wells B-9 and JOF-101 are currently located east of South Rail Loop Area 4 as background locations. The area northeast of the South Rail Loop Area 4 would be expected to be in an upgradient location; therefore, an additional well in that location in not needed at this time. Nested vibrating wire piezometers are planned for installation in the South Rail Loop Area 4 along the northeastern boundary as part of the Geotechnical Stability SAP. Data collected from the existing monitoring well network and the planned piezometers will be evaluated to investigate groundwater quality and flow direction. Based on the results of the initial phase of work, additional investigations may be proposed to further evaluate groundwater quality and flow.	In reviewing the provided groundwater data, there were no analytical results for well WP-4 however there were some limited physical data which did not seem to indicate elevated specific conductance and monitoring well B-9 (although more than 500 ft east of the landfill) has not shown any elevated metals concentrations for the past few years. This comment can be deferred pending the results of the initial phase of investigation.	Comment is acknowledged and the information will be provided in the EAR.
52	3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends observation well JOF-102 be added as a groundwater quality monitoring well to characterize groundwater flow and quality south of the South Rail Loop Area 4. If this is not feasible, a new well should be installed along the southern boundary of the South Rail Loop Area 4 for this purpose.	Well JOF-102 has recently been installed and is currently being evaluated in cooperation with the TDEC field office. This well will be added to the groundwater network if deemed appropriate.	TVA will evaluate the well with the TDEC CCR Team. Please provide any well completion diagrams, well logs, soil, and groundwater data generated for JOF-102. If monitoring well JOF-102 is not an appropriate well to monitor the southern potential flow path then a new well will be required along the southern boundary of the South Rail Loop Area 4 for this purpose.	The soil boring log, well completion diagram, well development form, and groundwater data for well JOF-102 have been added to Appendix P – Groundwater Monitoring Data. TVA will determine a path forward in cooperation with TDEC.
54	3.3.5	TDEC Active Ash Pond 2 Request No. 5	25	3	All	TVA states in this paragraph that active Ash Pond 2 will be closed and capped as a result of a 2011 agreement with the EPA. One of the purposes of the EIP process is the fully investigate the site and develop a CARA plan that will include the methods TVA will employ to remove and/or close in place CCR material at the site. TDEC recommends any closure activities at the site be completed after the EIP process is complete and an appropriate remedy	On April 14, 2011, TVA entered into a Federal Facilities Compliance Agreement (FFCA) with EPA, and a parallel Consent Decree (CD) with the States of Alabama, North Carolina, and Tennessee, the Commonwealth of Kentucky, and three environmental advocacy groups. The purpose of these agreements was to resolve disputes arising under the Clean Air Act. Under the FFCA and CD, TVA was required to retire all ten units at the Johnsonville Fossil Plant	Any closure actions that occur prior to complete characterization of the site as part of the EIP process are considered "at risk". Based on the results of the EIP, TVA may be required to take other and further remedial action at the site.	Comment noted.

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						has been selected for the site.	by December 31, 2017. Consistent with these requirements, all ten units are now retired. TVA may need to close Active Ash Pond 2 as required by the EPA CCR Rule before the CARA plan required by the Order can be development and/or implemented.		
59	3.4.2	Background Soil SAP	27	5	7	Will a background concentration be determined for each soil type? Please explain how many samples from each soil type will be considered a valid test population for statistical evaluation.	TVA proposes to collect a minimum of 12 background samples from each soil horizon or geographic strata for the purpose of establishing background concentrations of CCR parameters. Twelve samples is consistent with other State's guidance (Ohio) and consistent with the findings presented in Gilbert, 1987. Twelve samples also exceeds the recommended number of samples for several other States (n=4 for Wisconsin and Alabama). If TDEC has specific regulatory guidance on the number of samples required, please provide that guidance to TVA.	TVA should only develop background levels of constituents by totaling analytical results from soil samples from the same soil horizon. There should always be a minimum of 10 soil samples from the same soil horizon used to calculate the background levels of constituents. This may lead to different multiple background levels for a constituent within the profile of one boring.	Comment is acknowledged and the corresponding change has been made in the text.
68	Appendix C, Section 9.1.2	QAPP	23	4	9	Some of the requirements in the QAPP are written as should. The QAPP must be written as what will be done.If multiple coolers are needed, one COC Record ~~should~~ will accompany each cooler that contains the samples identified on the COC.	"Should" has been replaced with "will."	In keeping with verbiage used in previous EIPs. The word "will" will be replaced with "shall" where a TDEC regulation, rule or the Order is explicitly referenced. In all other uses, the word "will" can be interpreted by TDEC as having the same meaning as "shall" and reflect TVA's commitment to performing the specified task, action, activity, etc.	Comment is acknowledged and the corresponding change has been made in the text.
70	Appendix C, Section 11.1	QAPP	29	4	6	At least 10% of the screening data ~~should~~ will be confirmed using appropriate analytical methods and QA/QC procedures and criteria associated with definitive data.	"Should" has been replaced with "will."	see response to Comment #68	Comment is acknowledged and the corresponding change has been made in the text.

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73	Appendix C, Section 13.1	QAPP	37	1	2	Field pH meters used for collecting data will have to meet the calibration requirements of Method 9040C , which is 0.05 pH units of the bracketing buffer solution values. The QAPP references SESDPROC-100-R3, January 2013 and the TVA TI ENV-TI-05.80.46 which only require calibration to 0.1 SU.	TVA disagrees with the need to calibrate field pH meters according to the acceptance criteria published in SW-846 Method 9040C. The referenced acceptance criteria of +/- 0.1 pH units (EPA Region 4 SESDPROC-100-R3, January 2013) have been established for regulatory applications by EPA Region 4 Science and Ecosystem Support Division and are appropriate for pH readings under the JOF EI.	TVA will calibrate field pH meters to meet the requirements of 9040C.	Comment is acknowledged and the corresponding change has been made in the text.
74	Appendix C, Section 13.1	QAPP	37	2	4	Maintenance ~~should~~ will be performed when the instrument will not adequately calibrate. Maintenance of field equipment ~~should~~ will be noted in an instrument logbook or field notebook.	"Should" will be replaced with "will."	see response to Comment #68	Comment is acknowledged and the corresponding change has been made in the text.
75	Appendix C, Section 17.0	QAPP	47	3	2	This audit report ~~should~~ will include a list of observed field activities, a list of reviewed documents, and any observed deficiencies.	"Should" will be replaced with "will."	see response to Comment #68	Comment is acknowledged and the corresponding change has been made in the text.
76	Appendix C, Section 19.5	QAPP	54	1	4	By providing specific protocols for obtaining and analyzing samples, data sets ~~should~~ will be comparable regardless of who collects the sample or who performs the sample analysis.	"Should" will be replaced with "will."	see response to Comment #68	Comment is acknowledged and the corresponding change has been made in the text.
79	Appendix C, QAPP Appendix A	QAPP Appendix A.1	A-3	1	3	In the event that certain required information is not included on a particular form, the laboratory ~~should~~ will provide additional documentation (e.g., preparation logs or analytical run logs) to ensure that the minimum required level of documentation is supplied.	"Should" will be replaced with "will."	see response to Comment #68	Comment is acknowledged and the corresponding change has been made in the text.

Appendix B – Table 2

Summary of TDEC Comments & TVA Responses

May 11, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments	JOF EIP Rev 1 TDEC Comment	TVA Response to JOF EIP Rev 1 TDEC Comment
80	Appendix C, QAPP Appendix A	QAPP Appendix A.2	A-14	1	3	In the event that certain required information is not included on a particular form, the laboratory ~~should~~ will provide additional documentation (e.g., preparation logs or analytical run logs) to ensure that the minimum required level of documentation is supplied.	"Should" will be replaced with "will."	see response to Comment #68	Comment is acknowledged and the corresponding change has been made in the text.
85	Appendix E, Section 4.0	Monitoring Well Locations	4	3	10	TVA proposes JOF-115 as a potential background monitoring well. This well may not be suitable as groundwater quality may be influenced by the South Rail Loop Area 4 located to the northeast. TDEC recommends installing potential background monitoring wells up gradient of existing coal ash disposal areas. JOF-101 should be considered for a possible background location.	Monitoring well JOF-101 was specifically cited as not being in an appropriate location to serve as a background monitoring well for Active Ash Pond 2. TVA has attempted to meet TDEC requirements by proposing to install monitoring well JOF-107. If, after evaluation of groundwater quality data a determination is made that JOF-107 is not an appropriate background location, TVA proposes to install JOF-115. To be able to evaluate impacts of individual CCR units, background monitoring wells need to be installed between various units or other potential sources of CCR constituents. TVA believes that the proposed location for JOF-115 is appropriate. If an alternate to location JOF-115 is deemed necessary at a later time, then TVA will propose an alternate location and provide to TDEC for review. The proposed scope of work is consistent with an initial phase needed to evaluate groundwater. Based on the results of the initial phase of work, results will be evaluated and changes to the monitoring well network proposed, as necessary.	Agreed, JOF 101 does no appear to be an appropriate background monitoring well location for Active Ash Pond 2. TDEC understands that if results from JOF-107 installed on the southern end of Active Ash Pond 2 indicate that the well is not suitable as a background well, JOF-115 will be installed. However, JOF-107 will be retained as a downgradient monitoring well.	Comment is acknowledged. Please note that wells have been renumbered such that JOF-107 is now JOF-119 and JOF-115 is now JOF-120. If results from JOF-107 indicate that the well is not suitable as a background well, JOF-115 will be installed and JOF-107 will be retained as a downgradient monitoring well.
88	Appendix E, Section 5.2	Hydrogeological Investigation SAP	7	2	2	The elevation of the established and documented point on the top of each well casing will be correlated to Mean Sea Level	In order to align with existing data, the top of each well casing will be surveyed and correlated to the vertical datum used by the Plant.	That is acceptable as long as a cross walk is provided that indicates what the Plant datum's equivalency is to MSL.	Comment is acknowledged and the corresponding change has been made in the text.

Appendix B – Table 2

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments	JOF EIP Rev 1 TDEC Comment	TVA Response to JOF EIP Rev 1 TDEC Comment
89	Appendix E, Section 5.2.6	Hydrogeological Investigation SAP	10	2	1	Distribution of cuttings and discharge of water ~~should~~ will be performed in a manner as to not create a safety hazard.	"Should" will be replaced with "will."	see response to Comment #68	The SAP has been revised and no longer contains the language referenced in the comment.
111	Appendix F, Table 5	Groundwater Investigation SAP	15	Table 5		Field pH meters used for collecting data will have to meet the calibration requirements of Method C , which is 0.05 pH units of the bracketing buffer solution values. There is not a hold time associated with the field measurement of pH by Method 9040C.	TVA disagrees with the need to calibrate field pH meters according to the acceptance criteria published in SW-846 Method 9040C. The referenced acceptance criteria of +/- 0.1 pH units (EPA Region 4 SESDPROC-100-R3, January 2013) have been established for regulatory applications by EPA Region 4 Science and Ecosystem Support Division and are appropriate for pH readings under the JOF EI.	see response to Comment #73	Comment is acknowledged and the corresponding change has been made in the text.
112	Appendix F, Section 5.2.8	Groundwater Investigation SAP	16	4	1	Distribution of cuttings and discharge of water ~~should~~ will be performed in a manner as to not create a safety hazard.	"Should" will be replaced with "will."	see response to Comment #68	Comment is acknowledged and the corresponding change has been made in the text.
115	Appendix H, Section 5.2.7	Material Quantity SAP	13	4	1	Distribution of cuttings and discharge of water ~~should~~ will also be performed in a manner as not to create a safety hazard.	"Should" will be replaced with "will."	see response to Comment #68	Comment is acknowledged and the corresponding change has been made in the text.

Robert Wilkinson, P.G., CHMM CCR Technical Manager
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Shari Meghreblian, Ph.D.
Commissioner

Bill Haslam
Governor

June 11, 2018

M. Susan Smelley
Director
Environmental Compliance and Operations
Tennessee Valley Authority
1101 Market Street, BR 4A-C
Chattanooga, TN 37402

RE: TDEC Commissioner's Order OGC 15-1077
TVA Johnsonville Coal Fired Fossil Fuel Plant
Environmental Investigation Plan Revision 2 Comments

Dear Ms. Smelley:

The Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order OGC 15-0177 (the Order) to the Tennessee Valley Authority (TVA) that required TVA action at seven TVA Coal Fired Fossil Power Plants (active and inactive) located in Tennessee. The Order was signed on August 6, 2015 and included information about TVA's right to appeal the Order. TVA did not appeal the Order and it is now final.

TVA submitted the Environmental Investigation Plan (EIP) Revision 2 (EIP Rev 2) for TVA Johnsonville Coal Fired Fossil Power Plant (TVA JOF) on May 11, 2018. TDEC has completed its review of EIP Rev 2 and is providing comments listed in the attached **Table 1 TVA Johnsonville EIP Rev 2 Summary of TDEC Comments**.

Please address the attached comments and submit a revised plan (EIP Rev 3) with a cover letter summarizing TVA's response to each comment and subsequent modifications to TDEC by **July 20, 2018**.

TDEC's goal is to work with TVA to ensure the environmental investigation of the TVA JOF site is complete, accurate and timely. Should you have any questions, please do not hesitate to contact me via email at Robert.S.Wilkinson@tn.gov or phone at (615) 253-0689.

Sincerely,

Robert Wilkinson, P.G., CHMM

CC:	Chuck Head	Britton Dotson	James Clark
	Pat Flood	Caleb Nelson	Rob Burnette
	Jennifer Dodd	Angela Adams	Joseph E. Sanders
	Peter Lemiszki	Shawn Rudder	Bryan Wells

TVA Johnsonville EIP Rev 2
Summary of Comments

Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments	JOF EIP Rev 1 TDEC Comments	TVA Response to JOF EIP Rev. 1 TDEC Comments	TDEC EIP Rev 2 Comments
New	Appendix G	Dye Trace SAP	NA	NA	NA					How has TVA taken into account the potential that the fluctuation in pool elevation of Kentucky Lake may inundate the land surface, resulting in uncontrolled variations in hydraulic gradient within the network and in surface water diluting the groundwater tracer concentrations?
New	Appendix G	Dye Trace SAP	NA	NA	NA					TVA needs to provide a general profile that depicts the anticipated injection zone relative to the monitoring location elevation, lake level and potentiometric surface in impoundment.
New	Appendix G	Dye Trace SAP	NA	NA	NA					Based on the description in the text and the Appendix G SAP TDEC understands that the dye-tracer tests performed during this investigation are designed to be qualitative. If the dye-tracer tests indicate a connection between the Active Ash Pond 2 area and Kentucky Lake, follow on qualitative dye-tracer tests shall be performed to determine time of travel, persistence of a particular dye, peak concentration, and establish breakthrough curves by collecting water samples at select monitoring stations where dye positives were confirmed or suspected.
New	Appendix G	Dye Trace SAP	NA	NA	NA					The tracer test should be designed following the bench study to minimize disturbance to the natural flow field.
New	Appendix G	Dye Trace SAP	NA	NA	NA					Details on the specific procedures (following bench determination of chosen dyes) shall be provided to TDEC prior to initiation of the dye tracer test and shall include specific volumes of pre-dye injection potable water per injection point (wetting), the solution of dye to be injected, and the "chaser" volume of potable water per injection point as well as the rate of injection.
New	Appendix G	Dye Trace SAP	2	1	3					The only modification to the QAPP in relation to this Dye Trace SAP was the addition of the analytical laboratory, there are no procedural QA/QC additions. Field handling QA/QC procedures need to be addressed in the SAP. A dye standard QA requirement needs to be discussed as well as the laboratory blank procedures (a lab blank should be analyzed at the start and end of each batch of analyses).
New	Appendix G	Dye Trace SAP, Section 4.2	5	1	6					A single background location on the southwestern tip may not be sufficient to determine background concentrations since there is the potential for radial flow from the island. Also the area proposed is in a shallow shoal area and may not be representative of conditions at deeper intervals. TVA should propose a background location that will be sampled at various depths (shallow, mid point and deep) and may consider adding a southeastern background location.
New	Appendix G	Dye Trace SAP, Section 4.2	5	1	9					TDEC agrees with the recommendation that dye-tracer test begin after the installation of proposed wells JOF-118 and JOF-119, and based on the provided schedule that should be possible.
New	Appendix G	Dye Trace SAP, Section 4.3	5	1	3					Dye detectors in Kentucky Lake will be required to be placed at numerous depths along the wire during placement of the buoy or other tether. The specific depths need to be determined based on the water column at that location and at a minimum need to represent the near surface, midpoint and near floor depths. TDEC's concern would be putting the dye in below a level that would result in its appearance at the water's edge if only the shallow layer was monitored.

TVA Johnsonville EIP Rev 2
Summary of Comments

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New	Appendix G	Dye Trace SAP, Section 4.3	5	2	2					Prior to injection of dye the injection wells shall be tested with potable water to measure the rate of intake.
New	Appendix G	Dye Trace SAP, Section 4.3	5	2	6					What is the elevation of the CCR/clay bottom interface? How is it related to the monitoring well elevations? TDEC's concern would be putting the dye in above the screened intervals of the wells that would result in a false negative.
New	Appendix G	Dye Trace SAP, Section 4.3	6	2	1					What is the rationale behind two weeks for the initial retrieval? If this number is not based on actual hydraulic conductivity TDEC recommends that a sample be collected at n=1 week post injection, n=2 weeks post injection and then should continue at the 2 week interval proposed in the SAP.
New	Appendix G	Dye Trace SAP, Section 4.3	6	2	1					A two week sampling frequency for Kentucky Lake samples may not adequately reflect dye distribution in the lake due to the large amount of dilution. A shorter time frame should be proposed and or justification for the 2 week interval provided.
New	Appendix G	Dye Trace SAP, Section 4.3	6	2	1					Concurrent with dye receptor retrieval a grab sample of water should also be collected to provide dye concentrations at a known point in time.
New	Appendix G	Dye Trace SAP, Section 4.3	6	2	1					For monitoring wells and/or piezometers groundwater levels will be measured prior to sample collection. Pool elevation should be recorded for Kentucky Lake dye receptors.
New	Appendix G	Dye Trace SAP, Section 4.3	6	4	1					What is the rationale behind the six-month sampling period?
New	Appendix G	Dye Trace SAP, Section 5.2.1.1	9	2	5					Section 5.2.4 does not describe the soil sample collection. Please revise Section 5.2.4 to describe soil sample collection from the soils collected from the sample borings.
New	Appendix G	Dye Trace SAP, Section 5.2.6	14	all	all					What is the criteria that will be used to determine a positive detection of dye? What is the criteria that will be used to determine a positive trace?
New	Appendix G	Dye Trace SAP, Section 6.2	16	2	1					Field duplicate samples should be collected at a minimum of 10% of the total dye detectors for each sampling event.
New	Appendix G	Dye Trace SAP, Section 6.2	16	2	1					The use of split samples sent to a laboratory other than the primary laboratory should be considered by TVA so that a more robust QA comparison can be made.
New	Appendix G	Dye Trace SAP, Figure 1								It is unclear why the VBWPZs are on this figure since they are grouted in place and do not represent locations where dye receptors will be placed.

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New	Appendix G	Dye Trace SAP, Figure 1								Surface water buoys should be added on the northernmost tip of the island or near the gauging station.
New	3.1.1	TDEC General Request No. 1	9	2	4					Appendix E is the Hydrogeological SAP the monitoring well coordinates and construction details are in Appendix P.
New (170)	3.1.1	TDEC General Request	11	All	All			TVA discusses lowering the height of the current dikes for Active Ash Pond 2 from 390' to 380'. The 500 year flood surface water elevation is listed as 375'. This closure presupposes that TVA will be able to close in place. This should not be in the EIP. It should not be discussed until the Environmental Investigation has been completed. Approving the EIP with this language implies that TDEC agrees with closure in place as the corrective action at this site.	Comment is acknowledged, and the text has been updated to clarify that the proposed closure design is subject to TDEC approval.	TVA has not adequately responded to the comment, the language regarding closure will be removed. The purpose of the EIP is to evaluate current site conditions to develop an accurate site conceptual model. Selection of closure remedy will be based on the results of the EIP.
New (171)	3.3.5	TDEC General Request	29	5	1			The language concerning filling and capping Active Ash Pond 2 shall be removed. The corrective action for this site shall be determined by the information gained during the environmental investigation at the TVA JOF site.	Comment is acknowledged, and the text has been updated to clarify that the proposed closure design is subject to TDEC approval.	TVA has not adequately responded to the comment, the language regarding closure will be removed. The purpose of the EIP is to evaluate current site conditions to develop an accurate site conceptual model. Selection of closure remedy will be based on the results of the EIP.
20	General Technical	NA	NA	NA	NA	The active Johnsonville CCR surface impoundment was constructed within Kentucky Lake in the late 1940s and early 1950s. TDEC does not have the physical characteristics of the materials used to construct the impoundment nor the permeability of the dike structure upon completion. At the TVA Johnsonville site, the Tennessee River flows from the south to the north. To determine if the river is influencing the movement of groundwater within the active CCR surface impoundment, TVA shall propose a dye study to determine if the river is influencing ground water movement. TVA shall include in its amended Johnsonville EIP a groundwater dye study to determine the direction of groundwater flow below the active Johnsonville CCR surface impoundment.	TVA understands that TDEC would like to understand more information about the physical characteristics and permeability of dike materials. An alternative plan for the evaluation of groundwater movement has been proposed in this EIP, including hydraulic conductivity testing on wells where this information is lacking. Groundwater flow for Ash Disposal Area 2 will be evaluated using new and existing hydraulic conductivity data, gauging data from recently installed monitoring wells and surface water elevations from the gauging station. The results of the evaluation will be provided in the EAR.	TVA has not adequately responded to the comment. TVA shall propose the requested dye trace study. TVA has agreed to conduct an environmental investigation at the TVA JOF as required in the Commissioner's Order it received and did not appeal. It is TVA's responsibility to submit an Environmental Investigation Plan for TDEC's review and make changes to the EIP as requested by TDEC. When there are questions concerning any part of the EIP, TVA should discuss their concerns with TDEC and TDEC shall consider TVA's concerns. However, if TDEC and TVA disagree on any matter, TVA shall perform investigative activities as specified by TDEC.	Comment acknowledged, a dye trace study has been included as Appendix K in this revision of the EIP.	Appendix G
28	3.1	3.1.1	8	1	1	TVA states that it has existing ground water monitoring wells located at the TVA Johnsonville site. TVA shall include the location, description and construction methods for each well in the revised Johnsonville EIP submitted to TDEC in response to TDEC's comments. TVA shall also include the sampling results from each groundwater monitoring well including sampling date, sample results and identifying whether the levels of CCR constituents reported exceed either the MCL levels for CCR constituents or background levels for CCR constituents. Well location shall be identified on a TVA Johnsonville facility map, Results shall be reported in a table by monitoring well, CCR constituent and sampling date. Results shall be reported in µg/L. The wells reported shall include wells TVA installed at Johnsonville as required by the EPA CCR regulations.	The location, description and construction methods for existing groundwater wells and historical groundwater analytical data have been included in the revised EIP. Future sampling results and comparisons to background levels, which have not been calculated, will be included in the EAR.	TVA's response is incomplete. It does not appear that Appendix E contains coordinates, description or construction methods for existing or historical groundwater wells. The groundwater data tables provided are very helpful. However, a few instances where it appears there may be some QC issues were noted most obviously on the groundwater elevation data (e.g., JOF-C2 (C-2) GW elevation on 12/4/1991 was 357.84 (21.00 feet below some unidentified reference point) while on 6/11/1992 the groundwater elevation was 373.23 (20.51 ft below some unidentified reference point) . This occurred multiple time in 1993, 1995 at the same location. Well TVA needs to make sure all datums are uniform between historic and current data sets so that comparisons can be drawn. It also appears there are discrepancies at JOF-B4 (B-4). Also if a well was measured and then remeasured the same day please determine which is the appropriate measurement and place an asterisk explaining the discrepancies on the erroneous measurement (e.g., JOF-B10 [89-B10] 3/10/1999). TVA needs to indicate if the measurement is below top of casing, ground elevation or some other reference point.	Available monitoring well coordinates, description and construction methods for existing and closed wells are included in table format in Appendix O. Historical well measurements were obtained from a groundwater database. The differences in groundwater elevations at the same location over time could potentially be related to well repairs and re-surveying the location, obstructions in the well, conversion of units and/or human error. Water levels and depths to the bottom of the monitoring wells were measured from the top of the well casings. Groundwater elevations for existing wells will be confirmed during the investigation and provided in interim monthly reports and the EAR.	Available monitoring well coordinates, description and construction methods for existing and closed wells are included in table format in Appendix P.
39	3.2.2	TDEC General Request #2	16			How does TVA propose to adequately monitor groundwater at Ash Disposal Area 1 with no separation between property owners to the North? Please explain how one can infer that groundwater primarily flows east to west when the adjacent river flows North?	Comment acknowledged; The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater flow and direction. Based on the results of the initial phase of work, additional wells may be proposed. Based on current information, groundwater flows from east to west within Ash Disposal Area 1. Groundwater data collected as part of the proposed investigation activities will be used to evaluate groundwater flow direction and the results will be provided in the EAR.	TDEC is unclear on how groundwater flow can be inferred for the area since there are no current monitoring points located adjacent to the disposal area. However, the four proposed well locations could provide preliminary information on groundwater flow in the area. TDEC requests an additional well installed in an intermediate position between proposed wells JOF-109 and JOF-110.	To monitor and address groundwater flow, a vibrating wire piezometer will be installed between JOF-109 and JOF-110. A vibrating wire piezometer would provide additional information to help determine groundwater flow. This piezometer will have to be installed through ash as there is no subsurface divider.	TVA response is incomplete. Although a VWPZ provides information on groundwater flow and is an acceptable option, it will do nothing to address the question of groundwater quality and monitoring for CCR parameters.

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40	3.2.2	TDEC General Request #2	16			Can TVA adequately monitor groundwater at Ash Disposal Area 1 with no downgradient monitoring wells to the direct north between the two property owners?	Comment acknowledged; The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater flow and direction. Based on the results of the initial phase of work, additional wells may be proposed. Based on current information, groundwater flows from east to west within Ash Disposal Area 1. Groundwater data collected as part of the proposed investigation activities will be used to evaluate groundwater flow direction and the results will be provided in the EAR.	See response to Comment #39	Refer to response to comment #39.	TVA response is incomplete. Although a VWPZ provides information on groundwater flow and is an acceptable option, it will do nothing to address the question of groundwater quality and monitoring for CCR parameters.
41	3.2.2	TDEC General Request #2	16			How will TVA demonstrate groundwater quality in this area without a representative downgradient monitoring points between the two property owners?	Comment acknowledged; The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater quality. Based on the results of the initial phase of work, additional wells may be proposed. Based on current information, groundwater flows from east to west within Ash Disposal Area 1. Groundwater data collected as part of the proposed investigation activities will be used to evaluate groundwater quality and flow direction and the results will be provided in the EAR.	See response to Comment #39	Refer to response to comment #39	TVA response is incomplete. Although a VWPZ provides information on groundwater flow and is an acceptable option, it will do nothing to address the question of groundwater quality and monitoring for CCR parameters.
49	3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends installing additional monitoring points south of JOF-114 to characterize groundwater flow and quality along the western boundary of the Coal Yard. An additional upgradient monitoring well should also be installed along the southeastern boundary.	The proposed coal yard closure plan includes consolidation of CCR material in the northern portion of the coal yard. TVA believes that the proposed monitoring network is adequate for the intended area. Additionally, groundwater may not be present in the unconsolidated materials above bedrock south of JOF-114. The results of the initial phase of work will be evaluated and if data gaps exist, additional wells may be proposed.	TVA has not adequately responded to the comment. TVA shall provide the proposed coal yard closure plan for review. TVA shall propose locations for the requested monitoring wells. Groundwater flow on the southwestern side of the Coal Yard is not fully characterized and requires a monitoring well to characterize groundwater flow and quality along the southwestern boundary of the Coal Yard. TVA has agreed to conduct an environmental investigation at the TVA JOF as required in the Commissioner's Order it received and did not appeal. It is TVA's responsibility to submit an Environmental Investigation Plan for TDEC's review and make changes to the EIP as requested by TDEC. When there are questions concerning any part of the EIP, TVA should discuss their concerns with TDEC and TDEC shall consider TVA's concerns. However, if TDEC and TVA disagree on any matter, TVA shall perform investigative activities as specified by TDEC.	A monitoring well will be installed along the southwestern boundary of the Coal Yard to satisfy this request.	TVA shall provide TDEC with the requested proposed coal yard closure plan for review prior to conducting any closure activities at the site.

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New (211)	Appendix G	Dye Trace SAP	NA	NA	NA					How has TVA taken into account the potential that the fluctuation in pool elevation of Kentucky Lake may inundate the land surface, resulting in uncontrolled variations in hydraulic gradient within the network and in surface water diluting the groundwater tracer concentrations?	In a laboratory setting, dyes are detected at extremely low concentrations (parts per trillion to 10 parts per trillion). TVA does not believe that inundation of the land surface would result in dilution of tracer concentrations to levels below detection.
New (212)	Appendix G	Dye Trace SAP	NA	NA	NA					TVA needs to provide a general profile that depicts the anticipated injection zone relative to the monitoring location elevation, lake level and potentiometric surface in impoundment.	A profile/cross-section has been provided as Figure 2 (Attachment A) to the Dye Trace Study SAP.
New (213)	Appendix G	Dye Trace SAP	NA	NA	NA					Based on the description in the text and the Appendix G SAP TDEC understands that the dye-tracer tests performed during this investigation are designed to be qualitative. If the dye-tracer tests indicate a connection between the Active Ash Pond 2 area and Kentucky Lake, follow on qualitative dye-tracer tests shall be performed to determine time of travel, persistence of a particular dye, peak concentration, and establish breakthrough curves by collecting water samples at select monitoring stations where dye positives were confirmed or suspected.	Comment noted. The objective of this Dye Trace Study SAP is to determine if preferential hydrogeologic transport pathways are present between Active Ash Pond 2 and Kentucky Lake using dye detection. If a positive dye recovery occurs (as outlined in Comment #228) during this study, then TVA will notify TDEC and discuss a path forward.

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New (214)	Appendix G	Dye Trace SAP	NA	NA	NA					The tracer test should be designed following the bench study to minimize disturbance to the natural flow field.	Comment acknowledged – TVA plans on performing the tracer test following the bench study as indicated in the Dye Trace Study SAP.
New (215)	Appendix G	Dye Trace SAP	NA	NA	NA					Details on the specific procedures (following bench determination of chosen dyes) shall be provided to TDEC prior to initiation of the dye tracer test and shall include specific volumes of pre-dye injection potable water per injection point (wetting), the solution of dye to be injected, and the "chaser" volume of potable water per injection point as well as the rate of injection.	Comment acknowledged – TDEC will be notified when the bench study is complete and the details on specific procedures will be provided to TDEC prior to initiation of the tracer test.
New (216)	Appendix G	Dye Trace SAP	2	1	3					The only modification to the QAPP in relation to this Dye Trace SAP was the addition of the analytical laboratory, there are no procedural QA/QC additions. Field handling QA/QC procedures need to be addressed in the SAP. A dye standard QA requirement needs to be discussed as well as the laboratory blank procedures (a lab blank should be analyzed at the start and end of each batch of analyses).	The SAP has been modified to correct this reference. Field Handling is discussed in *Preservation and Handling*, Section 5.2.4. in the SAP. Section 6.2 of the SAP discusses the *Quality Control Checks* regarding field duplicate samples and trip blanks. The laboratory uses both laboratory reagent duplicates (eluent blanks) and laboratory duplicates.

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments	JOF EIP Rev 1 TDEC Comment	TVA Response to JOF EIP Rev 1 TDEC Comment	JOF EIP Rev 2 TDEC Comment	TVA Response to JOF EIP Rev 2 TDEC Comment
New (217)	Appendix G	Dye Trace SAP, Section 4.2	5	1	6					A single background location on the southwestern tip may not be sufficient to determine background concentrations since there is the potential for radial flow from the island. Also the area proposed is in a shallow shoal area and may not be representative of conditions at deeper intervals. TVA should propose a background location that will be sampled at various depths (shallow, mid point and deep) and may consider adding a southeastern background location.	TVA proposed 3 background locations but will add a 4th along the southeastern part of the Active Ash Pond 2 as depicted in the Figure 1 of Attachment A of the Dye Trace Study SAP. TVA's concern is that there may already be dyes present in the lake system that could enter the system during the study. TVA is also adding a 5th background location in the pond spillway to monitor for dye leaving the pond through the NPDES outfall. Various depth intervals are not practical for this study as dye is expected to disperse at detectable levels throughout the water column when in contact with open water. The objective of this study is to determine if preferential pathways are present. If a positive dye recovery occurs (as outlined in Comment #228) during this study, then TVA will notify TDEC and discuss a path forward.
New (218)	Appendix G	Dye Trace SAP, Section 4.2	5	1	9					TDEC agrees with the recommendation that dye-tracer test begin after the installation of proposed wells JOF-118 and JOF-119, and based on the provided schedule that should be possible.	Comment noted.

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New (219)	Appendix G	Dye Trace SAP, Section 4.3	5	1	3					Dye detectors in Kentucky Lake will be required to be placed at numerous depths along the wire during placement of the buoy or other tether. The specific depths need to be determined based on the water column at that location and at a minimum need to represent the near surface, midpoint and near floor depths. TDEC's concern would be putting the dye in below a level that would result in its appearance at the water's edge if only the shallow layer was monitored.	TVA will place a single dye receptor no less than 5 feet below the water surface at monitoring points in Kentucky Lake. Various depth intervals are not practical for this study as dye is expected to disperse at detectable levels throughout the water column when in contact with open water. The objective of this study is to determine if preferential pathways are present. If a positive dye recovery occurs (as outlined in Comment #228) during this study, then TVA will notify TDEC and discuss a path forward.
New (220)	Appendix G	Dye Trace SAP, Section 4.3	5	2	2					Prior to injection of dye the injection wells shall be tested with potable water to measure the rate of intake.	The rate of intake will be measured in injection borings with potable water prior to dye injection.
New (221)	Appendix G	Dye Trace SAP, Section 4.3	5	2	6					What is the elevation of the CCR/clay bottom interface? How is it related to the monitoring well elevations? TDEC's concern would be putting the dye in above the screened intervals of the wells that would result in a false negative.	Elevations of the CCR/clay bottom interface can be seen in the profile view in Figure 2 of Attachment A for the Dye Trace Study SAP. TVA's understanding of TDEC's request for a dye trace study is to determine if preferential flow pathways occur between the surface impoundment and the adjacent lake. The screened intervals of the wells are in the alluvial material best suited for groundwater flow under the ash disposal area. Many dye receptor locations are positioned in the surface water around the ash disposal area to collect movement of dye if flow occurs at higher elevations.

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New (222)	Appendix G	Dye Trace SAP, Section 4.3	6	2	1					What is the rationale behind two weeks for the initial retrieval? If this number is not based on actual hydraulic conductivity TDEC recommends that a sample be collected at n=1 week post injection, n=2 weeks post injection and then should continue at the 2 week interval proposed in the SAP.	The schedule has been modified to reflect TDEC's request with the first sample being collected after a one-week period.
New (223)	Appendix G	Dye Trace SAP, Section 4.3	6	2	1					A two week sampling frequency for Kentucky Lake samples may not adequately reflect dye distribution in the lake due to the large amount of dilution. A shorter time frame should be proposed and or justification for the 2 week interval provided.	A two-week sampling interval was selected as a practical time duration for checking receptors for dye adsorption but has been modified to a shorter one-week interval for the first two months.
New (224)	Appendix G	Dye Trace SAP, Section 4.3	6	2	1					Concurrent with dye receptor retrieval a grab sample of water should also be collected to provide dye concentrations at a known point in time.	The objective of this Dye Trace Study SAP is to determine if preferential hydrogeologic transport pathways are present between Active Ash Pond 2 and Kentucky Lake using dye detection. If a positive dye recovery occurs (as outlined in Comment #228), then TVA will notify TDEC and a more intricate, focused study will be conducted in the areas where detection occurred. If there is a need for the focused study, then TVA will discuss water grab samples as part of that study.

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Summary of TDEC Comments & TVA Responses

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Comment Number	Section Number	Section Title	Page	Paragraph	Line	JOF EIP Rev. 0 TDEC Comments	TVA Response to JOF EIP Rev. 0 TDEC Comments	JOF EIP Rev 1 TDEC Comment	TVA Response to JOF EIP Rev 1 TDEC Comment	JOF EIP Rev 2 TDEC Comment	TVA Response to JOF EIP Rev 2 TDEC Comment
New (225)	Appendix G	Dye Trace SAP, Section 4.3	6	2	1					For monitoring wells and/or piezometers groundwater levels will be measured prior to sample collection. Pool elevation should be recorded for Kentucky Lake dye receptors.	Wells and piezometers will be gauged to determine the groundwater elevations prior to each sample collection event and the lake elevation will be recorded.
New (226)	Appendix G	Dye Trace SAP, Section 4.3	6	4	1					What is the rationale behind the six-month sampling period?	Six months should be a sufficient duration of time to determine if dye is present within the wells or surrounding surface water due to preferential transport pathways. If there are no positive dye indications after six months, TVA presumes that a preferential pathway does not exist.
New (227)	Appendix G	Dye Trace SAP, Section 5.2.1.1	9	2	5					Section 5.2.4 does not describe the soil sample collection. Please revise Section 5.2.4 to describe soil sample collection from the soils collected from the sample borings.	Comment acknowledged – Section 5.2.1.1 has been revised to reference TVA TI ENV-TI-08.80.50, *Soil and Sediment Sampling*.

New (228)	Appendix G	Dye Trace SAP, Section 5.2.6	14	all	all					What is the criteria that will be used to determine a positive detection of dye? What is the criteria that will be used to determine a positive trace?	Positive dye recovery will be based upon the following five factors: 1. A spectro-fluoro-metric emission scan must show a peak at the appropriate wavelength for the dye and the sample matrix. The matrix pH is the principle determinant of that wavelength. A deviation of +/- 2 nm from the ideal wavelength will be considered acceptable for positive detection. 2. The spectro-fluoro-metric emission scan must reveal a peak with the appropriate shape, one similar to that observed in the scans of the standards. 3. The dye must be present only in the samples taken after injection, or the peak amplitude of post injection dye fluorescence must exceed the dye background peak amplitude fluorescence by a factor of 10. 4. The dye should appear in a series of samples, not just one sample. The peak amplitude of the dye fluorescence in successive samples from a sampling location should quickly reach a maximum value and decay gradually in successive samples. 5. Should one of the foregoing criteria be subject to a serious question, the detection must be shown to be repeatable.

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New (229)	Appendix G	Dye Trace SAP, Section 6.2	16	2	1					Field duplicate samples should be collected at a minimum of 10% of the total dye detectors for each sampling event.	Section 6.2 of the SAP, *Quality Control Checks*, has been revised such that one duplicate sample will be collected for every 10 samples.
New (230)	Appendix G	Dye Trace SAP, Section 6.2	16	2	1					The use of split samples sent to a laboratory other than the primary laboratory should be considered by TVA so that a more robust QA comparison can be made.	Comment noted. Field duplicate samples will be submitted to the primary laboratory at a frequency of 1 per 10 samples to evaluate field and laboratory precision. Submitting duplicate samples to a secondary laboratory would provide limited QA information outside the context of the full study.
New (231)	Appendix G	Dye Trace SAP, Figure 1								It is unclear why the VBWPZs are on this figure since they are grouted in place and do not represent locations where dye receptors will be placed.	The VBWPZs will not be a part of the dye trace study monitoring and have been removed from this figure.
New (232)	Appendix G	Dye Trace SAP, Figure 1								Surface water buoys should be added on the northernmost tip of the island or near the gauging station.	A sampling point has been added to the northernmost tip of the ash disposal area. Sampling points in the lake will be tethered to buoys.
New (233)	3.1.1	TDEC General Request No. 1	9	2	4					Appendix E is the Hydrogeological SAP the monitoring well coordinates and construction details are in Appendix P.	Comment acknowledged – this change has been made in the document.

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170	3.1.1	TDEC General Request	11	All	All			TVA discusses lowering the height of the current dikes for Active Ash Pond 2 from 390' to 380'. The 500 year flood surface water elevation is listed as 375'. This closure presupposes that TVA will be able to close in place. This should not be in the EIP. It should not be discussed until the Environmental Investigation has been completed. Approving the EIP with this language implies that TDEC agrees with closure in place as the corrective action at this site.	Comment is acknowledged, and the text has been updated to clarify that the proposed closure design is subject to TDEC approval.	TVA has not adequately responded to the comment, the language regarding closure will be removed. The purpose of the EIP is to evaluate current site conditions to develop an accurate site conceptual model. Selection of closure remedy will be based on the results of the EIP.	The reference to the proposed closure design has been removed from this section.
171	3.3.5	TDEC General Request	29	5	1			The language concerning filling and capping Active Ash Pond 2 shall be removed. The corrective action for this site shall be determined by the information gained during the environmental investigation at the TVA JOF site.	Comment is acknowledged, and the text has been updated to clarify that the proposed closure design is subject to TDEC approval.	TVA has not adequately responded to the comment, the language regarding closure will be removed. The purpose of the EIP is to evaluate current site conditions to develop an accurate site conceptual model. Selection of closure remedy will be based on the results of the EIP.	The reference to the proposed closure design has been removed from this section.
20	General Technical	NA	NA	NA	NA	The active Johnsonville CCR surface impoundment was constructed within Kentucky Lake in the late 1940s and early 1950s. TDEC does not have the physical characteristics of the materials used to construct the impoundment nor the permeability of the dike structure upon completion. At the TVA Johnsonville site, the Tennessee River flows from the south to the north. To determine if the	TVA understands that TDEC would like to understand more information about the physical characteristics and permeability of dike materials. An alternative plan for the evaluation of groundwater movement has been proposed in this EIP, including hydraulic conductivity testing on wells where this information is lacking. Groundwater flow for Ash Disposal Area 2 will be evaluated using new and existing hydraulic conductivity data, gauging	TVA has not adequately responded to the comment. TVA shall propose the requested dye trace study. TVA has agreed to conduct an environmental investigation at the TVA JOF as required in the Commissioner's Order it received and did not appeal. It is TVA's responsibility to submit an Environmental Investigation Plan for TDEC's review and make changes to the EIP as requested by TDEC. When there are questions concerning any part of the EIP, TVA should discuss their	Comment acknowledged, a dye trace study has been included as Appendix K in this revision of the EIP.	Appendix G	Comment acknowledged – the Dye Trace Study SAP is included as Appendix G.

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						river is influencing the movement of groundwater within the active CCR surface impoundment, TVA shall propose a dye study to determine if the river is influencing ground water movement. TVA shall include in its amended Johnsonville EIP a groundwater dye study to determine the direction of groundwater flow below the active Johnsonville CCR surface impoundment.	data from recently installed monitoring wells and surface water elevations from the gauging station. The results of the evaluation will be provided in the EAR.	concerns with TDEC and TDEC shall consider TVA's concerns. However, if TDEC and TVA disagree on any matter, TVA shall perform investigative activities as specified by TDEC.			

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28	3.1	3.1.1	8	1	1	TVA states that it has existing ground water monitoring wells located at the TVA Johnsonville site. TVA shall include the location, description and construction methods for each well in the revised Johnsonville EIP submitted to TDEC in response to TDEC's comments. TVA shall also include the sampling results from each groundwater monitoring well including sampling date, sample results and identifying whether the levels of CCR constituents reported exceed either the MCL levels for CCR constituents or background levels for CCR constituents. Well location shall be identified on a TVA Johnsonville facility map, Results shall be reported in a table by monitoring well, CCR constituent and sampling date. Results shall be reported in µg/L. The wells reported shall include wells TVA installed at Johnsonville as required by the EPA CCR regulations.	The location, description and construction methods for existing groundwater wells and historical groundwater analytical data have been included in the revised EIP. Future sampling results and comparisons to background levels, which have not been calculated, will be included in the EAR.	TVA's response is incomplete. It does not appear that Appendix E contains coordinates, description or construction methods for existing or historical groundwater wells. The groundwater data tables provided are very helpful. However, a few instances where it appears there may be some QC issues were noted most obviously on the groundwater elevation data (e.g., JOF-C2 (C-2) GW elevation on 12/4/1991 was 357.84 (21.00 feet below some unidentified reference point) while on 6/11/1992 the groundwater elevation was 373.23 (20.51 ft below some unidentified reference point) . This occurred multiple time in 1993, 1995 at the same location. Well TVA needs to make sure all datums are uniform between historic and current data sets so that comparisons can be drawn. It also appears there are discrepancies at JOF-B4 (B-4). Also if a well was measured and then remeasured the same day please determine which is the appropriate measurement and place an asterisk explaining the discrepancies on the erroneous measurement (e.g., JOF-B10 [89-B10] 3/10/1999). TVA needs to indicate if the measurement is below top of casing, ground elevation or some other reference point.	Available monitoring well coordinates, description and construction methods for existing and closed wells are included in table format in Appendix O. Historical well measurements were obtained from a groundwater database. The differences in groundwater elevations at the same location over time could potentially be related to well repairs and re-surveying the location, obstructions in the well, conversion of units and/or human error. Water levels and depths to the bottom of the monitoring wells were measured from the top of the well casings. Groundwater elevations for existing wells will be confirmed during the investigation and provided in interim monthly reports and the EAR.	Available monitoring well coordinates, description and construction methods for existing and closed wells are included in table format in Appendix P.	Comment acknowledged – this change has been made in the document.

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39	3.2.2	TDEC General Request #2	16			How does TVA propose to adequately monitor groundwater at Ash Disposal Area 1 with no separation between property owners to the North? Please explain how one can infer that groundwater primarily flows east to west when the adjacent river flows North?	Comment acknowledged; The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater flow and direction. Based on the results of the initial phase of work, additional wells may be proposed. Based on current information, groundwater flows from east to west within Ash Disposal Area 1. Groundwater data collected as part of the proposed investigation activities will be used to evaluate groundwater flow direction and the results will be provided in the EAR.	TDEC is unclear on how groundwater flow can be inferred for the area since there are no current monitoring points located adjacent to the disposal area. However, the four proposed well locations could provide preliminary information on groundwater flow in the area. TDEC requests an additional well installed in an intermediate position between proposed wells JOF-109 and JOF-110.	To monitor and address groundwater flow, a vibrating wire piezometer will be installed between JOF-109 and JOF-110. A vibrating wire piezometer would provide additional information to help determine groundwater flow. This piezometer will have to be installed through ash as there is no subsurface divider between the ash on TVA property and the waste on Chemours' property.	TVA response is incomplete. Although a VWPZ provides information on groundwater flow and is an acceptable option, it will do nothing to address the question of groundwater quality and monitoring for CCR parameters.	A vibrating wire piezometer (VWPZ) will be installed between JOF-109 and JOF-110 to provide additional information to evaluate groundwater flow. After installation of the VWPZ and a preliminary evaluation of groundwater flow direction, TVA will confer and collaborate with TDEC during the investigation phase about whether another well in addition to JOF-109 and JOF-110 is necessary to collect groundwater quality data, and if so, the location of the well will be informed by the preliminary groundwater flow data. The VWPZ (and potential additional well) will have to be installed through ash as there is no subsurface divider between the ash on TVA property and the waste on Chemours' property.
40	3.2.2	TDEC General Request #2	16			Can TVA adequately monitor groundwater at Ash Disposal Area 1 with no downgradient monitoring wells to the direct north between the two property owners?	Comment acknowledged; The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater flow and direction. Based on the results of the initial phase of work, additional wells may be proposed. Based on current information, groundwater flows from east to west within Ash Disposal Area 1. Groundwater data collected as part of the proposed investigation activities will be used to evaluate groundwater flow direction and the results will be provided in the EAR.	See response to Comment #39	Refer to response to comment #39.	TVA response is incomplete. Although a VWPZ provides information on groundwater flow and is an acceptable option, it will do nothing to address the question of groundwater quality and monitoring for CCR parameters.	A vibrating wire piezometer (VWPZ) will be installed between JOF-109 and JOF-110 to provide additional information to evaluate groundwater flow. After installation of the VWPZ and a preliminary evaluation of groundwater flow direction, TVA will confer and collaborate with TDEC during the investigation phase about whether another well in addition to JOF-109 and JOF-110 is necessary to collect groundwater quality data, and if so, the location of the well will be informed by the preliminary groundwater flow data. The VWPZ (and potential additional well) will have to be installed through ash as there is no subsurface divider between the ash on TVA property and the waste on Chemours' property.

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41	3.2.2	TDEC General Request #2	16			How will TVA demonstrate groundwater quality in this area without a representative downgradient monitoring points between the two property owners?	Comment acknowledged; The proposed scope of work in the EIP is consistent with an initial phase that is needed to evaluate groundwater quality. Based on the results of the initial phase of work, additional wells may be proposed. Based on current information, groundwater flows from east to west within Ash Disposal Area 1. Groundwater data collected as part of the proposed investigation activities will be used to evaluate groundwater quality and flow direction and the results will be provided in the EAR.	See response to Comment #39	Refer to response to comment #39	TVA response is incomplete. Although a VWPZ provides information on groundwater flow and is an acceptable option, it will do nothing to address the question of groundwater quality and monitoring for CCR parameters.	A vibrating wire piezometer (VWPZ) will be installed between JOF-109 and JOF-110 to provide additional information to evaluate groundwater flow. After installation of the VWPZ and a preliminary evaluation of groundwater flow direction, TVA will confer and collaborate with TDEC during the investigation phase about whether another well in addition to JOF-109 and JOF-110 is necessary to collect groundwater quality data, and if so, the location of the well will be informed by the preliminary groundwater flow data. The VWPZ (and potential additional well) will have to be installed through ash as there is no subsurface divider between the ash on TVA property and the waste on Chemours' property.

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49	3.2.4	Miscellaneous Groundwater	17	All	All	TDEC recommends installing additional monitoring points south of JOF-114 to characterize groundwater flow and quality along the western boundary of the Coal Yard. An additional upgradient monitoring well should also be installed along the southeastern boundary.	The proposed coal yard closure plan includes consolidation of CCR material in the northern portion of the coal yard. TVA believes that the proposed monitoring network is adequate for the intended area. Additionally, groundwater may not be present in the unconsolidated materials above bedrock south of JOF-114. The results of the initial phase of work will be evaluated and if data gaps exist, additional wells may be proposed.	TVA has not adequately responded to the comment. TVA shall provide the proposed coal yard closure plan for review. TVA shall propose locations for the requested monitoring wells. Groundwater flow on the southwestern side of the Coal Yard is not fully characterized and requires a monitoring well to characterize groundwater flow and quality along the southwestern boundary of the Coal Yard. TVA has agreed to conduct an environmental investigation at the TVA JOF as required in the Commissioner's Order it received and did not appeal. It is TVA's responsibility to submit an Environmental Investigation Plan for TDEC's review and make changes to the EIP as requested by TDEC. When there are questions concerning any part of the EIP, TVA should discuss their concerns with TDEC and TDEC shall consider TVA's concerns. However, if TDEC and TVA disagree on any matter, TVA shall perform investigative activities as specified by TDEC.	A monitoring well will be installed along the southwestern boundary of the Coal Yard to satisfy this request.	TVA shall provide TDEC with the requested proposed coal yard closure plan for review prior to conducting any closure activities at the site.	Comment acknowledged.

Summary of Proposed Updates to JOF EIP Rev 4 Final
General Documents

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response/SAP Edit	Proposed Update to JIF EIP Rev 4 Final
1	JOF	December 10, 2018	NA	NA	NA	NA	NA	NA	NA	NA	Programmatic revisions including clerical errors, revision logs, dates, etc. in EIP document and in all SAPs.
2	JOF	December 10, 2018	NA	Appendix B	TDEC Correspondence	NA	NA	NA	NA	NA	Addition of correspondence documents that were in previous revisions but left out of Rev 3, such as letters.
3	WBF	November 19, 2018	NA	4.5.7	1.1.1, E.7 TDEC Surface Water Impacts Request No. 7	NA	NA	NA	NA	NA	Received additional, historical biological monitoring reports from TVA for all Plants. Updating references to historical documentation
4	JOF	December 10, 2018	NA	NA	NA	NA	NA	NA	NA	NA	Added sheet for public comments in Appendix X

Summary of Proposed Updates to JOF EIP Rev 4 Final
Hydrogeological Investigation SAP

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response/SAP Edit	Proposed Update to JOF EIP Rev 4 Final
1	KIF	October 3, 2018	Email from Luisa to TVA re. Hydrogeological Investigation SAP and Exploratory Drilling SAP Deviation regarding placement of bentonite pellets and filter packs during well installation.	5.3.1	Materials and Installation	12	5	all lines	NA	NA	Replace 5th paragraph with this text: It should be noted that the grout will be placed by tremie method through one-inch (minimum) diameter PVC pipe. The grout will be placed using pumps gauged to allow the installation crew to monitor pressures during the grouting process. In open (uncased) boreholes, the sand filter zones and bentonite pellets will be placed by tremie method through one-inch (minimum) diameter PVC. In cased boreholes (i.e., through hollow-stem augers or temporary casing), the sand filter zones and bentonite pellets may be placed by tremie method or may be poured slowly into the annular space of the drill tooling to prevent bridging.

Summary of Proposed Updates to JOF EIP Rev 4 Final
Groundwater Investigation SAP

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response/SAP Edit	Proposed Update to JOF EIP Rev 4 Final
1	ALF	October 3, 2017	87	Appendix J, Section 5.2.2	Groundwater Investigation SAP, Well Purging	7	2	2	Indicate if specific conductance is measured in mS/cm or μS/cm.	Specific conductance will be measured and recorded in μS/cm in accordance with ENV-TI-05.80.42 (Rev 0001, effective date 3/31/2017).	Language added to SAP

Summary of Proposed Updates to JOF EIP Rev 4 Final
Material Quantity SAP

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response/SAP Edit	Proposed Update to JOF EIP Rev 4 Final
1	All	NA	NA	3	Health and Safety				NA	NA	Add Section 3 Health and Safety to be consistent with previously submitted MQ SAP's for other EIP sites

Summary of Proposed Updates to JOF EIP Rev 4 Final
Exploratory Drilling SAP

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response/SAP Edit	Proposed Update to JOF EIP Rev 4 Final
1	CUF	September 13, 2018	NA	5.2.7	Equipment Decontamination Procedures	14	First (new)	NA	NA	NA	Add new first paragraph to Section 5.2.7: The decontamination procedures below apply to drilling and sampling in borings for temporary wells. For drilling and sampling in all other borings, as well as for all cone penetration testing, decontamination (per procedures listed in TVA TI ENV-05.80.05, Field Sampling Equipment Cleaning and Decontamination) will only occur before the first boring/CPT and after the last boring/CPT.
2	KIF	October 3, 2018	Email from Luisa to TVA re. Hydrogeological Investigation SAP and Exploratory Drilling SAP Deviation regarding placement of bentonite pellets and filter packs during well installation.	5.4.2.1	Materials and Installation	20	2	NA	NA	NA	Replace 2nd paragraph on page 20 with the following: It should be noted that the groutwill be placed by tremie method through one-inch (minimum) diameter PVC pipe. The grout will be placed using pumps gauged to allow the installation crew to monitor pressures during the grouting process. In open (uncased) boreholes, the sand filter zones and bentonite pellets will be placed by tremie method through one-inch (minimum) diameter PVC. In cased boreholes (i.e., through hollow-stem augers or temporary casing), the sand filter zones and bentonite pellets may be placed by tremie method or may be poured slowly into the annular space of the drill tooling to prevent bridging.

Summary of Proposed Updates to JOF EIP Rev 4 Final
Background Soil SAP

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response/SAP Edit	Proposed Update to JOF EIP Rev 4 Final
2	All	NA	NA	SAP 5.0	Sample Collection and Field Activity Procedures	4	2nd	Last	NA	NA	Correct typo in reference to ENV-TI-0.5.80.01 Planning Sampling Events. Currently referenced TI-08.80.01, should be TI-05.80.01
3	All	NA	NA	SAP 5.0	Sample Collection and Field Activity Procedures	4	2nd	Last	NA	NA	Correct typo in reference to ENV-TI-0.5.80.50 Soil and Sediment Sampling. Currently referenced TI-08.80.50, should be TI-05.80.50
4	All	NA	NA	SAP 5.2	Sampling Methods and Protocol	6	1st	Last	NA	NA	Correct typo in reference to ENV-TI-0.5.80.50 Soil and Sediment Sampling. Currently referenced TI-08.80.50, should be TI-05.80.50
5	All	NA	NA	EIP 4.1.1	A.1 TDEC Site Information Request No. 1	35	Last	Last	NA	NA	Add the following language: "If a proposed boring location is discovered to have accessibility restrictions related to agricultural, cultural, biological, or other such limiting factors, then a replacement boring will be proposed at a location that will meet the study's goals with approval from TDEC"
6	All	November 16, 2018	Plant-specific Sampling Location change	NA	Table 4	NA	NA	NA	NA	NA	Amend the container cell in Table 4 for radium 226 and 228 by replacing "8-oz glass" with "One 16-oz widemouth glass for both samples"

Summary of Proposed Updates to JOF EIP Rev 4 Final
CCR Material Characteristics SAP

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response/SAP Edit	Proposed Update to JOF EIP Rev 4 Final
1	All	NA	NA	5.2	NA				NA	NA	Add “ENV-TI-.05.80.01 Planning Sampling Events” to bullet list in Section 5.2
2	All	NA	NA	5.2.1 & 5.2.6	NA				NA	NA	Clarify language on analyzing CCR material for totals, as well as leachability, in Sections 5.2.1 and 5.2.6
3	All	NA	NA	5.2.1.2	NA				NA	NA	Add "µS/cm" units to specific conductivity in Section 5.2.1.2
4	All	NA	NA	Table 6	NA				NA	NA	Change “groundwater” to “pore water” for clarification in Table 6 footnote.
5	All	NA	NA	5.2.4.2	NA				NA	NA	Add language to Section 5.2.4.2 that "during construction and installation of the temporary wells (i.e., sampling locations), a CCR material grab sample will be taken from each 5-foot core boring, from the top of the unit to its base."
6	All	NA	NA	6.2	NA				NA	NA	Clarify that rinsate blanks are to be collected for every 20 samples or once per sampling event.
7	KIF	November 6, 2018	NA	Table 6 & Section 5	NA				NA	NA	Remove arsenic speciation for all media from text and Table 6. Analytical Methods, Preservatives, Containers, and Holding Times in Section 5.
8	KIF	November 14, 2018	NA	Table 6	NA				NA	NA	Add SPLP leachability method to Table 6 for the CCR parameters.
9	All	NA	NA	Sections 5.0 and 5.2	NA				NA	NA	Correct TI Title numbers in Sections 5.0 and 5.2.
10	KIF	November 14, 2018	NA	NA	NA				NA	NA	Amend the container cell in Table 6 for radium 226 and 228 by replacing "8-oz glass (CCR)" with "One 16-oz widemouth glass (CCR) for both samples."

Summary of Proposed Updates to JOF EIP Rev 4 Final
Water Use Survey

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response/SAP Edit	Proposed Update to JOF EIP Rev 4 Final
1	ALF	October 3, 2017	87	Appendix J, Section 5.2.2	Groundwater Investigation SAP, Well Purging	7	2	2	Indicate if specific conductance is measured in mS/cm or µS/cm.	Specific conductance will be measured and recorded in µS/cm in accordance with ENV-TI-05.80.42 (Rev 0001, effective date 3/31/2017).	Specify units in Water Use Survey SAP
2	KIF	November 6, 2018	NA	5.5.5	Sample Analyses	13	Table 5	NA	NA	NA	Replace SW-846 analyses with EPA numbered methods for drinking water in Table 5. Analytical Methods, Preservatives, Containers, and Holding Times in Section 5 to match the analyses in the QAPP.

Summary of Proposed Updates to JOF EIP Rev 4 Final
Benthic SAP

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response/SAP Edit	Proposed Update to JOF EIP Rev 4 Final
1	NA	NA	TVA Comment	NA	Benthic SAP				NA	NA	Per TVA September 2018 email request, designating left and right banks as looking downstream. Reference added in Section 4.1.
2	NA	NA	TVA Comment	NA	Benthic SAP				NA	NA	Per TVA September 2018 email request, adding reference to potential collection of shallow sediment samples using self-closing mechanical benthic sampling device if Vibecore sampling not practical based on conditions encountered in the field. Reference added to Section 5.2.1.1.
3	NA	NA	TVA Comment	NA	EIP Section 4.5.7				NA	NA	Received additional biological monitoring reports from TVA. Will change reference to historical documentation from one document to multiple documents.
4	NA	November 8, 2018	TVA Comment	NA	Benthic SAP				NA	NA	Per TVA November 2018 email request, modifying references indicating that "upon arrival at a sample location where both sediment and surface water are being collected, the surface stream sample will be collected before the associated sediment sample." Adding the qualifier "If the sediment and surface water sampling is conducted concurrently/during the same event," to reflect the fact that this may not apply if sediment and surface water sampling conducted as two separate independent events. Reference added in Section 5.2.1.1.
5	All	November 16, 2018	NA	Table 8	Benthic SAP						Amend the container cell in Table 8 for radium 226 and 228 by replacing "8-oz glass jar" with "One 16-oz widemouth glass jar for both samples"

Summary of Proposed Updates to JOF EIP Rev 4 Final
Seepage Investigation SAP

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response/SAP Edit	Proposed Update to JOF EIP Rev 4 Final
1	All	November 1, 2018	NA	General Administrative	Seep SAP				NA	NA	Add TVA TI ENV-TI-05.80.01 to Section 5.3 and References list, and remove duplicate TVA TI ENV-TI-05.80.02 entry.
2	All	November 16, 2018	NA	General Administrative	Seep SAP				NA	NA	Amend the container cell in Table 5 for radium 226 and 228 by replacing "8-oz glass (soil)" with "One 16-oz widemouth glass (soil) for both samples."

Summary of Proposed Updates to JOF EIP Rev 4 Final
Surface Stream SAP

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response/SAP Edit	Proposed Update to JOF EIP Rev 4 Final
7	CUF	February 15, 2018	NA	5.2	Surface Stream SAP	9-11	NA	NA	NA	NA	Remove velocity measurements from surface stream SAPs as loading values were not necessary to achieve the objective. Comparison of concentration values is the preferred method for determining if CCR materials are having an effect on surface streams.
8	CUF	September 12, 2018	NA	5.2	Surface Stream SAP	NA	NA	NA	NA	NA	Add procedure for determining whether or not a thermocline exists.
9	BRF	June 5, 2018	TVA Comment	Table 7	Surface Stream SAP	NA	NA	NA	NA	NA	Add TDS & TSS to Table 7
10	JSF	October 11, 2018	NA	4.0	Sampling Locations	4	2	18	NA	NA	Will change "hardness" to total hardness in reference to previous comment to add total hardness to constituents (Item #6)
11	JSF	October 11, 2018	NA	5.2.4	Collection of Samples	12	3	12-14	NA	NA	Will add naming convention and clarifying language for right bank, left bank, thalweg.
12	WBF	November 8, 2018	NA	5.2.4	Collection of Samples	10	1	1-5	NA	NA	Add text to specify that if the sediment and surface water sampling is conducted concurrently/during the same event, upon arrival at a sample location where both sediment and surface water are being collected, the surface stream sample will be collected before the associated sediment sample.
13	WBF	November 8, 2018	NA	5.2.4	Collection of Samples	NA	NA	NA	NA	NA	Will clarify that filters will be treated as single-use.
14	ALF	October 3, 2017	87	Appendix J, Section 5.2.2	Groundwater Investigation SAP, Well Purging	7	2	2	Indicate if specific conductance is measured in mS/cm or µS/cm.	Specific conductance will be measured and recorded in µS/cm in accordance with ENV-TI-05.80.42 (Rev 0001, effective date 3/31/2017).	Incorporate similar change into JOF Surface Stream SAP.
15	JOF	October 19, 2017	143	Surface Stream SAP	All	All	All	All	TDEC recommends conducting sampling away from and upstream of the boat and motor.	Comment is acknowledged, and the corresponding change has been made in the document.	Incorporate similar change into JOF Surface Stream SAP.
16	JOF	March 27, 2018	New 191	5.2.4	Surface Water SAP	All	All	NA	Sampling will be conducted during seasonal mean flows and during flows of less than the 75th percentile. The mean would be below the 75th percentile, but you could be below the 75th percentile and be above the mean flow. Which condition will be the determining factor as to when sampling is conducted? Would a better approach be to conduct sampling when flows are between approximately the 25th and 75th percentile? You may want to consider sampling based on the median flow and some range around it.	Comment is acknowledged, and the corresponding changes have been made in the documents.	Incorporate similar change into JOF Surface Stream SAP.
17	JOF	October 19, 2017	145	Surface Stream SAP	All	All	All	All	Please confirm that sampling teams will change tubes on peristaltic pumps between sample sites.	Tubing will be changed between sampling sites.	Need to add.
18	ALF	October 3, 2017	59	Appendix C, Section 9.1.2	QAPP	23	4	9	Some of the requirements in the QAPP are written as should. The QAPP must be written as what will be done. If multiple coolers are needed, one COC Record should will accompany each cooler that contains the samples identified on the COC.	The word “will” will be replaced with “shall” where a TDEC regulation, rule or the Order is explicitly referenced. In all other uses, the word “will” can be interpreted by TDEC as having the same meaning as “shall” and reflect TVA’s commitment to performing the specified task, action, activity, etc.	Incorporate similar change into JOF Surface Stream SAP.

Summary of Proposed Updates to JOF EIP Rev 4 Final
Fish Tissue SAP

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response/SAP Edit	Proposed Update to JOF EIP Rev 4 Final
1	CUF	March 20, 2018	NA	5.2.4	Collection of Samples	13	4th Bullet	4	NA	NA	Deleted "no more than one week apart." TVA Biologists will freeze all samples at the lab prior to compositing. The samples will be collected within the same seasonal period/breeding season; typically within 3 weeks of each other.

Summary of Proposed Updates to JOF EIP Rev 4 Final
Quality Assurance Project Plan

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	Proposed Update to JOF EIP Rev 4 Final
1	All	NA	NA	NA	NA	NA	NA	NA	Edit document to remove "Investigation Consultant"
2	JOF	NA	NA	2.2.4	Analytical Laboratories	6	Table 2-1	NA	Change PM for both TestAmerica Facilities to Gail Lage
3	JOF	NA	NA	2.2.4	Analytical Laboratories	6	Table 2-1	NA	Update primary TestAmerica facility to Nashville, TN and identify Pittsburgh and St. Louis as support facilities
4	JOF	NA	NA	11.2	Field and Laboratory Quality Control Samples	28	Table 11-1	NA	Clarify field blank frequency to "1 per day of sampling activity per sampling team"
5	JOF	NA	NA	19.1	Precision	49	3	NA	Add language defining RER equation
6	JOF	NA	NA	Attachment D	Table A: TVA - TDEC Order Sample Naming Conventions - Johnsonville Fossil Plant	D-2, D-3	NA	NA	Update nomenclature coding for background soil and surface stream investigations.
7	JOF	NA	NA	Attachment E	Investigation-Specific Quality Control Requirements – Background Soil Sampling	E-2	Table E-1	NA	Update container type to 16-oz glass for radiological parameters
8	JOF	NA	NA	Attachment E	Investigation-Specific Quality Control Requirements – Background Soil Sampling	E-2	Table E-1	NA	Remove thermal preservation required for radiological parameters
9	JOF	NA	NA	Attachment E	Investigation-Specific Quality Control Requirements – Background Soil Sampling	E-3	Table E-2	NA	Update RLs to match current laboratory reporting limits
10	JOF	NA	NA	Attachment F	Investigation-Specific Quality Control Requirements – CCR Material	F-2	Table F-1	NA	Update container type to 16-oz glass for radiological parameters for CCR Material.
11	JOF	NA	NA	Attachment F	Investigation-Specific Quality Control Requirements – CCR Material	F-2	Table F-1	NA	Remove thermal preservation required for radiological parameters
12	JOF	NA	NA	Attachment F	Investigation-Specific Quality Control Requirements – CCR Material	F-2	Table F-1	NA	Add requirements for aqueous equipment blank sample containers, volume, and preservation.
13	JOF	NA	NA	Attachment F	Investigation-Specific Quality Control Requirements – CCR Material	F-2	Table F-1	NA	Add requirements for SPLP analyses.
14	JOF	NA	NA	Attachment F	Investigation-Specific Quality Control Requirements – CCR Material	F-3	Table F-2	NA	Update RLs to match current laboratory reporting limits
15	JOF	NA	NA	Attachment F	Investigation-Specific Quality Control Requirements – CCR Material	F-4	Table F=3	NA	Clarify filtered samples to be collected for metals/mercury only.

16	JOF	NA	NA	Attachment F	Investigation-Specific Quality Control Requirements – CCR Material	NA	new table	NA	Insert table of analytes, methods, and reporting limits for SPLP leachates.
17	JOF	NA	NA	Attachment F	Investigation-Specific Quality Control Requirements – CCR Material	F-6	Table F-4	NA	Remove surrogate requirement for radiological parameters in solid matrices.
18	JOF	NA	NA	Attachment F	Investigation-Specific Quality Control Requirements – CCR Material	NA	new table	NA	Insert table of Quantitative QA Objectives or SPLP leachates.
19	JOF	NA	NA	Attachment G	Investigation-Specific Quality Control Requirements – Water Use Survey	G-2	Table G-1	NA	Remove thermal preservation required for radiological parameters
20	JOF	NA	NA	Attachment G	Investigation-Specific Quality Control Requirements – Water Use Survey	G-3	Table G-2	NA	Update RLs to match current laboratory reporting limits
21	JOF	NA	NA	Attachment H	Investigation-Specific Quality Control Requirements – Groundwater	H-2	Table H-1	NA	Remove thermal preservation required for radiological parameters
22	JOF	NA	NA	Attachment H	Investigation-Specific Quality Control Requirements – Groundwater	H-3	Table H-2	NA	Update RLs to match current laboratory reporting limits
23	JOF	NA	NA	Attachment I	Investigation-Specific Quality Control Requirements – Surface Stream	I-2	Table I-1	NA	Remove thermal preservation required for radiological parameters
24	JOF	NA	NA	Attachment I	Investigation-Specific Quality Control Requirements – Surface Stream	I-3	Table I-2	NA	Update RLs to match current laboratory reporting limits
25	JOF	NA	NA	Attachment J	Investigation-Specific Quality Control Requirements – Benthic Sampling	J-2	Table J-1	NA	Remove thermal preservation required for radiological parameters
26	JOF	NA	NA	Attachment J	Investigation-Specific Quality Control Requirements – Benthic Sampling	J-3	Table J-2	NA	Update RLs to match current laboratory reporting limits
27	JOF	NA	NA	Attachment J	Investigation-Specific Quality Control Requirements – Benthic Sampling	J-5	Table J-3	NA	Update RLs to match current laboratory reporting limits
28	JOF	NA	NA	Attachment J	Investigation-Specific Quality Control Requirements – Benthic Sampling	J-5	Table J-3	NA	Removed note that biological samples will be reported on a dry-weight basis; tissue samples will be reported wet-weight.
29	JOF	NA	NA	Attachment K	Investigation-Specific Quality Control Requirements – Fish Tissue Sampling	K-3	Table K-2	NA	Removed note that biological samples will be reported on a dry-weight basis; tissue samples will be reported wet-weight.
30	JOF	NA	NA	Attachment K	Investigation-Specific Quality Control Requirements – Fish Tissue Sampling	K-3	Table K-2	NA	Update RLs to match current laboratory reporting limits
31	JOF	NA	NA	Attachment L	Investigation-Specific Quality Control Requirements – Seep Sampling	L-2	Table L-1	NA	Update container type to 16-oz glass for radiological parameters for seep soil
32	JOF	NA	NA	Attachment L	Investigation-Specific Quality Control Requirements – Seep Sampling	L-2	Table L-1	NA	Remove thermal preservation required for radiological parameters

33	JOF	NA	NA	Attachment L	Investigation-Specific Quality Control Requirements – Seep Sampling	L-3	Table L-2	NA	Update RLs to match current laboratory reporting limits
34	JOF	NA	NA	Attachment L	Investigation-Specific Quality Control Requirements – Seep Sampling	L-5	Table L-3	NA	Update RLs to match current laboratory reporting limits
35	JOF	NA	NA	Attachment L	Investigation-Specific Quality Control Requirements – Seep Sampling	L-5	Table L-3	NA	Clarify filtered samples to be collected for metals/mercury only.
36	JOF	NA	NA	Attachment L	Investigation-Specific Quality Control Requirements – Seep Sampling	L-7	Table L-4	NA	Remove surrogate requirement for radiological parameters in solid matrices.

JOF Location Revisions - EIP Revision 4

Location ID	Reason for location Change	Technical Driver	Actions Taken
JOF-BG-01	- Initially located within State Park in area that may have cultural significance. - Proactively moved to avoid schedule delays or future relocation.	- To meet a spatial distribution of BGS locations	- relocated to the side of a road outside the state park gate.
JOF-BG-02	- Located on large slope covered in riprap	- To meet a spatial distribution of BGS locations	- Relocated boring to flat grassy area close to fence line and newly installed GW well
JOF-BG-08	- Located in thick woods that would require clearing and an access path	- To meet a spatial distribution of BGS locations	- Relocated the boring to a cleared area nearby
JOF-BG-09	- Located under high voltage power lines and on steep slope	- To meet a spatial distribution of BGS locations	- Relocated to area away from power lines to area with similar geology/soil
JOF-BG-12	- Located under high voltage power lines and near a gas line	- To meet a spatial distribution of BGS locations	- Relocated to area away from power lines and gas line to area with similar geology/soil
JOF-119	- Located in soft shoreline area that would be difficult to access	- JOF-119 is the location of the potential background GW well	-Relocated well to higher ground, away from shoreline and easier to access
B01	Based on site walkdown, boring location is the slope of a drainage swale and would be difficult for drill rig access.	No change to technical objectives. Improve spatial coverage for CCR thickness, water levels, foundation type and thickness, top of bedrock elevations, and shallow bedrock characterization. Vibrating wire piezometers will be grouted in place in the major material zones encountered in the boring (e.g., CCR, foundation soil(s), bedrock).	Shift location of boring less than 100ft to the east, out of the drainage swale. Terrain will be flatter, access will be easier and safer for the drill rig.
B04	Based on site walkdown, boring location is too close to high voltage overhead power lines to allow for safe drill rig access.	No change to technical objectives. Improve spatial coverage for CCR thickness, water levels, foundation type and thickness, top of bedrock elevations, and shallow bedrock characterization. Vibrating wire piezometers will be grouted in place in the major material zones encountered in the boring (e.g., CCR, foundation soil(s), bedrock).	Shift location of boring roughly 500ft to the west, away from the power lines. The location will still be at the toe of the CCR unit.
B09	Based on site walkdown, boring location is low lying area that would be inaccessible for a drill rig.	No change to technical objectives. Improve spatial coverage for CCR thickness, water levels, foundation type and thickness, top of bedrock elevations, and shallow bedrock characterization. Vibrating wire piezometers will be grouted in place in the major material zones encountered in the boring (e.g., CCR, foundation soil(s), bedrock).	Shift location of boring roughly 300ft to the northwest, out of the inaccessible area. The location is also shifted away from the toe of the CCR unit slightly, to allow the drill rig a safe distance from high voltage overhead power lines.
TW15	Based on site walkdown, boring location is on a relatively steep slope and would be difficult for drill rig to place temp well.	No change to technical objectives. Improve spatial coverage for CCR thickness and water levels, and facilitate CCR material characterization. Temporary well will be installed to facilitate pore water sampling in CCR.	Shift location of boring less than 100ft to the northwest. Terrain will be flatter, access will be easier and safer for the drill rig.

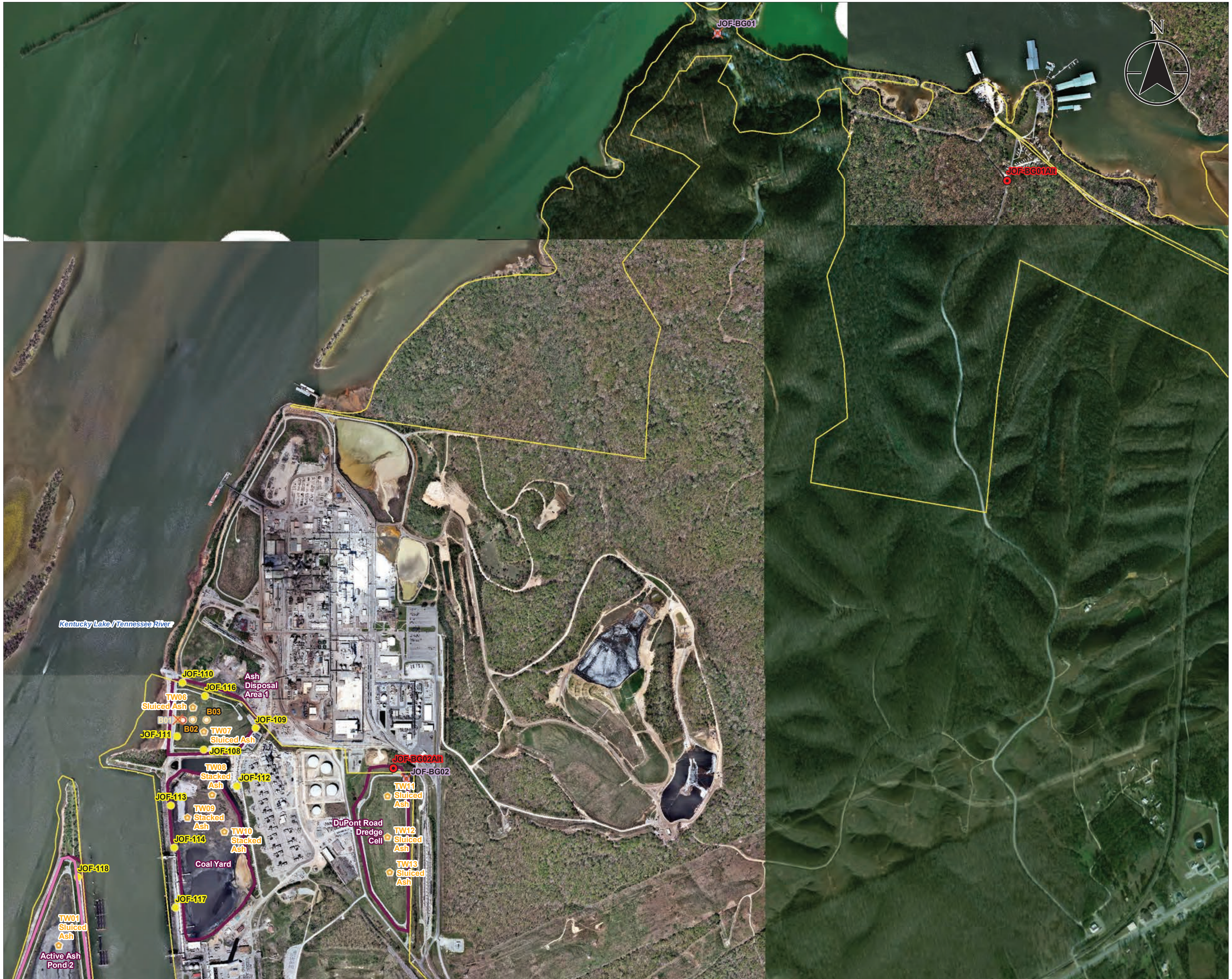


Figure No.
1

Title
Location Revisions - North

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-12-04
Technical Review by ZW on 2018-12-04

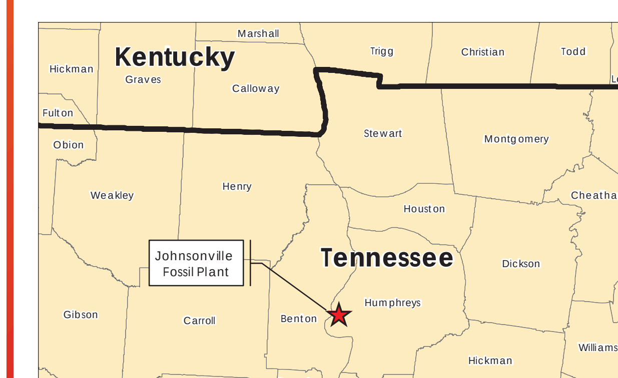
0 600 1,200 1,800 2,400 Feet
1:7,200 (At original document size of 22x34)

Legend

- Alternate Background Soil Sample
- Alternate Proposed Boring w/ PZVW
- Proposed Background Soil Sample Location
- Proposed Groundwater Monitoring Well
- Proposed Boring w/ PZVW
- Proposed Temporary Well (Screened Interval)
- Replaced Location
- TVA Property Boundary
- Unit Boundary (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TVA (2017) & ESRI World Imagery



Stantec TVA

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Figure No.
2

Title
Location Revisions - South

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-12-04
Technical Review by ZW on 2018-12-04

0 600 1,200 1,800 2,400 Feet
1:7,200 (At original document size of 22x34)

Legend

- Alternate Background Soil Sample
- Alternate Groundwater Monitoring Well
- Alternate Proposed Boring w/ PZVW
- Alternate Proposed Temporary Well (Screened Interval)
- Proposed Background Soil Sample Location
- Proposed Groundwater Monitoring Well
- Proposed Boring w/ PZVW
- Proposed Temporary Well (Screened Interval)
- Replaced Location
- TVA Property Boundary
- Unit Boundary (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TVA (2017) & ESRI World Imagery

APPENDIX C
QUALITY ASSURANCE PROJECT PLAN

Setting the Standards for Innovative Environmental Solutions

QUALITY ASSURANCE PROJECT PLAN
FOR THE TENNESSEE VALLEY AUTHORITY
JOHNSONVILLE FOSSIL PLANT
ENVIRONMENTAL INVESTIGATION

Revision 3

December 2018

Prepared by:

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1.0 TABLE OF CONTENTS

Figures

Tables

Attachments

2.0 QUALITY ASSURANCE PROJECT PLAN DESCRIPTION

2.1 Background

The primary goal of this Tennessee Valley Authority (TVA) Johnsonville Fossil Plant (JOF) Environmental Investigation Quality Assurance Project Plan (JOF QAPP) is to confirm that the JOF environmental investigation objectives are met by TVA consultants and contractors generating documented, high-quality, reliable investigative/analytical data. This document describes the quality assurance (QA) requirements for work performed under the *TVA Johnsonville Fossil Plant Environmental Investigation Plan*, *Revision 2* (JOF EIP, Revision 2; April 2018) and provides QA procedures and quality control (QC) measures to be applied to associated sampling and monitoring activities. This JOF QAPP will govern the quality aspects of the investigation-specific Sampling and Analysis Plans (SAPs).

This JOF QAPP describes the QA implementation for the JOF EIP and identifies the obligations of the various entities responsible for generating environmental data. Specific details on the various sampling programs and project-specific quality objectives are presented in this JOF QAPP and/or the associated SAPs, with TVA Technical Instructions (TIs) or standard operating procedures (SOPs) guiding the specific activities performed under these plans. The JOF QAPP describes the generation and use of environmental data associated with the JOF EIP and is applicable to current sampling and monitoring programs associated with the project. Data generated under the JOF EIP will be managed in accordance with the Data Management Plan for the TVA Multi-Site Order.

2.2 Quality Assurance Program Organization, Management, and Responsibilities

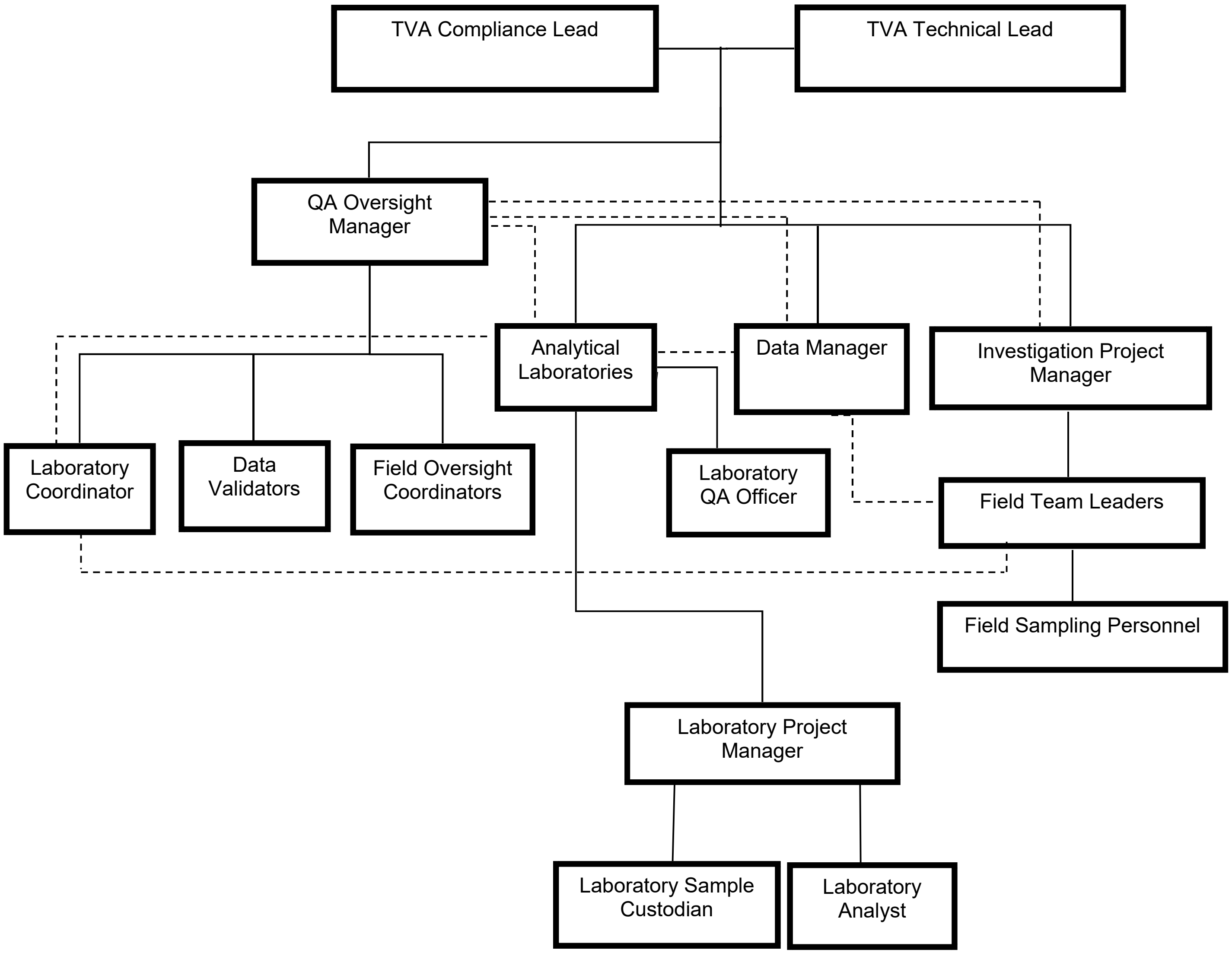
Successful implementation of a QA Program requires clear lines of reporting and authority, along with defined responsibilities for key individuals implementing and administrating the QA Program. This section describes the organizational structure, lines of authority, and responsibilities of key individuals accountable for the implementation and administration of the JOF EIP requirements. Project activities are performed within the framework of the organization and functions described in this section.

The organizational structure showing relationships of individuals with key responsibilities is presented in Figure 2-1. The organizational structure in Figure 2-1 represents a subsection of the overall organizational structure for the project as directly related to implementation of the JOF QAPP. The QA oversight consultant provides independent QA support to TVA including QA oversight of field and laboratory personnel. The organizational structure is designed to provide clear lines of responsibility and authority, regardless of the individuals filling particular roles. This organizational structure encompasses the following activities:

- Identifying lines of communication and coordination.
- Monitoring project schedules and performance.
- Managing technical resources.
- Providing periodic progress reports.
- Coordinating support functions such as laboratory analysis and data management.
- Rectifying deficiencies and issues that could impact data quality.

Field and laboratory personnel providing services in support of project efforts must perform work in compliance with the appropriate technical specifications for the activity.

Figure 2-1. Organization Chart and Lines of Communication for the JOF EIP



The sections below detail the roles and responsibilities for the positions involved in the JOF EIP.

2.2.1 TVA Compliance Lead

The TVA Compliance Lead is responsible for the coordination and direction of the JOF EIP. The TVA Compliance Lead is ultimately responsible for design and implementation of the JOF EIP. The TVA Compliance Lead interfaces with TVA Legal Counsel as necessary and provides reports to TVA Senior Management.

TVA Compliance Lead's responsibilities and duties include:

- Identifying lines of communication and coordination.
- Managing key technical resources.
- Providing periodic progress reports to TVA Senior Management.
- Reviewing and approving the JOF EIP strategy.
- Reviewing and approving JOF EIP quality objectives.
- Reviewing and approving SAPs.
- Rectifying deficiencies and issues.
- Participating in meetings with Tennessee Department of Environment and Conservation (TDEC).
- Providing compliance support to TVA Technical Lead.

2.2.2 TVA Technical Lead

The TVA Technical Lead is responsible for providing technical guidance for the JOF EIP. The TVA Technical Lead directs the Investigation Project Manager and independent QA Oversight Manager and is ultimately responsible for design and implementation of the JOF EIP. The TVA Technical Lead interfaces with TVA Legal Counsel as necessary and provides reports to TVA Senior Management.

TVA Technical Lead's responsibilities and duties include:

- Developing and reviewing the JOF EIP strategy.
- Developing and reviewing JOF EIP quality objectives.
- Reviewing and approving SAPs.
- Reviewing and analyzing overall task performance relative to planned QA requirements.
- Managing support functions such as laboratory analysis and data management.
- Rectifying deficiencies and issues.
- Providing technical support to the TVA Compliance Lead.
- Overseeing the budget.
- Monitoring project schedules and performance.

2.2.3 Investigation Project Manager

The Investigation Project Manager plans, coordinates, and oversees the performance of all investigation and sample collection activities. The Investigation Project Manager's responsibilities include:

- Developing SAPs.
- Planning and coordinating Field Sampling Personnel for investigation and sampling events.
- Reviewing field logbooks for completeness, consistency, and accuracy.
- Managing and reviewing field sample Chain-of-Custody (COC) Records and associated documentation.
- Obtaining the appropriate field gear and supplies.
- Notifying management of situations requiring corrective action.
- Responding to, and implementing corrective action, as described in Section 16.0.

2.2.3.1 Field Team Leaders

The Field Team Leaders are the primary contacts in the field and are responsible for field activities, as listed below.

- Provide coordination and management of Field Sampling Personnel and subcontractors involved in field investigation, sampling or calibration activities.
- Submit analytical requests to the Laboratory Coordinator.
- Ensure Field Sampling Personnel are familiar with field procedures and that these procedures are followed to achieve the data objectives.
- Review field logbooks and field data sheets for completeness, consistency, and accuracy.
- Conduct QA review of field data and coordinate submittal of field data to the Data Manager.

2.2.3.2 Field Sampling Personnel

Field Sampling Personnel are responsible for the performance of field activities as required by the investigation-specific SAPs and associated field TIs. Field Sampling Personnel document compliance with project requirements by recording field activities and observations in a field logbook at the time of the activity or observation. In addition, Field Sampling Personnel are responsible for collecting samples, submitting them to laboratories, and maintaining COC Records.

Field Sampling Personnel are responsible for field activities, including:

- Plan investigation and sample events and interface with Laboratory Coordinator.
- Collect, label, and package samples.
- Ensure field procedures are followed to achieve the data objectives.
- Review field notebooks/logbooks for completeness, consistency, and accuracy.
- Provide coordination of sample delivery to project laboratories for analysis.

If there are problems encountered during any field activities, Field Sampling Personnel will inform the appropriate Field Team Leader and/or the Investigation Project Manager.

2.2.4 Analytical Laboratories

The functional roles for project analytical laboratories are described in this subsection. From the Project perspective, the structure is designed to facilitate information exchange about planning, technical requirements, schedules, and QA measures among the laboratories, Investigation, QA Oversight personnel, and TVA personnel. Project information exchange specifically includes sample identification; preservation procedures; sample container requirements; sample collection procedures; decontamination protocols; and sample labeling, packing, holding times, and shipping.

Although internal laboratory structures may differ depending on the specific contractor, key functional roles include division management, technical direction, subcontracting coordination, data review, and data management.

The responsibilities of the analytical laboratories include, but are not limited to:

- Preparing and analyzing samples in a manner consistent with the analytical request, the JOF QAPP, and any applicable TVA TIs or other work instructions.
- Communicating with the QA Oversight team.
- Adhering to the laboratory QA Program.
- Implementing QC procedures for each test parameter.
- Reviewing analytical results, including raw data, calculations, and laboratory logbooks.
- Monitoring proper documentation and maintenance records.
- Identifying and implementing training requirements for the laboratory analytical personnel.
- Identifying QA problems and recommending appropriate corrective action.
- Preparing status reports (progress, problems, and recommended solutions).
- Preparing reports documenting completion of corrective actions.
- Providing electronic data deliverables (EDDs) in a format consistent with project requirements.

Laboratories will be selected based on a number of factors including capability, capacity, and ability to generate quality data that meet project objectives. The primary contracted laboratories may subcontract samples for special studies or non-routine analyte lists. In the event that samples are subcontracted, the primary laboratory is responsible for ensuring that analyses conform to the JOF QAPP requirements and the associated investigation-specific SAP. Data for subcontracted analyses will be reported through the primary contracted laboratory, which remains responsible for data quality.

The primary analytical laboratories expected to analyze samples associated with the JOF EIP are presented on Table 2-1.

Table 2-1. Analytical Laboratories for JOF EIP

Parameter/ Sample Type	Laboratory	Facility Address	Laboratory Contact
Metals, General Chemistry Parameters	TestAmerica Laboratories, Inc.	2960 Foster Creighton Drive Nashville, TN 37204[1]	Ms. Gail Lage (gail.lage@testamericainc.com)
		301 Alpha Drive Pittsburgh, PA 15237[2]	
Radiological Parameters		13715 Rider Trail North Earth City, MO 63045[2]	
Percent Ash	R.J. Lee Group	50 Hochberg Road, Monroeville, PA 15146	Ms. Monica Carse (MCarse@rjleegroup.com)
Biota Analyses	Pace Analytical Services, LLC	1241 Bellevue Street Suite 9 Green Bay, WI 54302	Mr. Tod Noltemeyer (tod.noltemeyer@pacelabs.com)
Benthic Invertebrate Community Assessment	Pennington & Associates, Inc.	161 McGee Lane Cookeville, TN 38501	Mr. Wendell Pennington (pai1@twlakes.net)
Geotechnical Characteristics	Stantec Consulting Services, Inc.	3052 Beaumont Centre Circle Lexington, KY 40513-1703	Ms. Ryan Jones (ryan.jones@stantec.com)
Dye Trace	Ewers Water Consultants, Inc.	160 Redwood Drive Richmond, Kentucky 40475	Dr. Ralph O. Ewers, Ph.D. (ewc@mis.net)

NOTES:

1 Primary analytical laboratory.
2 Support analytical laboratory.

2.2.4.1 Laboratory QA Officer

The Laboratory QA Officer ensures conformance with authorized policies, procedures, and sound laboratory practices as necessary. The Laboratory QA Officer will inform the Laboratory Project Manager of any non-conformances, introduce control samples into the sample train, and establish testing lots. In addition, the Laboratory QA Officer approves laboratory data before reporting or transmitting to permanent storage and is responsible for retention of supporting information such as control charts and other performance indicators to demonstrate that the systems that produced the data were in control. The Laboratory QA Officer also reviews results of internal QA audits and recommends corrective actions and schedules for their implementation.

The responsibilities of the Laboratory QA Officer include, but are not limited to:

- Administering the laboratory QA Program.
- Implementing QC procedures for each test parameter.
- Reviewing analytical results, including raw data, calculations, and laboratory log books.

- Monitoring proper documentation and maintenance of the records.
- Identifying and implementing training requirements for the laboratory analytical personnel.
- Overseeing QA implementation at the laboratory on a daily basis.
- Identifying QA problems and recommending appropriate corrective action.
- Preparing status reports (progress, problems, and recommended solutions).
- Preparing reports documenting completion of corrective actions.

2.2.4.2 Laboratory Project Manager

The Laboratory Project Manager is the primary contact for the Project Team at the analytical laboratory. A primary responsibility of the Laboratory Project Manager is to schedule analytical work within the laboratory, ensure that project-specific analytical requirements are communicated to staff, monitor analytical status/deadlines, approve laboratory reports, coordinate data revisions/corrections and re-submittal of data packages as necessary, and communicate sample preparation and analysis issues to the QA Oversight Manager and TVA Technical Lead on a real-time basis. The Laboratory Project Manager provides direction and support for laboratory administrative and technical project staff, interfaces with laboratory project staff on technical issues, and performs QA oversight of analytical data. The Laboratory Project Manager contacts the QA Oversight Manager and TVA Technical Lead if, at any point, there is a need to deviate from the JOF QAPP or other cited published materials. Any problems or inconsistencies identified at any time after laboratory sample receipt will be documented on a nonconformance report initiated by the Laboratory Project Manager and forwarded to the TVA Technical Lead and the Laboratory Coordinator.

The Laboratory Project Manager will provide sample receipt confirmations to the Laboratory Coordinator and Investigation Project Manager within one business day of sample login.

2.2.4.3 Laboratory Sample Custodian

The Laboratory Sample Custodian receives samples from TVA or its contractors, signs and dates COC Records, records the date and time of receipt, and records the condition of shipping containers and sample containers.

The Sample Custodian will verify and record agreement or non-agreement of information on sample custody documents. If there is non-agreement, the Sample Custodian will record the problems/inconsistencies for the case file and will inform the Laboratory Project Manager.

The Sample Custodian will also label sample containers with laboratory sample numbers, place sample containers and spent sample containers into the appropriate storage and/or secure areas, and monitor storage conditions.

2.2.4.4 Laboratory Analyst

The Laboratory Analyst is responsible for preparing and/or analyzing samples in accordance with this document and/or the applicable analytical methods. If there are problems encountered during sample preparation or analysis, the Laboratory Analyst will inform the Laboratory QA Officer and Laboratory Project Manager.

2.2.5 QA Functions

QA Oversight activities will be performed by a third-party, independent contractor. The QA oversight consultant is an independent third-party QA organization and reports directly to the TVA Technical Lead.

2.2.5.1 QA Oversight Manager

The QA Oversight Manager develops, implements, and administers the overall QA Program for the JOF EIP. The QA Oversight Manager holds overall authority for the project QA and maintains that authority independently from the operational/production aspects of the project. The QA Oversight Manager also holds the authority to communicate at any level of the project organization in order to be effective.

The QA Oversight Manager’s responsibilities and duties include:

- Establish a documented quality system for the project.
- Identify QA problems through periodic auditing and validation procedures.
- Initiate, recommend, or provide solutions to QA problems through designated channels.
- Ensure that project activities, including processing of information, delivery of products, and installation or use of equipment, are reviewed in accordance with QA objectives.
- Ensure that deficiencies or non-conformances are corrected.
- Ensure that further processing, delivery, or use of deficient or non-conforming data is controlled until correction of the non-conformance, deficiency, or unsatisfactory condition has occurred.
- Review and analyze overall task performance with respect to planned requirements.
- Perform general oversight of corrective action processes.
- Initiate and direct internal audits, inspections, surveillances, and observation of quality-related activities.
- Serve as point of contact for audits, inspections, surveillances, data management, and observation activities.
- Ensure deficiencies and non-conformances are corrected.
- Maintain QA documentation and records, including this JOF QAPP.

2.2.5.2 Laboratory Coordinator

The Laboratory Coordinator serves as a liaison between Field Team Leaders and the analytical laboratories for all work conducted under the JOF EIP. The Laboratory Coordinator’s responsibilities include:

- Review analytical requests to verify consistency with project SAPs.
- Submit analytical requests to the Laboratory Project Manager.
- Schedule sample submission and transportation (as needed).
- Review and approve laboratory bottleware orders.
- Review COC Records submitted to the laboratories and sample receipt documentation provided by the laboratories.

- Serve as the point of contact for questions and issues arising during laboratory analysis.

2.2.5.3 Data Validators

Data Validators are responsible for performing review and validation of project data generated by the laboratories in accordance with the JOF QAPP and data specifications, producing data validation reports, and notifying the QA Oversight Manager of any specific issues or concerns.

2.2.5.4 Field Oversight Coordinators

Field Oversight Coordinators are independent from field sampling activities and work with the Field Team Leaders to ensure compliance with the JOF QAPP, investigation-specific sampling plans, and the associated project TIs. The Field Oversight Coordinators are responsible for training personnel involved in field sampling activities (if training is required), sample handling procedures, and sample custody as detailed in project TIs and the investigation-specific SAPs, and for periodically overseeing their performance of these functions. The Field Oversight Coordinators perform quality oversight of the Field Teams during sample collection and assess the procedures and performance of the Field Teams relative to the requirements in the JOF QAPP, TIs, and investigation-specific SAPs. As part of the quality oversight, the Field Oversight Coordinators will review COCs prior to submission of samples to the analytical laboratories.

2.2.6 Data Manager

The Data Manager is responsible for managing the project EQuIS™ database, which includes analytical data from the project laboratories, field data from the Investigation, and historical data of known quality used as part of the JOF EIP. The Data Manager is the main point-of-contact for data-related issues. The Data Manager is responsible for ensuring compliance with the JOF QAPP and the Data Management Plan for the TVA Multi-Site Order (Data Management Plan). The Data Manager or designee receives EDDs directly from the project laboratories after sample analysis and formats the deliverables such that they can be used during the validation/verification process. Field data is collected and submitted to the Data Manager from the Investigation utilizing field EDDs and is loaded and managed in the project database. A complete description of the Data Manager's responsibilities and responsibilities of Data Management support staff is provided in the Data Management Plan.

3.0 PROJECT DESCRIPTION AND APPLICABILITY

On August 6, 2015, TDEC issued Commissioner's Order No. OGC15-0177 (TDEC Order), to TVA, setting forth a process for the investigation, assessment, and remediation of unacceptable risks at TVA's coal ash disposal sites in Tennessee. The TDEC Order is limited to the purposes and processes set forth in the TDEC Order. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at JOF on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management at JOF. TDEC submitted a follow-up letter dated February 23, 2017 and October 19, 2017, to TVA which provided specific questions and tasks to be addressed in the JOF EIP. TVA submitted JOF EIP Revision 1 to TDEC on January 12, 2018. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

The purpose of the JOF EIP is to characterize the hydrology and geology of the JOF, identify the extent of soil, surface water, and groundwater impact by CCR. At the conclusion of the investigation, an Environmental Assessment Report (EAR) analyzing results of these investigations will be prepared and submitted to TDEC. The EAR will support the development of an appropriate corrective action plan, if necessary, for JOF.

To support the JOF EIP objectives, a QA program has been implemented to ensure the environmental data generated for use in decision making is of high-quality and is legally defensible. The project's environmental data have been and continue to be used for purposes such as, but not limited to, operational decisions; delineation of the extent of contamination and transport of ash by river flows; and demonstration of achievement of project objectives.

On behalf of TVA, Environmental Standards, Inc., an independent QA firm, has prepared this JOF QAPP. The requirements of the JOF QAPP are applicable to project environmental personnel, support staff, consultants, and subcontractors.

3.1 Purpose and Scope

The JOF QAPP is intended to establish an overall environmental QA framework for the JOF EIP and to provide quantitative quality objectives for analytical data generated under the JOF EIP. Requirements associated with various analyses; data generation, reduction, and management; and results reporting are stipulated herein. Additional specific requirements are described in the investigation-specific SAPs.

The scope of this document is to describe the QA requirements developed for the JOF EIP and provide the appropriate QA procedures and QC measures to be applied to the associated sampling and monitoring activities. The JOF QAPP addresses the following items:

- Project organizational structure, roles, and responsibilities.
- QA objectives.
- Training requirements.
- Field and laboratory documentation requirements.
- Sample collection, handling, and preservation.
- COC procedures.
- Field and laboratory instrumentation and equipment calibration and maintenance.
- Preventive maintenance procedures and schedules.
- Laboratory procedures.
- Analytical methods requirements.
- Sample analysis, data reduction, validation, and reporting.
- QC sample types and frequency.
- QA performance and system audits.
- Data assessment procedures, including processing, interpretation, and presentation.
- Corrective actions.
- QA reports to management.

Investigation-specific SAPs have been developed to address program-specific sampling requirements to provide data sufficient to address the objectives of the particular investigation.

QC requirements and quantitative objectives for analytical data are presented in Attachments E through L of this JOF QAPP.

3.2 Schedule

Investigation-specific sampling schedules are addressed in each associated SAP.

In general, the anticipated schedule of activities related to analytical data generated from chemical analyses is presented below.

- The laboratory will provide analytical results and EDDs to TVA within its standard turn-around time (TAT; approximately 10 business days for chemical analyses and approximately 40 days for radiological analyses) from sample receipt (or sooner when expedited TAT is requested).
- The QA oversight consultant will screen the EDD for acceptability to the database and complete the initial verification within 2 business days of EDD receipt and successful EDD loading. Verified data will be available to TVA and Investigation personnel for internal use and reporting.
- The laboratory will provide full data deliverable packages to TVA and the QA oversight consultant within its standard TAT (approximately 20 business days for chemical analyses and approximately 45 days for radiological analyses) from sample receipt.
- The QA oversight consultant will complete data validation as requested by TVA, generate reports following receipt of the complete data package, and add data validation qualifiers to the database as appropriate.

The overall schedule for the JOF EIP is presented in the EIP. Schedules for the various sampling activities associated with each Environmental Investigation (EI) are addressed in the investigation-specific SAPs.

3.3 QAPP Distribution and Revision

The JOF QAPP will be distributed to each consultant and contractor responsible for the collection, generation, and interpretation of field and analytical data. The TVA Technical Lead, QA Oversight Manager, or designee will be responsible for ensuring that necessary revisions are made so that the JOF QAPP is up-to-date with actual practices and will ensure that revisions and updates are distributed to necessary users. The document control format used in the JOF QAPP will identify the revision number and revision date. A revision history that identifies each revision and a summary of the revision will be maintained.

4.0 DATA QUALITY OBJECTIVES PROCESS

The data quality objectives (DQO) process is a series of planning steps based on a scientific method to ensure that the type, quantity, and quality of environmental data used in decision-making are appropriate for the intended application. In general, DQOs provide a qualitative and quantitative framework around which data collection programs can be designed. The qualitative aspect of DQOs seeks to encourage good planning for field investigations. The quantitative aspect of DQOs involves designing an efficient field investigation that reduces the possibility of incorrect decision-making.

The DQO process is a tool employed during the project planning stage to ensure that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA, its QA oversight consultant, and Investigation personnel considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts at the JOF EIP.

5.0 SPECIAL TRAINING/CERTIFICATIONS

Field Sampling Personnel performing sample collection activities will be properly trained in equipment use and procedures necessary for each task prior to entering the field. Training will be conducted by TVA, the QA oversight consultant, the Investigation, and/or other subcontractors. Any proposed training not provided by the QA oversight consultant will be reviewed and approved by the Field Oversight Coordinator before training is conducted. Field Sampling Personnel training will be fully documented and the documentation will be maintained as part of the Project Record.

Individuals who plan to participate in field activities must have current health and safety training prior to commencement of sample collection activities. The Investigation Field Team Leader will verify that participants who arrive on site have provided evidence of health and safety training. It will be the responsibility of the Investigation Field Team Leader to ensure that Field Sampling Personnel understand and comply with the applicable requirements for their individual tasks.

Field Sampling Personnel will be trained on applicable field QC measures associated with a particular sampling program during investigation-specific training. Training received by Field Sampling Personnel will be documented. In addition, Field Sampling Personnel will receive training based on field oversight activities and additional training sessions on applicable project TIs.

Personnel who are responsible for performing laboratory analyses will be properly trained by the Laboratory Director or her/his designee to conduct the various laboratory analyses described in the JOF QAPP. Each laboratory shall assure sufficient personnel with the necessary education, training, technical knowledge, and experience for their assigned functions. Laboratory personnel training will be documented in accordance with the laboratory’s Quality Program requirements.

Data verification and validation will be conducted under the direction of the QA Oversight Manager, who will be experienced with the production, reporting, verification, and validation of analytical data.

Additional QA training will be conducted at the discretion of the TVA Technical Lead and the QA Oversight Manager. Generally, the need for QA training for project personnel will be identified through systems and performance audits and training will be conducted as part of the corrective action process. Any QA training provided to project personnel will be documented.

6.0 DOCUMENTATION AND RECORDS

Appropriate records will be maintained in a secure project file to provide adequate documentation of the entire data generation process, including field sampling and laboratory analysis. Field records will include maintaining field logs, field data sheets, and sample COC documentation. Field QC samples will be documented in both the field logbook and sample COC Records.

The Project File will be the central repository for documents relevant to sampling and analysis activities as described in the JOF QAPP and in the investigation-specific Work Plans and/or SAPs. The TVA Technical Lead will hold overall responsibility for maintenance of documentation associated with the project, including relevant records, correspondence, reports, logs, data, field records, pictures, subcontractor reports, analytical data, and data reviews. The file will include the following information, if generated:

- Field records.
- Field data and data deliverables.
- Photographs.
- Drawings.
- Sample logs.
- Laboratory data deliverables.
- Data validation reports.
- Field and laboratory audit reports.
- Reports (*e.g.,* progress reports, QA reports).
- Custody documentation.

Electronic and hardcopy analytical data will be archived for a minimum of 10 years from the date of report. TVA will maintain a complete project file and will archive hardcopy and electronic data in accordance with TVA records retention rules as delineated by TVA's records management documents. Electronic or hardcopy data associated with the JOF EIP will not be discarded, deleted, or destroyed by any party without the written consent of TVA Legal Counsel.

6.1 Field Data Documentation

Field data collected during the EI will be evaluated for usability by conducting a QA review, which will consist of checking the procedures used by field staff and comparing the data to previous measurements. Field QC samples will be used to verify that field measurements and sampling protocols have been observed and followed. The field data will be reviewed by the Field QA Oversight Coordinator or designee for the following:

- Compliance with TIs.
- Compliance with SAPs.
- Field equipment calibration method and frequency.
- Field calibration standard lot numbers and expiration dates.
- Date and time sampled.
- Preservation.
- Sampler collection procedures.
- COC Records.
- Date sample shipped.

Any deviations from applicable TIs or the investigation-specific SAPs will be approved and documented in the field logbook during sampling and data collection operations. The Field Team leader or designee will be notified of deviations.

The original COC Records will accompany samples to the analytical laboratories. Upon receipt and login of the samples at the laboratory, the remaining sections of the COC Record (such as description of the sample condition at the time of receipt, assigned laboratory identification number, and any special conditions) will be completed. The complete original COC Record will be archived at the analytical laboratory in accordance with the laboratory's document retention requirements and the requirements herein.

6.2 Laboratory Data Documentation

Analytical laboratories performing work on this project will retain records of the analytical data for a minimum of 10 years after project completion. Analytical data will not be disposed of without TVA's consent. In addition, laboratory data will be provided to TVA in hardcopy or approved electronic form. TVA will retain data in accordance with TVA records management requirements. Laboratory data will not be disposed without specific approval from the TVA Legal Counsel and the TVA Technical Lead.

6.2.1 Laboratory Data Reporting/Deliverable Package

Analytical l laboratories will report data at their standard TAT; generally, 10 business days from sample receipt at the laboratory for all chemical parameters. In some cases, expedited TATs are required. Results of sample chemical analyses are completed and results reported to TVA and the QA oversight consultant as a Level II report and EDD within 10 business days (refer to Attachment A for data deliverables requirements). Level IV data packages (refer to Attachment A for data deliverables requirements), in a hardcopy and/or electronic Adobe® Acrobat® portable document format (.pdf), will be submitted to TVA and the QA oversight consultant within approximately 20 business days from sample receipt at the laboratory. Radiological analysis results are completed and reported to TVA and the QA oversight consultant as a Level IV report and EDD within 40 business days.

Laboratories performing chemical analyses will be responsible for providing an EDD consistent with the Data Management Plan, as well as a Level II report and/or Level IV data package (see Attachment A). The deliverable package will contain final results (uncorrected for blanks and recoveries except where required by the referenced method), analytical method reference, sample results and detection limits, and results of field and laboratory QC samples. In addition, special analytical problems and/or any modifications of referenced methods will be noted in the Case Narrative of the laboratory report/data package. The number of significant figures reported will be consistent with the limits of uncertainty inherent in the analytical method.

As a general statement, chemical analytical data will typically be reported as follows.

- Concentrations for aqueous samples are expressed in terms of weight per unit volume (such as milligrams per liter [mg/L] or micrograms per liter [µg/L]).
- Concentrations for chemical analyses of solid samples (including biological samples) are expressed in terms of weight per unit weight of sample (such as milligrams per kilogram [mg/kg] or micrograms per kilogram [µg/kg]). Unless specifically directed otherwise, solid sample chemical analysis results will be reported on a dry-weight basis. Biological samples will be reported on a wet-weight basis. The reporting basis for solid samples will be clearly indicated in the laboratory data package.

- Radiological activities are expressed in terms of picocuries per unit volume or weight (such as pCi/L or pCi/g). For solid samples, radiological activities are not corrected for sample moisture content.

Chemical analytical data will be reported in the units specified in the Method Analyte Groups (MAGs) to ensure consistent reporting among the contracted laboratories.

Chemical analytical laboratory data will be provided in the Level II report and Level IV data package formats presented in Attachment A. In general, the Level IV data package will include summary forms and raw data for calibrations, QC, and sample analyses. QC results reported will include a method blank, matrix spike/matrix spike duplicate (MS/MSD) samples, field QC samples, and laboratory control samples (LCSs). Sample chemical analyses data (both field and laboratory QC sample results) will also be provided in EDDs. The laboratory is responsible for reviewing the electronic data to ensure that these data are consistent with those presented in the laboratory report/data package. Data discrepancies between the EDD submission and laboratory report/data package, if any, will be reconciled at validation; the data validators will notify the contract laboratory and TVA so that the laboratory deliverables may be revised by the contract laboratory. In the event that revisions to Level II or Level IV data packages are required based on data validation, complete revised deliverables clearly stamped with revision number and date will be provided by the contract laboratory so that a final complete data package is archived for each sample submittal.

6.3 Record Keeping

Written and/or electronic records generated under the JOF EIP, including but not limited to notes, logbooks, reports, draft and final documents, and forms, are maintained by the originator for inclusion in the project file as appropriate. In addition, electronic files, including but not limited to draft and final documents, and laboratory analytical reports are maintained as part of the electronic project file.

Chemical analytical data for this project will be reported in both an EDD and an analytical data package. An EarthSoft EQuIS database will be used for processing, storage, and reporting of all data (historical and investigatory) to be used as part of the JOF EIP. To maintain uniformity and consistency among analytical laboratories, the EDD format for the transfer of data associated with the JOF EIP will be a complex EDD specification compatible with EQuIS. A simple EDD specification may be substituted for laboratories that do not possess the capabilities to generate a complex EDD or for analyses for which automated data review is not applicable (*e.g.*, percent ash analyses by polarized light microscopy). The EQuIS data transfer parameters are discussed further in the Data Management Plan. The EDD will be generated by the laboratories and will be used to facilitate loading the analytical data into the EQuIS Project Database.

Field data generated during the JOF EIP will also be stored in the EQuIS Project Database. A simple EDD specification will be utilized by the Field Team Leader (or designee) to submit field data to the EQuIS Project Database.

Analytical data packages will be prepared by the laboratory for sample analyses performed. A Limited data deliverable (Attachment A) in Adobe Acrobat .pdf and EQuIS EDD will be provided by the contract laboratory within the laboratory's standard TAT for limited deliverables (approximately 10 business days from sample receipt for chemical analyses and approximately

40 business days from sample receipt for radiological analyses). Full deliverables (Attachment A) will be provided by the laboratory in an Adobe Acrobat .pdf electronic format for all analyses within the laboratory's standard TAT for Full data deliverables (approximately 20 business days from sample receipt for chemical analyses and approximately 45 business days from sample receipt for radiological analyses).

6.4 Data Archival

Applicable electronic field and laboratory data collected during sampling will be archived electronically. Backup tapes containing databases and programs or software utilities will be maintained in a secure location. Hardcopy data, including but not limited to field logbooks, laboratory data deliverables, and data validation reports, will be archived in accordance with TVA's Document Control protocols. Formal records custody procedures will be maintained in accordance with TVA's Records Custody procedures.

7.0 SAMPLING PROCESS DESIGN

This section briefly outlines field investigation procedures for the JOF EIP. Detailed discussions of field protocol are provided in the various TIs developed for the project. In addition, detailed descriptions of field activities are provided in the investigation-specific SAPs.

Aqueous, solid, and biological samples may be collected in association with the JOF EIP. These samples will be subject to a variety of chemical, radiological, and physical analyses to support the objectives outlined in the JOF EIP and associated investigation-specific SAPs.

Field investigation and sampling procedures will be conducted such that samples are representative of the media sampled and the resultant data can be compared to other data sets. Sampling schemes (as described in the associated investigation-specific SAPs) are designed to provide a statistically meaningful number of field sampling points and the rationale for the collection of these samples. A sufficient number of samples will be collected for each sampling program to adequately characterize the area and provide a sufficiently large data set such that statistical analyses can be performed. Field investigation and sampling methods will be conducted in accordance with the investigation-specific SAPs and associated TVA TIs, which include equipment requirements and decontamination procedures to meet the objectives of the project.

The investigative rationale for a specific sampling and analytical program is addressed in the investigation-specific SAPs. Sampling and monitoring activities are subject to the requirements set forth in the TVA TIs and this JOF QAPP. Investigation-specific SAPs will describe specific sampling and monitoring activities when QA requirements, more stringent than those presented herein, are required to support the sampling and monitoring projects.

The sampling design and execution for monitoring activities associated with the JOF EIP are described in the various investigation-specific SAPs. For some investigations it is anticipated that the sampling and monitoring activities will evolve in a phased approach as data are gathered under the planned investigations. As the sampling and monitoring programs are developed, additional SAPs and TIs may be prepared.

As the project progresses, the data generated will be used to evaluate sampling and analytical needs. Subject to regulatory approval, adjustments may be made to sampling schedules, analyte lists, and requested methods when supported by the results of field investigations.

Investigation-specific SAPs will present Site maps, including sampling locations (when applicable), for the various sampling and monitoring programs performed at the Site. Detailed descriptions of sampling process design and field sampling activities are provided in the investigation-specific SAPs. Field investigations will be addressed in investigation-specific SAPs.

8.0 SAMPLING METHODS REQUIREMENTS

Descriptions of the procedures for the sampling, identification, packaging, and handling of project samples; the decontamination of sampling equipment; and the calibration and maintenance of sampling equipment are presented in the associated TIs and the investigation-specific SAPs. An overview of sample identification, documentation, and custody as related to data collection activities is presented in Section 9.0.

8.1 Sample Containers, Preservation, and Holding Times

Sample container/media, preservation, and holding time requirements will be presented in the investigation-specific SAPs. Samples will be stored in accordance with the requirements set forth in the referenced analytical method and/or laboratory TIs.

Field samples will be contained and preserved in accordance with appropriate United States Environmental Protection Agency (US EPA) analytical method specifications which are cited in each SAP. Sampling containers and preservatives will be provided by the laboratory. In most cases, the supplied sampling containers will be pre-preserved by the laboratory prior to shipment. On an investigation-specific basis, samples may be filtered and/or preserved at the analytical laboratory. For chemical analyses, sample containers provided will be new pre-cleaned I-Chem® Series 300 (or equivalent). Samples will be placed in individual pre-cleaned containers for shipment to the laboratory.

Sample container orders, when shipped by the laboratory, will include a packing list that details the number and type of bottles shipped, the bottle lot numbers, chemical preservatives, and the packer's signature. The COC Records will be completed by Field Sampling Personnel and returned to the laboratory with the samples. Sample containers will be individually custody-sealed and placed inside the sample cooler. After the cooler is sealed, sampling personnel will attach signed/dated custody seals to the outside of the cooler as described in TVA *Sample Labeling and Custody* TI (ENV-TI-05.80.02).

Samples will be stored according to the applicable storage criteria from the time of collection until the time of analysis by the laboratory. Field Sampling personnel will keep samples cold by placing ice in the coolers in which samples will be stored until delivery to the analytical laboratory personnel. After receipt of the samples, it is the laboratory's responsibility to store the applicable samples according to the applicable preservation conditions until preparation and analysis has been initiated.

Samples have a finite holding time (the time between sample collection, sample digestion, and sample analysis) to limit the potential for degradation of the analytes. The holding times for required analyses are measured from the verified time of sample collection. When possible, samples will be shipped by overnight carrier or delivered by same-day courier to minimize the time between collection and laboratory receipt.

8.2 Decontamination

Tools and equipment decontamination procedures are implemented to prevent cross-contamination of samples and to control potential inadvertent transport of hazardous constituents. Disposable sampling equipment will be utilized to the extent possible in an effort to limit the potential for cross-contamination. The non-disposable equipment will be decontaminated using the procedures described in the TVA *Field Sampling Equipment Cleaning and Decontamination* TI (ENV-TI-05.80.05) and/or the investigation-specific SAP.

9.0 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

Field Sampling Personnel are responsible for the collection, description, documentation, labeling, packaging, storage, handling, and shipping of samples obtained in the field. These practices are necessary to ensure sample integrity from collection through laboratory analysis and data reporting. To demonstrate and document sample integrity aspects, information relative to the collected project samples will be described and thoroughly documented. Samples will be labeled, packaged, preserved, and shipped to the laboratories for analysis in appropriate sample containers, under the recommended temperature conditions with a COC Record documenting the time and day of sample collection.

Laboratory-supplied sample kits with custody seals, packing materials, sample containers and preservatives will be used for project samples during sample collection and transport to the TVA-contracted laboratories. The sample containers and preservation requirements for samples collected under each investigation will be presented in Attachments E through L to this JOF QAPP.

COC Records will be assigned standardized identification numbers and task codes describing the intended purpose of the sampling event. Attachment D provides specific requirements for sample nomenclature for the JOF EIP.

Samples will be assigned identifications using the sample nomenclature scheme identified in Attachment D of this document. As additional site sampling and monitoring plans are developed, nomenclature will be developed in accordance with the sample locations and naming codes (when necessary) will be generated.

9.1 Sample Documentation

Field activity evidentiary files will be maintained by the Investigation personnel and will include information that defines the Project in its entirety, including but not limited to, the information below.

- Field logbooks.
- Field data sheets.
- Raw data.
- QC information.
- COC Records.
- Airbills (when used) for sample shipments.
- Photographs.

Field documentation procedures are described in the *Field Record Keeping* TI (ENV-TI-05.80.03) and in the investigation-specific SAPs.

9.1.1 Chain-of-Custody Record

A primary consideration for environmental data is the ability to demonstrate that samples have been obtained from specific locations and have reached the laboratory without alteration. Evidence of collection, shipment, laboratory receipt, and laboratory custody while samples are in the laboratory's possession will be documented by maintaining a COC that records each sample and the individuals responsible for sample collection, shipment, and receipt at the project laboratory. Samples that are collected will be accompanied by a COC Record. An example COC Record is included in Attachment C. The following information will be recorded on the COC Record:

- Project name and number.
- Name of sampler.
- Sample identifier/name, location, date and time collected, and sample type.
- Analyses requested.
- Special instructions and/or sample hazards, if applicable.
- Signature of sampler in the designated blocks, including date, time, and company.
- Sample condition (including temperature) upon receipt as reported by the analytical laboratory.
- Signature of the laboratory receipt personnel in the designated blocks, including date, time, and company affiliation.

Original COC Records are transferred to the analytical laboratories such that sample custody is maintained through analysis and reporting. Copies of COC Records are maintained on site by the Field Team Leaders. Duplicates of COC Records are retained by the TVA Technical Lead and .pdf versions of COC Records are maintained by the Data Management Team as part of the Project File.

COC Records will reference defined MAGs to communicate sample analysis requirements to the analytical laboratories. MAGs identify the required analytical methods, parameter lists, and reporting units to ensure consistent reporting of data among multiple laboratories. In addition, MAGs enable automated data completeness evaluation and data verification upon receipt of electronic data. An overview of the data management process is provided in Section 15.0.

For samples collected for chemical, optical, or radiological analyses, field COCs are provided to the Data Manager by the Field Sampling Personnel performing the sample collection. EQuIS field sample EDDs are subsequently created to facilitate completeness review upon laboratory submittal of the associated analytical data.

9.1.2 Sample Custody in the Field

The purpose of sample custody procedures is to document the history of samples (and sample extracts or digestates) from the time of sample collection through shipment and sample receipt, analysis, and disposal. A sample is considered to be in one's custody if one of the following conditions applies:

- The sample is in an individual's actual possession.
- The sample is in view after being in an individual's physical possession.
- It was in the physical possession of an investigator and then they secured it to prevent tampering; and/or
- It is placed in a designated secure area.

Each individual field sampler is responsible for the care and custody of the samples he/she collects until the samples are properly transferred to temporary storage or are shipped to the laboratory. The following COC procedures will be followed for samples submitted to the laboratory for analyses:

- Each individual field sampler is responsible for the care and custody of samples he/she collects until the samples are properly transferred (relinquished on the COC by Field Sampling Personnel) to another person ("acceptor" of the samples) or are shipped to the laboratory.
- A COC Record will be completed at the time of sample collection by the Field Sampling Personnel for each batch of samples submitted to the laboratory in accordance with the *Sample Labeling and Custody* Technical Instruction (ENV-TI-05.80.02). Field sampling logs may be used in the place of formal COCs in the field.
- If multiple coolers are needed, one COC Record will accompany each cooler that contains the samples identified on the COC.
- Sample coolers will be packed and sealed with custody seals for transport from field and shipment to laboratory in accordance with the *Handling and Shipping of Samples* Technical Instruction (ENV-TI-05.80.06).
- Each time a sample batch is transferred (Field Sampling Personnel relinquish custody to the laboratory or other sampling team personnel), signatures of the individuals relinquishing and receiving the sample batch, as well as the date and time of transfer, will be documented on the COC or courier documentation form. Note that commercial courier custody is tracked by commercial courier records and not by COC.
- A copy of the carrier air bill will be retained as part of the permanent COC documentation record.
- The laboratory will record the condition of the sample containers, and cooler temperature upon receipt, and record this information on a combination of sample receipt documentation including a sample receipt confirmation checklist and the COC. Documentation of sample preservation checks (where applicable) will be recorded in the sample preparation documentation.

Changes or corrections to the information documented by the COC Record (including, but not limited to, field sample ID or requested analyses) must be changed by marking through the incorrect information with a single strike through line and, dating, and initialing the change in accordance with the *Field Record Keeping* Technical Instruction (ENV-TI-05.80.03). If the request for a change or correction comes from the Field Sampling Personnel after the COC Records have been relinquished to the laboratory, a copy of the COC Record will be revised, initialed, and forwarded to the laboratory, where the revised version will supersede the original COC Record. This record will be used to document sample custody transfer from the sampler to the laboratory and will become a permanent part of the Project File.

Sample coolers with appropriate custody seals will be shipped to the contract laboratory in a timely fashion to ensure proper thermal preservation and meet analytical method holding times.

9.2 Sample Packaging and Shipment

Samples will be packed and shipped to the laboratory in accordance with applicable U.S. Department of Transportation (US DOT) regulations, consulting corporate guidelines, and International Air Transport Association (IATA) standards (as detailed in the most current edition of *IATA Dangerous Goods Regulations* for hazardous materials shipments), as applicable.

Samples that are to be stored at a temperature < 6 degrees Celsius (°C) (not frozen) will be placed on wet ice within 15 minutes of sample collection and packaged with additional wet ice for shipment to the analytical laboratory. Samples requiring temperature preservation at < -10°C are packaged with dry ice for shipment to the analytical laboratory.

9.3 Sample Custody in the Laboratory

The following subsections describe the COC procedures associated with sample receipt, storage, tracking, and documentation by the laboratory.

9.3.1 Sample Receipt

A designated Laboratory Sample Custodian will be responsible for samples received at the laboratory. The Laboratory Sample Custodian will be familiar with custody requirements and the potential hazards associated with environmental samples. In addition to receiving samples, the Laboratory Sample Custodian will also be responsible for documenting sample receipt, maintaining samples at < 6 °C (or < -10 °C for frozen samples) during the sample log-in process, storage at < 6 °C (< -10 °C for frozen samples) before and after sample analysis, and the proper disposal of samples. Upon sample receipt, the Sample Custodian will:

- Inspect the sample containers for integrity and ensure that custody seals are intact on the shipping coolers. The temperature of the samples upon receipt and the presence of leaking or broken containers will be noted on the COC Record/sample receipt forms.
- Sign (with date and time of receipt) the COC/sample analysis request forms, thereby assuming custody of the samples and assign the laboratory sample identification numbers.
- Compare the information of the COC Record/sample receipt with the sample labels to verify sample identity. Any inconsistencies will be resolved through the Laboratory Coordinator before sample analysis proceeds.
- Store samples in accordance with Section 9.3.2.

The QA Oversight Manager and Laboratory Coordinator must be notified immediately via e-mail or documented telephone call when samples are received broken or improperly preserved. Samples received in a condition that may potentially impact results will be placed on hold pending direction from the QA Oversight Manager or Laboratory Coordinator. In the event that aqueous samples for metals analyses are received at pH > 2, acid preservative will be added in the originally received sample bottleware by the laboratory and the pH of the samples will be allowed to equilibrate in the originally received bottleware for a minimum of 24 hours prior to digestion. Sample preservation and equilibration will be fully documented via laboratory logbooks.

9.3.2 Sample Storage

Analytical samples will be stored in a locked facility and maintained within the appropriate temperature range as specified in US EPA SW-846 Chapter 3, or Table II of 40 CFR 136.3 sample storage requirements. The temperature will be monitored and recorded daily by laboratory personnel.

Required sample storage conditions are presented in Attachments E through L of this JOF QAPP.

9.3.3 Sample Tracking

Each sample will receive a unique laboratory sample identification number at the laboratory when the sample is logged into the laboratory information management system (LIMS).

Sample preparation/digestion records will be generated to fully document sample handling prior to analysis. Laboratory data will be entered on the sample digestion form and permanently recorded in a laboratory logbook.

The laboratory will maintain a sample tracking system that documents the following:

- Organization/individual who performed sample analyses.
- Date of sample receipt, extraction or digestion, and analysis.
- Names of Analysts.
- Sample preparation procedures.
- Analytical methods used to analyze the samples.
- Calibration and maintenance of instruments.
- Deviations from established analytical procedures, if applicable.
- QC procedures used to ensure that analyses were in control during data generation (instrument calibration, precision checks, method standards, method blanks, *etc*.).
- Procedures used for the calculation of precision and accuracy for the reported data.
- Statement of quality of analytical results.

9.4 Sample Archive

Upon request, unused portions of samples may be requested by TVA from the laboratory for archival. Archived samples will be shipped under COC and relinquished to the TVA Technical

Lead or designee. The sample archive will be equipped to properly maintain thermal preservation of the samples and will be locked or in an access controlled locations such that sample custody is maintained.

Unused portions of samples collected in association with the JOF EIP may be returned to TVA for archive or disposal or may be disposed of by the contract laboratories. Archived samples will be cataloged and stored in an organized manner. In the event that project objectives are not met for a sample, any remaining portion with preparation/analytical holding time remaining may be retrieved and submitted to a TVA contracted laboratory for additional analysis.

10.0 ANALYTICAL METHODS REQUIREMENTS

Analytical methods cited in this JOF QAPP reference US EPA's *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846); US EPA Clean Water Act Test Methods; and *Standard Methods for the Examination of Water and Wastewater*. These and potentially other methods, constituents, and reporting limits for samples collected under this EI are presented in Attachments E through L of this JOF QAPP. Analytical methods will be selected based on the ability to detect constituents of concern at reporting limits sufficient to meet project requirements and quality objectives for precision, accuracy, and sensitivity.

10.1 Field Analysis

Field analyses will be conducted in accordance with the associated field sampling TIs and/or published field method as applicable. The results from field analysis are reviewed and stored electronically.

Detailed descriptions of field monitoring activities, the field analytical equipment, and the sampling equipment utilized to perform the field activities are provided in the investigation - specific SAPs and/or in the associated TVA TIs.

10.2 Laboratory Analysis

To support the objectives of the JOF EIP, the collected samples will be tested for the methods, constituents, and reporting limits presented in Attachments E through L of this JOF QAPP. Individual sample reporting limits may vary from the laboratory's routinely reported limits; this variance may be a result of dilution requirements, sample weight or volume used to perform the analysis, dry-weight adjustment for solid samples, the presence of analytical background contaminants, or other sample-related or analysis-related conditions. Additional analytical needs may be identified based on future project needs, and as such, the JOF QAPP and SAPs will be modified to document the QC requirements associated with these additional analyses.

Dissolved metals analysis of aqueous samples shall be performed on field-filtered (0.45-μm filter) select water samples. Alternatively, dissolved metals analysis of aqueous samples may be performed on a sample that has been filtered in the laboratory. In the event that laboratory filtration is required, sample aliquots collected for dissolved metals analyses will be preserved after filtration and these preserved aqueous samples will be allowed to equilibrate a minimum of 24 hours between sample preservation and digestion.

For some investigations, a filtered and nonfiltered sample aliquot may be submitted for all requested analytical parameters. In the event that the filtered and nonfiltered aliquots are not assigned distinct sample identifications (IDs), each parameter will be identified as either "total" (*i.e.*, nonfiltered) or "dissolved" (*i.e.*, filtered) in the project database.

The reporting limits indicated in Attachments E through L of this JOF QAPP shall represent the maximum reporting limits (not adjusted for sample weight/volume, dilution factors, and percent moisture for non-aqueous samples).

All analytical methods performed by the TVA-contracted laboratory must have valid method detection limit (MDL) studies and MDL verifications by matrix type, by preparation method, and by analytical method. MDL studies must include all preparatory and analytical processes used for the preparation and analysis of investigative samples. Formal MDL evaluations must be performed at the frequency dictated by the current US EPA-promulgated procedures or the current The NELAC Institute (TNI) laboratory accreditation standard or the frequency dictated below, whichever is more frequent. TVA's contracted laboratories will conduct MDL studies in accordance with the current TNI laboratory accreditation standard as described below.

The initial MDL study will include a minimum of seven spiked replicates prepared and analyzed in a minimum of three separate batches, spaced over the course of three separate calendar days. If an MDL is to be determined over more than one instrument, each instrument must have at least two analyses on two different calendar days. For an analyte to be considered detected during an MDL study it must meet the analytical method's qualitative identification criteria without any manual searching routines. Only analyses associated with acceptable initial calibration, continuing calibration, and batch QC can be used. The MDL based on spiked replicates will be calculated as follows:

$$MDL_s = t_{(n-1, 1-\alpha = 0.99)} S$$

Where: MDL_s = MDL based on analysis of replicate spikes,
t = Students 99th percentile single-tailed t-value and
S = the sample standard deviation of the replicate analyses.

If the calculated MDL_s for any analyte is less than 10% the concentration of the spiked concentration, repeat the study for that analyte at a lower spike concentration. If the calculated MDL_s is higher than the spiked concentration, the study must be repeated at a higher spike concentration from the original study.

In addition to the spiked samples, an MDL will be determined using method blank results (MDL_b). The initial MDL_b determined using the method blanks will be a minimum of seven method blanks prepared and analyzed in at least three separate batches, spaced over the course of three separate calendar days. If an MDL_b is to be determined over more than one instrument, each instrument must have at least two analyses on two different calendar days. For an analyte to be considered detected during an MDL study it must meet the analytical method qualitative identification criteria without any manual searching routines. Only analyses associated with acceptable initial calibration, continuing calibration, and batch QC can be used.

If the analytical system for which the MDL_b is being determined gives numeric results for every analysis, the MDL_b will be calculated as follows:

$$MDL_b = \overline{X} + t_{(n-1,1-\alpha=0.99)}S$$

Where: $\overline{X}$ = the mean of the method blank results,
t = Students 99th percentile single-tailed t-value and
S = the sample standard deviation of the replicate analyses.

If the analytical system for which the MDL_b is being determined gives censored results or otherwise gives numeric results for some, but not all method blanks:

- If fewer than 101 numeric method blank results are available, set the MDL_b to the highest method blank result.

- If more than 100 numeric method blank results are available, set the MDL_b to the level that is no less than the 99th percentile of the method blank results.

MDL_s and MDL_b must be compared and the higher value utilized for MDL reporting.

The MDL is to be verified annually through the quarterly analysis of standards spiked at the same concentration used to determine MDL_s. For verification analyses for a pooled MDL for more than one instrument, each instrument must have at least two analyses, prepared in different batches and analyzed on separate days. MDL verification analyses must meet the analytical method qualitative identification criteria, again without any manual searching routines. Only analyses associated with acceptable initial calibration, continuing calibration, and batch QC can be used.

On an annual basis, the MDL calculation is to be repeated using the results from the quarterly spiked samples and method blanks. The resulting MDL is to be compared to the initially derived MDL. If the repeated MDL is within a factor of 0.5 to 2.0 of the existing MDL, and fewer than 3% of the method blank results have numerical results above the existing MDL, then the initially derived MDL may be left unchanged. Otherwise, adjust the MDL to the new repeated MDL.

To add a new instrument, the new instrument must have at least two spike analyses and at least two method blanks. The new spike results would be combined with the existing results and a new MDL_s would be calculated. If the new MDL_s is within a factor of 0.5 to 2.0 of the existing MDL, then the initially derived MDL_s may be left unchanged. If all method blank analyses are below the existing MDL and the MDL_s meets the criteria described above, the MDL may be left unchanged. Otherwise, adjust the MDL to the new MDL. Once 6-months of blank data have been generated on a new instrument, MDLs will be evaluated to assess the need for adjustment.

The laboratory will perform a percent moisture analysis on solid samples where possible. Chemical analysis results for solid samples will be reported on a dry-weight basis unless specifically requested otherwise. Radiological activities and physical/optical analysis results will not be corrected for sample moisture. The reporting basis (wet-weight, dry-weight, *etc*.) will be maintained as an attribute of the result in the database.

11.0 QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

This section describes the data objectives and associated data quality indicators used for the project. QA procedures are designed to ensure high quality for all environmental data associated with this project.

The subsections below are intended to provide an introduction to site-wide QA objectives and protocols and set forth minimum requirements for the JOF EIP. Specific quantitative QA objectives for each investigation are presented in Attachments E through L of this JOF QAPP.

11.1 General

There are four levels of data quality that have been developed for this project. The data quality levels defined below provide general indications of measurement defensibility. The data quality level of a particular measurement is used to determine whether that measurement is sufficient to meet the investigation-specific DQOs.

Field Screening – This level is characterized by the use of portable analytical instruments (such as temperature probe) which can provide real-time data to assist in the optimization of sampling locations and health and safety support. Data can be generated regarding the presence or absence of certain contaminants at sampling locations.

Field Analyses – This level is characterized by the use of portable analytical instruments, which can be used on site (such as Hydrolab® instrument) or in a mobile laboratory stationed near a site. Depending on the types of contaminants, sample matrix, and personnel skills, qualitative and quantitative data can be obtained.

Screening Data with Definitive Confirmation – These data are generated by rapid, less precise methods of analysis with less rigorous sample preparation. Sample preparation steps may be restricted to simple procedures such as dilution with a solvent, instead of elaborate extraction/digestion and cleanup. Screening data provides analyte identification and quantitation, although the quantitation may be relatively imprecise. At least 10% of the screening data will be confirmed using appropriate analytical methods and QA/QC procedures and criteria associated with definitive data. Screening data without associated confirmation data is not considered to be data of known quality.

Definitive Data – These data are generated using rigorous analytical methods, such as approved US EPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. These methods produce tangible raw data (such as chromatograms, spectra, or digital values) in the form of paper printouts or computer-generated electronic files. Data may be generated by an on-site or off-site laboratory, as long as the QA/QC requirements are satisfied. To be definitive, either the analytical or total measurement error must be determined.

Field Screening data will be obtained with portable instruments, such as conductivity meters, temperature probes, and may be used for health and safety and field operational monitoring. In addition, these instruments and field test kits may be used to produce Field Analysis data to determine where to collect a sample to assess impacts and identify which samples are to be designated for laboratory confirmation analyses.

Field pH measurements for aqueous samples will be performed in accordance with TVA TI *Field Measurement Using a Multi-Parameter Sonde* (ENV-TI-05.80.46), U.S. EPA SW-846 Method 9040C, and the associated investigation-specific SAP. Field pH meters used for collecting aqueous sample data will also meet the calibration requirements of these procedures including calibration adjustment to account for buffer temperature during calibration. Field-collected pH measurements for aqueous samples will be considered field analysis data and are appropriate for quantitative use. Field pH measurements for soil samples will be conducted using pH kits or equivalent with confirmation samples submitted to the fixed-base analytical laboratory for definitive analysis.

Attainment of qualitative data indicators is assessed by monitoring QA measures, such as precision, accuracy, representativeness, comparability, and completeness, as discussed in Section 19.0. Specific qualitative criteria for the chemical analyses to be performed in association with the JOF EIP are presented in Attachments E through L of this JOF QAPP. The objectives associated with accuracy and precision of laboratory results are assessed through an evaluation of the results of QC samples. The accuracy of field measurements will be assessed by calibration, as described in the associated field TIs.

11.2 Field and Laboratory Quality Control Samples

The quality of data collected in the field will be controlled, monitored, and verified by maintaining site logs, by documenting field activities, and by collecting and analyzing of QC samples concurrently with investigative samples. Field and laboratory QC samples will be used to assess accuracy and precision for chemical analyses to gauge both field and laboratory activities. Further discussion and equations for determining precision and accuracy may be found in Section 19.0 of the JOF QAPP. In addition, specific requirements for comparability, completeness, and representativeness of field and laboratory QC samples may be found in Section 19.0 of the JOF QAPP. QC samples will be used to assess laboratory performance and gauge the likelihood of cross-contamination associated with both field and laboratory activities.

The subsections below apply to chemical analyses performed on aqueous, solid, and biological samples associated with the JOF EIP.

QC samples will be collected and analyzed in conjunction with samples designated for laboratory analysis. The QC checks that may be instituted by field and laboratory personnel may include, but not be limited to, the following:

- Equipment Rinsate Blanks.
- Field Blanks
- Filter Blank Samples
- Field Duplicate Samples.
- MS/MSD Samples.
- Laboratory Method Blanks.

- LCSs/Laboratory Control Sample Duplicates (LCSDs).
- Laboratory Duplicate Samples.

These types of QC samples are discussed in the following subsections. Field QC samples will be submitted to the laboratory using the same information as the associated investigative samples.

Field QC samples will be collected at the frequency specified on Table 11-1. Laboratory QC samples will be analyzed at the frequency specified in the associated laboratory SOPs and referenced analytical methods. The analysis frequencies specified below are considered the minimum required frequencies; investigation-specific Work Plans and/or SAPs and/or TIs may require more frequent collection of field QC samples.

Table 11-1. Field Quality Control Sample Minimum Frequency

Field QC Sample	Aqueous Sampling Frequency	Solids Sampling Frequency	Biological Sampling Frequency
Equipment Rinsate Blank	1 per sampling event	1 per 20 field samples	Prior to use for decontaminated equipment
Field Blank	1 per day of sampling activity per sampling team	N/A	N/A
Filter Blank	1 per sampling event when dissolved parameters are collected for analysis and 1 per lot of filters used	N/A	N/A
Field Duplicate[a]	1 per 20 field samples; minimum of 1 per sampling event	1 per 20 field samples; minimum of 1 per sampling event	1 per 20 field sample aliquots or 1 per species (when possible)
MS/MSD or Laboratory Duplicate[b]	1 per 20 field samples; minimum of 1 per sampling event	1 per 20 field samples; minimum of 1 per sampling event	1 per 20 field sample aliquots or 1 per species[d] (when possible)

N/A Not Applicable
[a] True field duplicate samples are not feasible for whole ash/sediment cores (depending on volume recovered), or biological specimens; consequently, co-located samples will be collected when possible.
[b] Laboratory duplicate analyses will be performed in lieu of MS/MSD for parameters not amenable to spiking (*e.g.*, pH, total dissolved solids [TDS]).
[c] Filter lot check is to be performed one per lot of filters used and scheduled in a manner to allow for laboratory to report data prior to investigative sample collection.
[d] Sufficient biological sample mass is not always available to perform an MS/MSD pair; when sufficient mass does not exist, the laboratory will perform LCS/LCSD.

11.2.1 Equipment Rinsate Blanks

Collection and analysis of equipment rinsate blanks are performed to assess the efficiency of field equipment decontamination procedures in preventing cross-contamination between samples. Laboratory-supplied analyte-free reagent water will be poured into/through/over clean (decontaminated) sampling equipment used in the collection of investigative samples and subsequently collected into prepared sample bottles. For biological specimens, equipment rinsate blanks will be used to monitor decontamination of holding tanks, processing equipment or similar laboratory equipment; equipment blanks associated with biological specimens will be collected prior to specimen introduction. For Vibecore® sampling and other sediment/soil core sampling, analyte-free reagent water will be poured through Lexan® tubing. The rinsate blank will be analyzed for the same parameters as the investigative samples.

11.2.2 Field Blanks

Field blanks are used to assess the potential for cross-contamination of aqueous samples during the sampling process due to ambient conditions and to validate the cleanliness of sample containers. The collection of field blanks is recommended if known or suspected sources of contamination are located within close proximity to the sampling activities. Field blank samples will be generated using laboratory-supplied deionized water.

11.2.3 Filter Blank Samples

Filter blanks are samples of laboratory-supplied deionized water passed through in-line filters used in the collection of dissolved metals (and other analytes requested on a filtered basis).

11.2.4 Field Duplicate Samples

Field duplicate samples are used to check for sampling and analytical error, reproducibility, and homogeneity. For soil or sediment samples, the duplicate will be obtained by collecting a sample from an area adjacent to the routine sample (that is, co-located sample), or by collecting a separate aliquot of homogenized soil or sediment from within the same core, whichever is more appropriate for the type of sample/sampling technique (surface or subsurface sediment sample). For biological specimens, the duplicate will be obtained by collecting additional specimen(s) from a particular area. Duplicates will be analyzed for the same parameters as the associated investigative samples.

11.2.5 Matrix Spike/Matrix Spike Duplicate

MS/MSD samples are investigative samples to which known amounts of compounds are added in the laboratory before extraction/digestion and analysis. The recoveries for spiked analytes can be used to assess how well the method used for analysis recovers target analytes in the site-specific sample matrix, a measure of accuracy. Additionally, the relative percent difference (RPD) between the results of the MS and MSD provide a measure of precision. In the event that sufficient sample volume to perform MS/MSD analyses is not provided, the laboratory may substitute LCS/LCSD analyses (see Section 11.2.7).

For parameters that are not amenable to spiking (*e.g.*, pH, total dissolved solids [TDS]), a laboratory duplicate (see Section 11.2.8) will be used to demonstrate matrix-specific precision.

11.2.6 Laboratory Method Blanks

Method blanks consist of analyte-free materials (such as reagent water) and reagents (such as sodium sulfate) that are prepared in the same manner as the associated samples (digested, extracted, *etc*.) and that are analyzed and reported in the same manner as the associated investigative samples. Laboratory method blanks will be performed as indicated in the analytical method and in the associated laboratory SOPs.

11.2.7 Laboratory Control Samples/Laboratory Control Sample Duplicates

An LCS is a sample of laboratory certified material that is fortified (spiked) with the analytes of interest or a certified reference material that is prepared and analyzed in the same manner as investigative samples. The LCS must be from a source that is different from the source of the initial calibration standards (that is, second-source). LCS data are used to monitor analytical accuracy and laboratory performance. LCSs are prepared and analyzed with each preparation batch of 20 (or less) field samples. In the event that insufficient sample volume to perform MS/MSD analyses (Section 11.2.5) is received, an LCSD will be prepared to assess laboratory precision. LCS will be performed at a minimum frequency of 1 per batch of 20 (or fewer) field samples or as required by the referenced analytical method and as specified in the associated laboratory SOPs.

11.2.8 Laboratory Duplicate Samples

A duplicate sample is obtained by splitting a field sample into two separate aliquots and performing separate preparation and analysis on the respective aliquots. The analysis of laboratory duplicate samples monitors precision; however, precision may be affected by sample homogeneity, particularly in the case of solid samples. Laboratory duplicates will be analyzed and reported with every batch of 20 (or fewer) field samples. MSDs (see Section 11.2.5) may be substituted for laboratory duplicates for inorganic analyses. The laboratory will utilize a project sample for the laboratory duplicate in every batch that includes project samples.

12.0 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

12.1 Field Equipment

Equipment failure will be minimized by routinely inspecting field equipment to ensure that it is operational and by performing preventive maintenance procedures. Field sampling equipment will be inspected prior to sample collection activities by the Field Sampling Personnel and necessary repairs will be made prior to use of the sampling equipment. Routine preventive maintenance procedures, at a minimum, will include removal of foreign debris from exposed surfaces of the sampling equipment, storage of equipment in a cool dry place protected from the elements, inspections of the equipment each day prior to use, and verification of instrument calibrations as described in Section 13.0.

Field equipment, instruments, tools, gauges, and other items requiring preventive maintenance will be obtained from a contracted equipment supplier. All equipment will be serviced in accordance with the manufacturer's specified recommendations or written procedure based on the manufacturer's instructions or recommendations. Maintenance will be performed in accordance with the schedule specified by the manufacturer to minimize the downtime of the measurement system. Maintenance work will be performed by qualified personnel.

Field equipment will be maintained in good working order to minimize downtime while fieldwork is in progress. Field equipment will be maintained under service contract for rapid instrument repair or provision of backup instruments in the case of instrument failure.

Non-routine maintenance procedures require field equipment be inspected prior to initiation of fieldwork to determine whether or not the equipment is operational. If not operational, the equipment will be serviced or replaced by a contracted equipment provider. Batteries will be fully charged or new, as applicable.

The ability to collect valid samples requires that field equipment be appropriately cleaned and maintained. The elements of an effective maintenance program are identified below.

- Pre-cleaned or certified-clean equipment.
- Spare parts or service contract for equipment repair or replacement.
- Contingency plan.
- Maintenance and repair of non-dedicated equipment.

12.2 Supplies and Consumables

Field supplies and consumable items (including, but not limited to, pre-cleaned containers, preserved containers, tubing, and filters) will be inspected upon receipt. Certificates of cleanliness for consumables provided by the laboratory will be retained on file at the laboratory. Chemical preservatives provided in pre-preserved containers will be certified by the laboratory prior to use. Certificates of cleanliness for supplies and lot numbers of supplies obtained by the Field Sampling Personnel will be retained by Investigation personnel as part of the project records. All supplies and consumable materials will be certified clean to levels sufficient to meet data objectives for the associated investigation.

12.3 Laboratory Equipment

The ability to generate valid analytical data requires that analytical instrumentation be properly maintained. The laboratory will be responsible for appropriate maintenance for major instruments. The elements of an effective maintenance program are identified below and discussed in the following subsection:

- Instrument maintenance logbooks.
- Instrument maintenance and repair.
- Available spare parts.
- Contingency plans.

Periodic preventive maintenance is required for sensitive equipment. Instrument manuals will be kept on file for reference when equipment needs repair. The troubleshooting sections of factory manuals may be used to assist personnel in performing maintenance tasks.

Major instruments in the laboratory are covered by annual service contracts with manufacturers or other qualified personnel (internal or external). Under these agreements, regular preventive maintenance visits are made by trained service personnel. Maintenance is documented and maintained in permanent records by the individual responsible for each instrument.

The calibration and maintenance sections of the laboratories' SOPs will establish the schedule for servicing critical items to minimize the downtime of the measurement system. The laboratory will adhere to the maintenance schedule and will promptly arrange any necessary service. Qualified personnel will perform the required service.

12.3.1 Instrument Maintenance Logbooks

In the laboratory, each analytical instrument will be assigned an instrument logbook. Maintenance activities will be recorded in the instrument logbook and the information entered will include:

- Date of service.
- Person performing the service.
- Type of service performed and reason for service.
- Replacement parts installed (if applicable).
- Miscellaneous information.

If service is performed by the manufacturer or its representative, a copy of the service record will be inserted into the page immediately following the logbook page where the above-cited information has been entered.

12.3.2 Instrument Calibration and Maintenance

An overview of the routine calibration procedures used for analytical instrumentation is presented in Section 13.0. Preventive maintenance and calibration by manufacturer service representatives will be provided on a routine basis.

In addition to maintenance by manufacturer service representatives, procedures for routine maintenance in accordance with manufacturer specifications for each analytical instrument will be followed by the laboratory. These procedures will include maintaining inventories of spare parts used routinely (such as spare torches for inductively coupled plasma/mass spectrometry [ICP/MS] instruments). Instrument operators have the responsibility to ensure that an acceptable inventory of spare parts is maintained.

Instrument calibration and maintenance procedures will be conducted in accordance with the laboratory's QA Program and the specific calibrations sections of the laboratory's analytical SOPs.

13.0 INSTRUMENT CALIBRATION AND FREQUENCY

This section provides the requirements for calibration of measuring and test equipment/instruments used in field sampling and laboratory analysis. The calibration procedures stipulated in the JOF QAPP are designed to ensure that field equipment and instrumentation are calibrated to operate within manufacturer specifications and that the required traceability, sensitivity, and precision of the equipment/instruments are maintained. Measurements that affect the quality of an item or activity will be taken only with instruments, tools, gauges, or other measuring devices that are accurate, controlled, calibrated, adjusted, and maintained at predetermined intervals to ensure the specified level of precision and accuracy.

In general, instrument calibration will be conducted in accordance with manufacturer's recommendations, method requirements, and field TIs or laboratory SOPs.

13.1 Field Equipment Calibration and Procedures

Field instruments that may be used include, but are not limited to, the following:

- Multi-parameter Sonde Water Quality Meter.
- Oxidation Reduction Potential Meter.
- Dissolved Oxygen Meter.
- Water Flow Meter.
- Depth-to-Water Level Meter.
- Turbidimeter.

All field analytical equipment used to conduct monitoring will be calibrated/standardized daily prior to use. The calibration/standardization procedures for field instrumentation are described in the calibration section of the applicable field TIs. The calibration/standardization acceptance criteria for field instruments are provided in the applicable TVA TIs.

Personnel performing instrument calibrations/standardizations shall be trained in its proper operation and calibration. Records of instrument calibration/standardization will be maintained by the Field Team Leader and will be subject to audit by the Field Oversight Coordinator or designee. The Field Team Leader will maintain copies of the instrument manuals on site.

The calibration records will include documentation of the following information:

- Instrument name and identification number.
- Name of person performing the calibration.
- Date of calibration.
- Calibration points.
- Results of the calibration.
- Manufacturer lot number of the calibration standards.
- Expiration dates for the calibration standards, when applicable.

Field equipment will be properly inspected, charged, and in good working condition prior to the beginning of each working day. Prior to the start of each working day, the Field Team Leader will inspect equipment to ensure its proper working condition. If equipment is not in the proper working condition, the Field Team Leader must repair or replace the equipment prior to the start of field activities. Field equipment and instruments will be properly protected against inclement weather conditions during the field work. At the end of each working day, field equipment and instruments will be properly decontaminated, taken out of the field, and appropriately placed for overnight storage and/or charging.

Field-collected pH measurements for aqueous samples will be considered field analysis data and are appropriate for quantitative use. Field-collected pH measurements for solid samples will be considered field screening data. Field pH measurements for aqueous samples will be conducted using calibrated instrumentation sufficient to meet the requirements of SW-846 Method 9040C. In addition to the TVA and method requirements, post-calibration checks will be performed on pH 4.0 and pH 10.0 buffer solutions. All post-calibration checks (pH 4.0, 7.0, and 10.0) will be subject to an acceptance criterion of ±0.05 pH units. Aqueous sample pH measurements will not be conducted until the pH meter is calibrated within these acceptance criteria. Field pH measurements for solid samples will be conducted using pH test kits or equivalent; samples will be subsequently submitted to a fixed-base laboratory for definitive pH analysis.

Dissolved oxygen meter calibration will be conducted using a single-point water-saturated air method in accordance with the instrument manufacturer's recommendations.

Calibration checks may suggest the need for maintenance or calibration by the manufacturer. Field instruments that do not meet the calibration requirements will be taken out-of-service until acceptable performance can be verified. Maintenance will be performed when the instrument will not adequately calibrate. Maintenance of field equipment will be noted in an instrument logbook or field notebook.

Field equipment calibration is addressed in greater detail in the TIs associated with each field investigation or monitoring activity.

13.2 Laboratory Equipment Calibration

Instruments and equipment used in the laboratory will be controlled by a formal calibration program as described in the laboratory's Quality Assurance Manual. The program will verify that the equipment has the proper calibration range, accuracy, and precision to generate data comparable with specific requirements. Calibration will be performed by laboratory personnel experienced in the referenced methods for the analysis of project samples for the constituents of concern.

Instrument calibration procedures and corrective actions are described in the calibration section of the associated laboratory SOP. At a minimum, laboratory instrument calibration will be performed in accordance with the associated technical and quality control requirements specified in the method applicable to the associated SAPs.

The laboratory will provide all data and information to demonstrate that the analytical system was properly calibrated at the time of analysis, including: calibration method, required frequency, source of standards, response factors, linear range, check standards, and applicable control limits, as part of the data deliverables.

Before any instrument is used as a measuring device, the instrument's response to reference materials must be determined. The manner in which various instruments are calibrated is dependent on the particular type of instrument and its intended use. Preparation of reference materials used for calibration will be documented in a laboratory notebook.

The two types of laboratory instrument calibration are initial calibration and continuing calibration verification. Initial calibration procedures establish the calibration range of the instrument. Typically, multiple analyte concentrations are used to establish the calibration range and calibration data. The laboratory evaluates the resulting calibration data as detailed in the calibration section of the associated SOP.

Continuing calibration verification usually measures the instrument's response to fewer calibration standards and requires instrument response to fall within certain limits of the initial measured instrument response. Continuing calibration verification may be used within an analytical sequence to verify stable calibration throughout the sequence and/or to demonstrate that instrument response did not drift during a period of non-use of the instrument.

The QA measures in the calibration section of the associated laboratory SOP will be used for calibration, calibration verification, and subsequent sample analyses. In addition, the following procedures will be used for the calibration of balances and thermometers.

Laboratory balances will be calibrated and serviced annually by a certified contractor. Balances will undergo a calibration check prior to use each day using multiple S-Class or equivalent class weights that bracket the usage range. A record of calibrations and daily checks will be documented.

Oven and refrigerator thermometers will be calibrated annually against a National Institute of Standards and Technology- (NIST-) certified thermometer in the range of interest. Annual calibrations will be documented. Daily oven and refrigerator readings will be recorded. Thermometers must be tagged with any applicable correction factors.

Records will be maintained as evidence of required calibration frequencies, and equipment will be marked suitably to indicate calibration status. If marking on the equipment is not possible, records traceable to the equipment will be readily available for reference.

14.0 DATA ACQUISITION REQUIREMENTS FOR NON-DIRECT MEASUREMENTS

Historical and legacy data will be gathered and evaluated for acceptability prior to use in the JOF EIP and inclusion in the EAR. Historical and legacy data may be procured from several sources, including TVA and TDEC records or TVA-led investigations performed outside the scope of the JOF EIP. Historical and legacy chemical data of known quality/defensibility may be used quantitatively as supplemental information to design specific investigation or for human health and ecological risk assessments. Chemical data are considered of known quality/defensibility if sample collection information and data deliverables are available to substantiate the reported analytical results. Historical and legacy data of unknown quality may be used for qualitative purposes.

Historical and legacy geotechnical data of known quality/defensibility may be used quantitatively as supplemental information to planned investigations under the JOF EIP. The quality/defensibility of geotechnical data will be determined by qualified personnel (*i.e.*, Professional Engineer or Professional Geologist) depending on the type of data requiring evaluation. Generally, these data will be compared against changes in site conditions, changes in the state of practice (*e.g.,* revisions/updates to standard methods), and changes in governing standards (*e.g.*, technical standards or professional guidelines) since the data were generated and also will be compared to more recently collected data for consistency of results.

Historical and legacy data will be transmitted in its original format whenever possible. In addition, raw data and other supporting documentation is acquired and may be validated if appropriate or feasible.

Historical and legacy data that are determined to be intended for quantitative use will be subjected to a formal critical review process. Historical data will minimally be subjected to a reasonability review to identify potentially suspect data, apparent anomalies, or data that are not representative of current site conditions. Additional evaluation and/or validation may be conducted following the reasonability review; the level of review and validation conducted will be dependent on the data type, availability of supporting documentation, and criticality of the dataset for completing project objectives. In the event that historical or legacy data cited in the JOF EIP cannot be substantiated, the data may not be suitable to support certain aspects of the investigation, and new data may be collected to supplement the historical/legacy data.

TVA, QA oversight, and investigation subject-matter experts will cooperatively develop formal criteria for evaluating historical data sets for potential quantitative use in the EAR.

15.0 DATA MANAGEMENT

A comprehensive Data Management Plan will be developed for all data generated and used under the TVA Multi-Site Order. Consolidated management of data related to the Order will ensure that environmental data associated with the EIs are appropriately maintained and accessible to data end users. The Data Management Plan will provide a basis for supporting a full technical data management business cycle from pre-planning of sampling events to reporting and analysis with a particular emphasis on ensuring completeness, data usability, and most importantly defensibility of the data.

Historical data and data generated from EI collection events at each facility addressed in the Order will be consolidated in the single EQuIS database. The EQuIS database will implement QA procedures at each step in the data transfer process to ensure that a complete, correct data set is maintained. A detailed description of the various elements of the data management program is presented in the Data Management Plan. In addition, the Data Management Plan describes sample planning and tracking process and details the flow of field and laboratory data into the project database. Finally, the Data Management Plan describes the process by which errors in data already reported in the project database are rectified and how those changes are managed and documented.

16.0 ASSESSMENTS AND RESPONSE ACTIONS

The primary goal of the JOF QAPP is to ensure that project data objectives are met and that defensible, high-quality, analytical data are generated for use decision-making processes. The JOF QAPP includes systems and performance audits to ensure that established QA procedures are properly implemented.

The JOF QAPP will be distributed to each consultant and contractor responsible for the collection, generation, and interpretation of field and analytical data. The QA Oversight Manager or designee will be responsible for ensuring that necessary revisions are made so that the JOF QAPP is up-to-date with actual practices and will ensure that revisions and updates are provided to everyone on the distribution list. The document control format used in the JOF

QAPP will identify the JOF QAPP revision number and revision date. A revision history that identifies each revision and a summary of the revision will be maintained.

16.1 Field Activities

Field QA will include (but not be limited to) the following:

- Instrument calibration.
- Documentation of sample collection and field conditions.
- Adherence to COC procedures.
- Adherence to the JOF QAPP, the investigation-specific SAPs, and the associated field TIs.
- Collection of field QC samples.

The QA review for usability of objective field data will be performed at two levels. For the first level, data will be reviewed at the time of collection by following SAPs and TVA TIs. For the second level, after data reduction to table format or arrays, the data will be reviewed for inconsistent values.

Any inconsistencies identified during data review will be investigated by the Field Team Leader. When possible, the Field Team Leader will seek clarification from the Field Sampling Personnel responsible for collecting the data. Resolution of discrepancies will be documented using the corrective action process detailed in Section 16.4.

Field data will be reviewed for reasonableness and completeness. In addition, random checks of sampling and field conditions will be made to check recorded data at that time to confirm the recorded observations. Whenever possible, peer review will also be incorporated into the QA review process in order to maximize consistency among Field Sampling Personnel.

Any observed discrepancies between the COC Record and the samples received will be documented by the laboratory, and the TVA Technical Lead, Laboratory Coordinator, and the Field Team Leader will be contacted for resolution.

The field COC Record information will be initially keyed into and maintained in the laboratory's database. A copy of the laboratory's COC Record, referred to as sample receipt confirmation, will be sent to the QA Oversight Manager and Data Manager following sample login for verification of properly entered and COC Record requests and information such as sample identification numbers, analyses requested, and the quantity of samples. In case of discrepancies between the COC Record and the sample receipt confirmation, the appropriate revisions will be communicated to the laboratory for the appropriate COC Record corrections. Corrected information on the COC Record will be recorded into the project data management system.

16.2 Laboratory Analysis

Internal laboratory QA will consist of the following:

- Instrument performance checks.
- Instrument calibration and calibration verification.

- Retrieval of documentation pertaining to instrument standards, samples, and data.
- Adherence to the JOF QAPP and the associated laboratory SOPs.
- Documentation of sample preservation, transport, and analytical methodology.
- Adherence to the analytical methodology (at a minimum).
- Analysis of QC samples (discussed in Section 11.2).

The samples received by the laboratory will be handled in accordance with internal laboratory QC procedures. The laboratory's deliverables, on submission to Data Validators, will be verified and/or validated with guidance from the National Functional Guidelines. Data package completeness will be assessed and missing or incomplete information will be obtained from the laboratory. Any incorrect data will be corrected. Data usability will be evaluated and appropriate qualifiers will be added to the database. Any data deemed unreliable by data validation efforts due to imprecision, holding time exceedances, and failure of relevant QC measures will be qualified appropriate and/or not utilized for the project.

16.2.1 Data Reduction

Data reduction is performed by the individual Analysts and consists of calculating concentrations in samples from the raw data obtained from the measuring instruments. Data reduction complexity is dependent upon the specific method and the number of discrete operations (extractions/digestion, dilutions, and levels/concentrations) involved in obtaining a sample that can be measured.

For analytical methods, sample response will be applied to the average response factor or the regression line to obtain an initial raw result, which will then be factored into equations to obtain the estimate of the concentration in the original sample. Rounding will not be performed until after the final result has been obtained to minimize rounding errors; results will not normally be expressed in more than three significant figures.

Copies of raw data and calculations used to generate the final results will be retained on file to allow reconstruction of the data reduction process at a later date.

The laboratory data reduction process is described in detail in the associated laboratory SOPs.

16.2.2 Laboratory Data Review

System reviews are performed at all levels. The individual analyst continuously reviews the quality of data through calibration checks, QC sample results, and performance evaluation (PE) samples. These reviews will be performed prior to submission to the Laboratory Project Manager or designee.

Criteria for analytical data review/verification include checks for internal consistency, transmittal errors, laboratory protocol, and laboratory QC. QC sample results and information documented in field notes will be used to interpret and evaluate laboratory data. The Laboratory QA Officer will independently conduct a complete review of selected reports to confirm analytical results.

The laboratory will complete data verification procedures, including:

- Verifying analyses requested were analyses performed.
- Preliminary data proofing for inconsistencies; investigation and corrections, where possible.
- Reviewing laboratory data sheets for reporting/detection limits, holding times, surrogate recovery performance, and spike recovery performance.
- Double-checking computerized data entry, if applicable.

The Laboratory Project Manager or designee will review data for consistency and reasonableness with other generated data and determine whether project requirements have been satisfied. Selected hardcopy output of data will be reviewed to ensure that results have been interpreted correctly. Unusual or unexpected results will be reviewed, and a determination will be made as to whether the analyses will be repeated. In addition, the Laboratory Project Manager or designee may recalculate selected results to verify the calculation procedure.

The Laboratory QA Officer will independently conduct a review of the Project data to determine project requirements have been met. Discrepancies will be reported to the Laboratory Project Manager or designee for resolution.

Prior to final review/signoff by the Laboratory Project Manager or designee, the laboratory personnel will verify that the report deliverable is complete and in proper format, screen the report for compliance to laboratory and JOF QAPP requirements, and ensure that the Case Narrative addresses any noted deficiencies. The Laboratory Project Manager or designee will perform the final laboratory review prior to reporting the results to the QA oversight consultant and TVA. Any discrepancy noted during laboratory review that results in sample reanalysis or data correction must be documented using the corrective action procedure addressed in Section 16.4.

16.3 Performance and System Audits

Internal audits will be initiated by the QA Oversight Manager at the discretion of the TVA Technical Lead. Internal audits may be conducted based upon issues identified during various other assessment activities. The internal systems and performance audits will be planned and conducted by the QA Oversight Manager or designee or other appropriate QA Program personnel with the experience and competency to perform the audits/assessments. As part of the planning process for conducting internal audits, internal audits or assessments will first be scheduled. Next, the Audit Team will be identified, and the pertinent documentation and procedures relevant to the audit will be obtained and reviewed by the Audit Team. Internal audits may be announced or unannounced. The Audit Team members will hold a minimum of a Bachelor’s degree in a scientific discipline and have 5 or more years of QA and on-site laboratory auditing experience. As indicated in Section 2.0, the QA Oversight Manager holds overall authority for the project QA Program and maintains that authority independently from the operational/production aspects of the project.

Documentation of systems and performance audits and any resulting corrective actions will be maintained as part of the Project File. Audit documentation will be reported to the TVA Technical Lead.

16.3.1 Performance Audits

Performance audits are quantitative evaluations of data quality produced by a particular activity or function. Performance audits of the participating laboratories performing chemical analyses of project samples may be conducted through the submission and analysis of performance evaluation samples.

The QA Oversight Manager or designee will coordinate the manufacture and submission of performance audit samples to the laboratory. A TNI-approved performance testing sample provider will be used to obtain the performance evaluation samples. PE sample studies will be conducted at the discretion of the TVA Technical Lead for TVA contract laboratories analyzing aqueous, solid, and biological samples associated with the JOF EIP. The performance evaluation sample matrices and requested analytes will be determined based on the nature of the work performed by that laboratory for the project.

Upon receipt of results from the performance evaluation study analyses, the QA Oversight Manager or designee will evaluate the data relative to the certified “true values” and will prepare a comprehensive report (including a discussion of non-analytical issues, such as data package preparation and presentation). If multiple laboratories are included in the performance evaluation study, a statistical evaluation of the results will be performed and a simple fencepost test will be conducted for each analyte to determine outliers; a set of warning limits and acceptance limits (based on the set of data excluding outliers) will be generated for the analytes. The performance evaluation study report will contain a detailed account of any results that are outside of the established acceptance limits. Laboratories will be contacted to explain discrepancies between the reported concentrations and the “known” (true) concentrations of the analytes in the performance evaluation samples and to provide corrective actions in accordance with the corrective action process described in Section 16.4. Performance evaluation sample documentation, inclusive of corrective action responses, will be maintained as part of the Project File.

16.3.2 System Audits

System audits entail on-site observation and evaluation of participating laboratories and field sampling activities for compliance with the JOF QAPP, TIs, and/or investigation-specific Work Plans and/or SAPs. Prior to conducting an on-site audit, the Auditor will conduct a thorough examination of procedures and records. These on-site audits will also include verification of effectiveness of implemented corrective actions.

The system audits will address both field and laboratory activities, including a review of personnel qualifications, equipment, documentation, sampling techniques, analytical methods, and adherence to QA procedures. Each laboratory has its own QA Plan; therefore, the laboratory audit activities under the JOF QAPP will entail a general review of laboratory QA practices.

Systems audits of laboratories conducting chemical analyses of project samples will be performed by the QA Oversight Manager or designee. Field Audits will be conducted by the Field Oversight Coordinator or designee.

On-site audits of laboratories analyzing samples associated with the JOF EIP will be conducted at the discretion of the TVA Technical Lead. Each laboratory will be audited on an annual basis or more frequently as directed by the TVA Technical Lead. Field activities will be subjected to assessments and/or surveillances on a regular basis as new Field Sampling Personnel, new procedures, or new sampling activities are performed. In addition, the Field Oversight Coordinator may observe sampling events as appropriate given the sensitivity of the samples collected.

16.4 Feedback and Corrective Action

In general, feedback and corrective action processes for the JOF EIP will be conducted in accordance with TVA's *Corrective Action Program*. TVA's Corrective Action Program includes various pathways depending on the nature and severity of the issue identified. Issues will be resolved using the lowest-level pathway that adequately identifies and addresses the cause of the non-conformance or deficiency and prevents recurrence.

16.4.1 Feedback Mechanism

There are mechanisms within the project structure that allow for the identification, feedback, and control of any non-conformances or deficiencies. In general, the technical personnel involved with the project are responsible for reporting suspected technical non-conformances through standard communication channels established by the organizational structure. In the same manner, project personnel are responsible for reporting suspected QA non-conformances.

Feedback will be provided to laboratory personnel and Field Sampling Personnel by the TVA Technical Lead, QA Oversight Manager, and/or Investigation Project Manager. Laboratories may receive feedback based on systems and performance audits and ongoing data validation. In addition, laboratories may provide feedback to the QA Oversight Manager. Documentation of feedback will be maintained in the Project File.

16.4.2 Corrective Action for Field Activities

Field Sampling Personnel have the initial responsibility to monitor the quality of field measurements and observations. The Field Team Leader is responsible for verifying that QC procedures are followed. This responsibility requires the Field Team Leader to assess the correctness of field methods and the ability to meet QA objectives. If a problem occurs that might jeopardize the integrity of the project or that might cause a specific QA objective not to be met, the Field Team Leader will notify the TVA Technical Lead and QA Oversight Manager. An appropriate corrective action will then be determined and implemented. The Field Team Leader will document the problem, the corrective action, and the results. A copy of the documentation form will be provided to the TVA Technical Lead.

Field auditing is a recognized technique for evaluating the performance of Field Sampling Personnel and assessing how team performance may affect data quality. Field audits will be conducted by the Field Oversight Coordinator to ensure that sampling, handling, and transportation to project laboratories provide assurance that such procedures meet QA protocols and that field documentation is sufficient to produce data of satisfactory quality, to provide a "defense" in the event that field procedures are called into question. Field audits will be conducted at a minimum of once (for one-time field collection activity) or semi-annually (for reoccurring field activities), or as directed by the TVA Technical Lead or designee to verify that corrective actions have been implemented if deficiencies were identified in prior field audits or as requested by the TVA Technical Lead.

16.4.3 Laboratory Corrective Action

Corrective action within the laboratory will be performed in accordance with the laboratory's formal QA Program.

The laboratory has the responsibility to monitor the quality of the analytical system and to provide a corrective action process adequate to address problems encountered in laboratory analysis of samples. The laboratory will verify that QC procedures are followed and that the analytical results of QC samples are within the acceptance criteria. The verification requires that the laboratory assess the correctness of the following items, as appropriate:

- Sample preparation procedure.
- Initial calibration.
- Calibration verification.
- Method blank result.
- Laboratory control sample.
- Laboratory duplicate analysis.
- Fortified sample result.
- Internal standard performance.

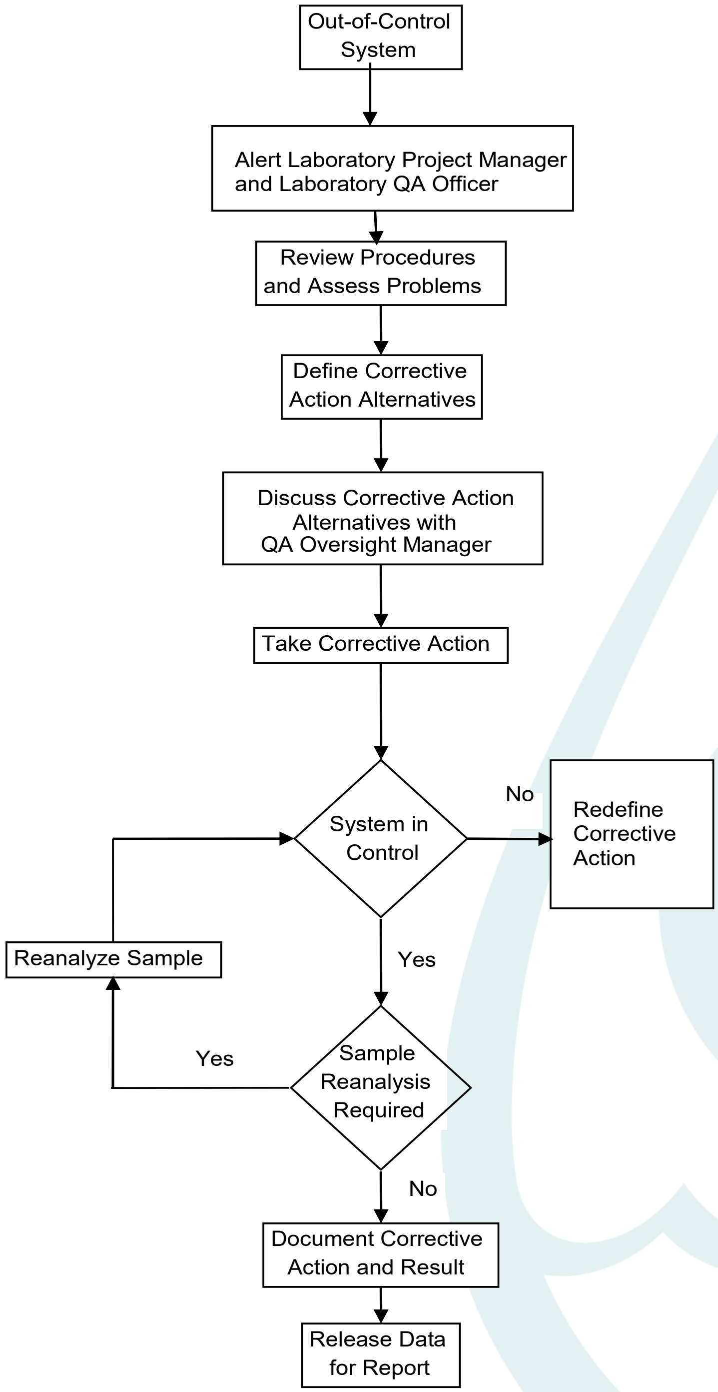
If the assessment reveals that the QC acceptance criteria are not met, the laboratory must immediately evaluate the analytical system and correct the problem. The Laboratory Analyst will notify the Laboratory Project Manager and Laboratory QA Officer of the problem and, if possible, will identify potential causes and suggest correct action.

When the appropriate corrective action measures have been implemented and the analytical system is determined to be "in control," the Laboratory Analyst will document the problem, the corrective action taken, and resultant data demonstrating that the analytical system is in control. Copies of the documentation will be provided to the Laboratory Project Manager and the Laboratory QA Officer.

Data generated concurrently with an out-of-control system will be evaluated for usability relative to the nature of the deficiency. If the deficiency does not adversely impact the usability of the results, data will be reported and the deficiency will be addressed in the Case Narrative. If sample results are adversely impacted, the Laboratory Project Manager will be notified and appropriate corrective action (such as reanalysis) will be taken.

Figure 16-1 presents the critical pathway for laboratory corrective actions.

Figure 16-1. Critical Path for Laboratory Corrective Action



17.0 REPORTS TO MANAGEMENT

The QA activities performed by laboratories conducting analyses of JOF EIP samples will be monitored by the TVA Technical Lead and the QA Oversight Manager.

Communication among TVA, QA personnel, the Field Team Leader, and laboratory personnel is important to ensure that problems are remedied and that solutions are documented in an informed and timely manner.

After the completion of a performance and systems audit, the QA Oversight Manager will submit an audit report to the TVA Technical Lead. This audit report will include a list of observed field activities, a list of reviewed documents, and any observed deficiencies. The TVA Technical Lead and QA Oversight Manager or designee will meet with the Laboratory Project Managers of any area with observed deficiencies to review the audit findings, confirm the observations, and resolve misunderstandings. In the event that inadequacies are identified, corrective actions will be undertaken as outlined in Section 16.4.

17.1 Field QA Reports

The Field Team Leader and Investigation Project Manager will provide the TVA Technical Lead with routine field progress reports. Compiled field data sets will be provided to the Data Manager for inclusion in the project EQuIS database. The TVA Technical Lead and QA Oversight Manager or designee will be immediately notified about field QA situations that require corrective action. Corrective action will be performed and documented in accordance with the protocol set forth in Section 16.4.

17.2 Laboratory QA Reports

The Laboratory QA Officer may provide periodic summary reports specific to the project to the QA Oversight Manager. These reports may summarize QA activities for the reporting period, including results of performance audits (external and internal), results of system audits (external and internal), summaries of corrective action to remedy out-of-control situations, and recommendations for revisions of laboratory procedures to improve the analytical systems. The Laboratory Project Manager will notify the QA Oversight Manager and Laboratory Coordinator about laboratory QA situations that appear to systematically impact data quality.

The Laboratory QA Officer will immediately notify the QA Oversight Manager and the Laboratory Coordinator of any laboratory QA situations that require corrective action and ascertain if such measures meet the DQOs of the project. Corrective action will be performed and documented in accordance with the protocol set forth in Section 16.4 or internal laboratory corrective action tracking system, as appropriate.

17.3 Internal Performance and System Audit/Assessment Reports

Documentation of systems and performance audits and any resulting corrective actions will be maintained as part of the Project File. Audit documentation will be reported to the TVA Technical Lead.

18.0 DATA REVIEW, VERIFICATION, AND VALIDATION

The Data Validators will verify or validate data generated by the laboratories for chemical analyses of project samples. Any issues observed during data validation will be brought to the attention of the QA Oversight Manager and TVA Technical Lead; the Laboratory Project Manager will be contacted to determine and implement an appropriate corrective action.

The purpose of analytical data verification and validation is to ensure data completeness, correctness, and method compliance/conformance, and identify data quality, including unusable data that would not be sufficient to support environmental decisions. In addition to the laboratory QA review, the data presented in Level IV data packages will be verified and validated by the Data Validators for the following:

- Compliance with requested testing requirements.
- Completeness.
- Reporting accuracy (including hardcopy to EDD).
- Confirmation of receipt of requested items.
- Traceability, sensibility, and usability of the data.

In addition to the above criteria, data will be validated with guidance from the following documents:

- US EPA Contract Laboratory Program (CLP) National Functional Guidelines (NFG) for Inorganic Data Review (October 2004);
- US EPA Region 4 Data Validation SOPs for CLP Inorganic Data by Inductively Coupled Plasma – Atomic Emission Spectroscopy (September 2011);
- US EPA Region 4 Data Validation SOPs for CLP Mercury Data by Cold Vapor Atomic Absorption (September 2011);
- US EPA Region 4 Environmental Investigations SOPs and Quality Assurance Manual (November 2001).

It should be noted that data validation guidelines specified above were developed for work conducted under the US EPA Contract Laboratory Program; therefore, these guidelines are not completely applicable to the Clean Water Act (CWA), Standard Methods, and SW-846 methods referenced for the JOF EI. Professional judgment will be used as necessary to adapt the guidelines for use in evaluating usability of data generated in accordance with CWA, Standard Methods, and SW-846 methodology.

Analytical data from off-site, commercial laboratories will be qualified with guidance from the National Functional Guidelines previously referenced. The data validation qualifiers listed below will be used for project samples:

- Organic Data Validation Qualifiers

U*	This result should be considered "not detected" because it was detected in an associated field or laboratory blank at a similar level.
R	Unreliable positive result; compound may or may not be present in sample.
UR	Unreliable reporting or detection limit; compound may or may not be present in sample.
J	Quantitation is approximate due to limitations identified during data validation.
UJ	This compound was not detected, but the reporting or detection limit should be considered estimated due to a bias identified during data validation.

- Inorganic Data Validation Qualifiers

U*	This result should be considered "not detected" because it was detected in a rinsate blank or laboratory blank at a similar level.
R	Unreliable positive result; analyte may or may not be present in sample.
UR	Unreliable reporting or detection limit; analyte may or may not be present in sample.
J	Quantitation is approximate due to limitations identified during data validation.
UJ	This analyte was not detected, but the reporting or detection limit may or may not be higher due to a bias identified during data validation.

The EDD and Full data packages for data generated from the chemical analysis of project samples will summarize the deviations from approved protocols and significant data findings in the Case Narratives. Analytical reports will be submitted as separate documents and will be transmitted in an electronic (.pdf and EDD) and/or hardcopy formats. The Data Manager will maintain a database of TVA data for data validation and/or verification. The Data Validators will complete data validation and generate reports for TVA. Data validation and project reports will be submitted to the TVA Technical Lead. Electronic validated data will be submitted upon approval from the TVA Technical Lead. The Data Management Plan details the process for appending data qualifiers in the EQuIS database and submitting verified and validated data to data users.

In addition to the validation qualifiers, qualifier reason codes will be maintained in the database. The reason codes below will be used to describe the usability issue(s) associated with results qualified during data review. Additional reason codes may be added as needed to address recurring usability issues.

Reason Code	Explanation
BE	Equipment blank contamination. The result should be considered "not-detected."
BF	Field blank contamination. The result should be considered "not-detected."
BL	Laboratory blank contamination. The result should be considered "not-detected."
BN	Negative laboratory blank contamination.
C	Initial and/or continuing calibration issue, indeterminate bias.
C+	Initial and/or continuing calibration issue. The result may be biased high.

Reason Code	Explanation
C-	Initial and/or continuing calibration issue. The result may be biased low.
FD	Field duplicate imprecision.
FG	Total versus Dissolved Imprecision.
H	Holding time exceeded.
I	Internal standard recovery outside of acceptance limits.
L	LCS and LCSD recoveries outside of acceptance limits, indeterminate bias.
L+	LCS and/or LCSD recoveries outside of acceptance limits. The result may be biased high.
L-	LCS and/or LCSD recoveries outside of acceptance limits. The result may be biased low.
LD	Laboratory duplicate imprecision.
LP	LCS/LCSD imprecision.
M	MS and MSD recoveries outside of acceptance limits, indeterminate bias.
M+	MS and/or MSD recoveries outside of acceptance limits. The result may be biased high.
M-	MS and/or MSD recoveries outside of acceptance limits. The result may be biased low.
MP	MS/MSD imprecision.
P	Post-digestion spike recoveries outside of acceptance limits, indeterminate bias.
P+	Post-digestion spike recovery outside of acceptance limits. The result may be biased high.
P-	Post-digestion spike recovery outside of acceptance limits. The result may be biased low.
Q	Chemical preservation issue.
R	RL standards outside of acceptance limits, indeterminate bias.
R+	RL standard(s) outside of acceptance limits. The result may be biased high.
R-	RL standard(s) outside of acceptance limits. The result may be biased low.
RL	Positive result reported between the MDL and QL.
S	Radium-226+228 flagged due to reporting protocol for combined results.
SD	Serial dilution imprecision.
T	Temperature preservation issue.
X	Percent solids < 50%.
Y+	Chemical yield outside of acceptance limits. The result may be biased high.
Y-	Chemical yield outside of acceptance limits. The result may be biased low.
Z	ICP/MS interference.

Reason Code	Explanation
ZZ	Other.

19.0 VERIFICATION AND VALIDATION METHODS

The overall QA objective for field activities, laboratory analyses, and data assessment is to produce data of sufficient and known quality to support the investigation-specific objectives and to produce high-quality, legally defensible data.

This data assessment activity is an ongoing coordinated process with data production and is intended to ensure that data produced during the JOF EI are acceptable for use in subsequent evaluations. Both statistical and qualitative evaluations will be used to assess the quality of the data. The primary evaluation of the data will be based upon the control samples. The blank samples will be used to evaluate whether or not the laboratory and/or field sample handling represent a possible source of sample contamination. Duplicate sample results will be used to evaluate data precision.

All data submitted to the project EQuIS database will undergo data verification. Analytical data will be available for preliminary internal use after verification. Initially, 100% of the all chemical and physical analysis data will be reported in fully documented (Level IV) data packages for full independent data validation. If, after the percentage of full data validation has decreased, a trend in frequency of reporting issues, method non-compliances, or data usability issues is identified, data validation will be conducted for specific data points or the percentage of full data validation percentage may be increased until the issues have been minimized to their initial frequency.

Data verification includes the review of laboratory deliverables for completeness, correctness, and compliance with applicable methods. The validation of data presented in a Level IV data package includes the review of commercially-available raw data and associated QC summary forms for compliance with the applicable methods and for data usability with respect to the appropriate guidance documents. The nature and extent of the data package available for review is dependent on the analytical method used (such as US EPA methods, SW-846, *etc*.) and the reporting and deliverables requirements defined in JOF QAPP and investigation-specific SAPs. After completion of either full or limited data validation, a QA report will be prepared. The QA report will address JOF QAPP and method non-compliance issues, reporting errors, data usability issues, and include summary tables with qualified sample results. The QA report will also address laboratory calculation errors (*i.e*., the reported value is more than 10% different than the value calculated from the raw data by the data validator). The summary tables will include reported sample results and the associated data qualifiers. The QA report will be fully supported by photocopied pages of the laboratory data showing deficiencies identified in the review, as an attachment to the report.

The data produced during the sampling tasks included in the field investigation will be compared with the defined QA objectives and criteria for precision, accuracy, representativeness, completeness, and comparability (PARCC) and sensitivity. The primary goal of these procedures is to ensure that the data reported are representative of actual conditions at the Site.

Standard procedures are used so that known and acceptable levels of PARCC are maintained for each data set. Descriptions of these criteria are presented in the following subsections.

Specific quantitative QA objectives for chemical analyses associated with the JOF EIP are presented in Attachments E through L of this JOF QAPP.

19.1 Precision

The degree of agreement between the numerical values of a set of duplicate samples performed in an identical fashion constitutes the precision of the measurement.

During the collection of data using field methods and/or instruments, precision is checked by reporting measurements at one location and comparing results. For example, soil measurements are taken in pairs at a certain point and depth and the values compared. The measurements are considered sufficiently precise only if the values are within a specified percentage of each other.

Analytical precision for non-radiological parameters is calculated by expressing, as a percentage, the RPD between results of analyses of laboratory duplicate samples for a given analyte. Precision is expressed as an RPD when both results are greater than 5× the reporting limit as calculated by the following formula:

$$RPD = abs\left[\frac{\mathrm{A} - \mathrm{B}}{\left(\frac{A+B}{2}\right)}\right] \times 100$$

Where: A = Value of original sample
B = Value of duplicate sample

When at least one result is less than 5× the reporting limit, the difference between the results is used to evaluate precision.

Analytical precision for radiological analyses is calculated as the relative error ratio (RER) using the following formula:

$$RER = abs\left[\frac{ACT_s - ACT_d}{\sqrt{(TPU_s)^2 + (TPU_d)^2}}\right]$$

Where:
Abs = Absolute Value
ACT_s = Sample Activity
ACT_d = Duplicate Activity
TPU_s = Total Propagated Uncertainty of Sample
TPU_d = Total Propagated Uncertainty of Duplicate

Specific precision and difference objectives for field duplicate samples and laboratory duplicate samples (including MSDs) are presented in Attachments E through L of this JOF QAPP.

19.2 Accuracy

Accuracy is the degree of agreement of a measurement, X, with an accepted reference or true value, T. Accuracy is usually expressed as the difference between the two values, X-T, or the difference as a percentage of the reference or true value, 100(X-T)/T; accuracy is also sometimes expressed as a ratio X/T. Accuracy, which is a measure of the bias in a system, is assessed by means of reference samples and percent recoveries. Error may arise due to personal, instrumental, or method factors.

The two types of analytical check samples used are LCSs and MSs. Analytical accuracy is expressed as the percent recovery (%R) of an analyte that has been added to the control sample or a standard matrix (such as blank soil) at a known concentration prior to analysis.

The formula used to calculate accuracy for the LCS is:

$$\%\,R = \left(\frac{A_T}{A_F}\right) \times 100$$

Where: A_T = Total concentration of the analyte measured or recovered
A_F = Concentration of the analyte spiked

When calculating accuracy for the MS analysis, a correction for background concentration found in the unspiked sample must be made. MS recovery is calculated using the following formula:

$$\%\,R = \left(\frac{A_T - A_O}{A_F}\right) \times 100$$

Where: A_T = Concentration of the analyte measured or recovered
A_0 = Unspiked concentration of the analyte
A_F = Concentration of the analyte spiked

In general, the accuracy objectives are based on the requirements set forth in the referenced analytical method and in Attachments E through L of this JOF QAPP.

19.3 Representativeness

Representativeness expresses the degree to which sample data are accurate and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter associated with the proper design of the sampling program. The representativeness criterion can, therefore, be met through the proper selection of sampling locations, the collection of a sufficient number of samples and the use of standardized sampling procedures (*viz*., TVA TIs) to describe sampling techniques and the rationale used to select sampling locations to ensure representativeness of the sample data.

Representativeness will also be measured by the collection of field duplicates or co-located samples, as appropriate given the sample matrix. Comparison of the analytical results of field duplicates will provide a direct measure of individual sample representativeness.

19.4 Completeness

Completeness is a measure of the degree to which the amount of sample data collected meets the needs of the sampling program and is quantified as the relative number of analytical data points that meet the acceptance criteria (including accuracy, precision, and any other criteria required by the specific analytical method used). Completeness is defined as a comparison between actual numbers of usable data points expressed as a percentage of expected number of points.

Difficulties encountered while handling samples in the laboratory, as well as unforeseen complications regarding analytical methods, may affect completeness during sample analysis. The minimum goal for completeness is 90%; the ability to exceed this goal is dependent on the applicability of the analytical methods to the sample matrix analyzed. If data cannot be reported without qualifications, project completion goals may still be met if the qualified data (data of known quality, even if not perfect) are suitable for specified project goals. Percent completeness will be expressed as the ratio of the total number of usable results relative to the total number of analytical results. The total number of usable analytical results will be total number of results minus any results deemed unusable (or rejected) at validation.

19.5 Comparability

Comparability is a qualitative parameter used to express the confidence with which one data set can be compared with another. The comparability of the data, a relative measure, is influenced by sampling and analytical procedures. By providing specific protocols for obtaining and analyzing samples, data sets will be comparable regardless of who collects the sample or who performs the sample analysis.

The laboratory will be responsible providing the following controls to allow assessment of comparability:

- Adherence to current, standard US EPA-approved methodology for sample preservation.
- Compliance with holding times and analysis consistent with JOF QAPP.
- Consistent reporting units for each parameter of similar matrices.
- US EPA-traceable or NIST-traceable standards, when applicable.

20.0 RECONCILIATION OF DATA TO PROJECT OBJECTIVES

The QA Oversight Manager, in conjunction with the TVA Technical Lead, will determine whether field and validated analytical data or data sets meet the requirements necessary for decision-making. The results of measurements will be compared to the objectives set forth in the investigation-specific SAPs.

Generally, data assessment begins with verification and validation of project data to ensure that the sampling and analysis protocols specified in the associated TVA TIs and SAPs were followed, and that the measurement systems were performed in accordance with the criteria specified in these documents and this JOF QAPP. Data limitations identified during data verification and validation are communicated to the project team via reports and qualification in the project database.

Following data assessment, statistical analysis is performed to determine if the investigation and project objectives were achieved. As data are evaluated, anomalies in the data or data gaps may become apparent to the data users. Data that do not meet the data users' needs will be identified and appropriately noted so that decision-makers are aware of data limitations.

Data that are determined not to meet the investigation and project objectives may be used qualitatively or may be rejected depending on the investigation-specific requirements and the intended use of the data. The TVA Technical Lead, with the support of the QA Oversight Manager or designee and Data Validators, will assist data end users in evaluating data limitations identified and determining whether data are acceptable for their intended use.

21.0 REFERENCES

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ATTACHMENT A

DATA PACKAGE DELIVERABLE REQUIREMENTS

Required Data Deliverables Elements

All Sample Data Packages will include data for analyses of all samples in one sample delivery group (SDG), including field samples, reanalyses, secondary dilutions, blanks, laboratory control samples (LCS), laboratory control sample duplicates (LCSD), matrix spikes (MS), matrix spike duplicates (MSD), and/or laboratory duplicates. A fraction-specific unit is not a required deliverable if the analysis of that fraction was not required for samples in the SDG. The Sample Data Package must be complete before submission and must be consecutively paginated. The Sample Data Package will be arranged in the following order:

- Cover Letter/Letter of Transmittal signed by Technical Project Manager or designee
- Title Page
- Table of Contents
- SDG Narrative

The SDG Narrative will be clearly labeled “SDG Narrative” and will contain laboratory name; SDG number; TVA sample identifications; laboratory sample numbers; and detailed documentation of any QC, sample, shipment, and/or analytical problems encountered in processing (preparing and analyzing) the samples reported in the data package. A glossary of qualifier codes used in the SDG must also be provided.

The laboratory must also include reference to preparation and analytical methods performed and applicable project documents (*e.g.,* approved work plans), any problems encountered, both technical and administrative, corrective actions taken and resolution, and an explanation of all flagged edits (*i.e*., exhibit edits) on quantitation reports (including results flagged due to storage blank contamination).

The SDG Narrative must be signed and dated by the Laboratory Manager or designee. The SDG Narrative must include a statement or statements relative to compliance with this document and any applicable project documents and description of any deviations from these documents:

- Field and Internal (Laboratory) Chain-of-Custody Records
- Sample Receipt Documentation Log, and all Project Correspondence

Copies of both the external and internal Chain-of-Custody Records for all samples within the SDG must be included in the deliverables. The Chain-of-Custody Records will list all temperature and pH measurements for all samples requiring pH adjustment for preservation.

A.1 Inorganic and General Chemistry Deliverables Requirements

The following subsections provide detailed requirements for the information presented on each of the deliverables elements referenced in Table A-1. In the event that certain required information is not included on a particular form, the laboratory will provide additional documentation (e.g., preparation logs or analytical runlogs) to ensure that the minimum required level of documentation is supplied.

A.1.1 Target Analyte Results Summaries

Target analyte results summaries are required for all MS/MSD samples, laboratory duplicate samples, LCS/LCSDs, and preparation blanks and will be arranged in increasing alphanumeric order by laboratory sample number.

The target analyte results summary must include:

- SDG Number
- TVA sample number
- laboratory sample identifier
- matrix of the TVA sample
- date of sample collection
- sample percent solids (if applicable)
- name and CAS number for each target analyte
- concentration or project-required detection limit (PRDL) for each target analyte
- any applicable flags for target analyte results (e.g., “U” to designate a “not-detected” result)
- concentration units

A.1.2 Initial and Continuing Calibration Verification Summary

The initial and continuing calibration verification summaries will be arranged in chronological order, by instrument and must include:

- SDG number
- names for all target analytes
- instrument identifier

- start and end dates and times of the analytical sequence
- true concentrations for all target analytes for the ICV and CCV standards
- observed concentrations for all target analytes for each ICV and CCV analyses
- calculated percent recoveries for all target analytes for each ICV and CCV analyses
- control limits for ICV and CCV
- percent recoveries
- concentration units

A.1.3 PRDL Standard Summary

The PRDL standard summaries will be arranged in chronological order, by instrument and must include the following:

- SDG number
- names for all target analytes
- instrument identifier
- dates and times for the PRDL standard analyses
- true concentrations for all target analytes
- observed concentrations for all target analytes for each PRDL standard analysis
- calculated percent recoveries for all target analytes for each PRDL
- standard analysis
- control limits for PRDL standard recoveries
- concentration units

A.1.4 Initial and Continuing Calibration Blank Summary

The initial and continuing calibration blank summaries will be arranged in chronological order, by instrument and must include the following:

- SDG number

- names for all target analytes
- instrument identifier
- start and end dates and times of the analytical sequence
- observed concentration or PRDL for each target analyte for each initial calibration blank (ICB) or continuing calibration blank (CCB) analysis
- acceptance limits for ICB and CCB analyses
- concentration units

A.1.5 Preparation Blank Analytical Summary

The preparation blank analytical summaries will be arranged in chronological order, by instrument and must include:

- SDG number
- preparation blank sample identifier
- names for all target analytes
- instrument identifier
- observed concentration or PRDL for each target analyte
- acceptance limits
- concentration units

A.1.6 ICP and/or ICP/MS Interference Check Sample Summary

The ICP and/or ICP/MS interference check sample summaries will be arranged in chronological order, by instrument and must include:

- SDG number
- names for all target analytes
- instrument identifier
- dates and times for the ICP interference check standard analyses
- true concentrations for all target analytes

- observed concentrations for all target analytes observed in each ICP interference check standard analysis
- calculated percent recoveries for all target analytes for each ICP interference check standard analysis
- control limits for ICP interference check standard recoveries
- concentration units

A.1.7 Matrix Spike /Matrix Spike Duplicate Summary

The MS/MSD summaries will be arranged in alphanumeric order by laboratory sample number and must include:

- SDG number
- TVA sample number for the spiked sample
- percent solids for the TVA sample (if applicable)
- names for all target analytes
- analyte concentration observed in the non-spiked sample aliquot
- true concentrations for all target analytes in the spike solutions
- observed concentrations for all target analytes in the spike sample/spike sample duplicate analyses
- calculated percent recoveries for all target analytes
- control limits for spike sample/spike sample duplicate recoveries
- calculated RPD between spike sample/spike sample duplicate results
- RPD limit for each analyte
- concentration units

A.1.8 Post-Digestion Spike Sample Recovery Summary (if applicable)

The post-digestion spike sample recovery summaries will be arranged in alphanumeric order by laboratory sample number and must include:

- SDG number

- TVA sample number for the post-digestion spike parent sample
- percent solids for the TVA sample (if applicable)
- names for all target analytes
- analyte concentration observed in the non-spiked sample aliquot
- true concentrations for all target analytes in the post-spike solution
- observed concentrations for all target analytes in the post-spike sample analysis
- calculated percent recoveries for all target analytes
- control limits for post-spike sample recoveries
- concentration units

A.1.9 Duplicates Precision Summary

The duplicate precision summaries will be arranged in alphanumerical order by TVA sample number and must include:

- SDG number
- TVA sample number for the duplicate sample
- percent solids for the TVA sample (if applicable)
- names for all target analytes
- analyte concentration observed in the original sample aliquot
- observed concentrations for all target analytes in the duplicate sample analysis
- calculated RPD for all target analytes
- control limits for RPD
- concentration units

A.1.10 LCS/LCSD Recovery Summary

The LCS/LCSD recovery summaries will be arranged in chronological order, by instrument and must include:

- SDG number
- LCS/LCSD identification number
- names for all target analytes
- true concentrations for all target analytes in the LCS/LCSD solution
- observed concentrations for all target analytes in the LCS/LCSD analysis
- calculated percent recoveries for all target analytes
- control limits for LCS/LCSD recoveries
- concentration units
- RPD between LCS/LCSD results
- RPD limit for each analyte

A.1.11 Standard Addition Results Summary (where applicable) must include:

- SDG number
- TVA sample number for the sample that underwent the standard additions procedure
- names for all target analytes
- analyte concentration or absorbance observed in the non-spiked sample aliquot
- true concentrations for all target analytes for each standard addition analysis
- observed concentration or absorbance for each standard addition analysis
- calculated concentration for each target analyte
- calculated correlation coefficient for each target analyte
- concentration units

A.1.12 ICP and/or ICP/MS Serial Dilution Summary

The ICP and/or ICP/MS serial dilution summaries will be arranged in alphanumeric order by laboratory sample number and must include:

- SDG number
- TVA sample number for the ICP serial dilution sample
- names for all target analytes
- analyte concentration observed in the original sample aliquot
- observed concentrations for all target analytes in the ICP serial dilution analysis
- calculated RPD for all target analytes
- control limits for RPD
- concentration units

A.1.13 PRDL and MDL Summary

The PRDL and MDL summaries will be arranged in chronological order, by instrument and must include:

- SDG number
- instrument identifier
- date the MDL determination was performed
- names for all target analytes
- determined MDL for all target analytes
- PRDL for all target analytes
- concentration units

A.1.14 ICP Interelement Correction Factors Summary

The ICP interelement correction factors summaries will be arranged in chronological order, by instrument and must include:

- SDG number
- instrument identifier
- date the ICP interelement correction factors determination was performed
- names for all target analytes
- determined ICP interelement correction factors concentrations for all target analytes
- concentration units

A.1.15 ICP and/or ICP/MS Linear Range Summary

The ICP and/or ICP/MS linear range summaries will be arranged in chronological order, by instrument and must include:

- SDG number
- instrument identifier
- date the ICP linear range determination was performed
- names for all target analytes
- determined ICP linear range concentrations for all target analytes
- concentration units

A.1.16 Preparation Logs

- TCLP or SPLP Preparation Logs (if TCLP or SPLP extraction was performed)
- TVA sample and QC sample digestion logs

A.1.17 Analytical Sequence Form

The analytical sequence forms will be arranged in chronological order, by analyte, by instrument and must include:

- SDG number
- instrument identifier
- TVA sample numbers associated with the sequence
- QC sample identifiers associated with the sequence
- analysis date and time for each TVA sample and QC sample associated with the sequence
- identification of all target analytes reported from each TVA sample
- QC sample analysis
- dilution factor for each TVA sample and QC sample analysis
- start and end dates and times for the sequence

A.1.18 ICP/MS Additional Forms

ICP/MS Data Packages will include the following forms in addition to the requirements listed above.

- ICP/MS Tune Summary
- ICP/MS Internal Standards Relative Intensity Summary

A.1.19 Raw Data for Metals/Mercury

- For each reported value, the laboratory will provide all raw data used to obtain that value. This requirement applies to all required QA/QC measurements and instrument standardization as well as all sample analysis results. This statement does not apply to the Quarterly Verifications Parameters submitted as part of each data package. Raw data must contain all instrument readouts used for the sample results. Each exposure or instrumental reading must be provided, including those readouts that may fall below the PRDL. All ICP, ICP/MS, and AA instruments must provide a legible hardcopy of the direct real-time instrument readout (e.g., strip-charts, printer tapes, etc.). A photocopy of the instrument's direct sequential readout must be included. A hardcopy of the instrument's direct instrument readout for cyanide must be included if the instrumentation has the capability.

- Raw data must include instrument calibration and calibration curves/equations.

A.1.20 Raw Data for General Chemistry Parameters

- For each reported value, the laboratory will provide all raw data (instrument printouts or logbook pages) used to obtain that value. This requirement applies to all required QA/QC measurements and instrument standardization, as well as all sample analysis results. Raw data must contain all instrument readouts/logbooks pages used for the sample results. Each exposure or instrumental reading must be provided, including those readouts/logbook pages that may fall below the quantitation limit. A photocopy of the instrument's direct sequential readout must be included if the instrumentation has the capability.

- Raw data must include instrument calibration and calibration curves/equations as applicable.

- Wet Chemistry Preparation Logs (by parameter)

Table A-1: Required Deliverables for Inorganic and General Chemistry Analyses

	Section	ICP/MS Metals	Mercury	General Chemistry Parameters
Cover Letter/Letter of Transmittal	n/a	X	X	X
Case Narrative	n/a	X	X	X
Field and Internal (Laboratory) COC Records	n/a	X	X	X
Sample Receipt Documentation Log	n/a	X	X	X
Project Correspondence	n/a	X	X	X
Target Analyte Results Summary	A.1.1	X	X	X
ICP/MS Tune Summary	A.1.18	F		
Initial Calibration Summary	A.1.19 A.1.20	F	F	F
Initial and Continuing Calibration Verification (ICV/CCV) Summary	A.1.2	F	F	F
PRDL Standard Summary	A.1.3	F	F	
Initial and Continuing Calibration Blank Summary	A.1.4	F	F	F[A]
Preparation Blank Summary	A.1.5	X	X	X
ICP and/or ICP/MS Interference Check Sample Summary	A.1.6	F		
MS/MSD Duplicate Summary	A.1.7	X	X	X[A]
Post-Digestion Spike Sample Recovery Summary	A.1.8	F	F	
Duplicates Precision Summary	A.1.9	X	X	X
LCS/LCSD Recovery Summary	A.1.10	X	X	X
ICP and/or ICP/MS Serial Dilution Summary	A.1.12	F		
PRDL and MDL Summary	A.1.13	F	F	F[A]
Standard Additions Results Summary	A.1.11	F[A]	F[A]	
ICP Interelement Correction Factors Summary	A.1.14	F		
ICP and/or ICP/MS Linear Range Summary	A.1.15	F		
ICP/MS Tune Internal Standards Relative Intensity Summary	A.1.18	F		
TCLP or SPLP Preparation Logs	A.1.16	F[A]	F[A]	
Digestion Logs	A.1.16	F	F	
General Chemistry Preparation Logs	A.1.20			F
Analytical Sequence Form	A.1.17	F	F	F
Raw Data	A.1.19	F	F	F

Notes:

X Required element for all deliverables Levels

F Required additional element for full deliverables (in addition to elements required for all deliverables levels)

[A] Required element for associated deliverable level when applicable to the analyses performed

A.2 Radiological Deliverables Requirements

The following subsections provide detailed requirements for the information presented on each of the deliverables elements referenced in Table A-2. In the event that certain required information is not included on a particular form, the laboratory will provide additional documentation (e.g., preparation logs or analytical runlogs) to ensure that the minimum required level of documentation is supplied.

The radiological data will be arranged in the following order by individual parameter requested for the samples in the SDG.

A.2.1 Target Analyte Results Summary: Target analyte results summaries are required for all samples and will be arranged in increasing alphanumeric order by TVA sample number. The target analyte results summary must include the following:

- SDG Number
- TVA sample number
- laboratory sample identifier
- matrix of the TVA sample
- date of sample collection
- date of sample analysis
- sample activity, uncertainty, and the sample-specific minimum detectable concentration (MDC). The sample-specific MDC will be based on the background of the detector that the sample was counted on. The sample activity (positive or negative), uncertainty, and sample-specific MDC will be reported for positive and "not-detected" results
- any applicable flags for target analyte results (e.g., "U" to designate a "not-detected" result)
- concentration units

A.2.2 Chemical Yield (Tracer/Carrier) Recovery Summary that must include the following:

- SDG number
- TVA sample number
- Method blank sample number
- Laboratory Duplicate sample number

- LCS identification number
- LCSD identification number (if performed)
- percent recovery for all tracers/carriers
- applicable recovery limits for each tracer/carrier

A.2.3 Method Blank Summary: The method blank summaries will be arranged in chronological order, by instrument and method and must include the following:

- SDG number
- names for all target analytes
- observed activity, uncertainty, and MDC for each target analyte for each method blank analysis
- concentration units

A.2.4 Duplicates Precision Summary: The duplicate precision summaries will be arranged by instrument and method and must include the following:

- SDG number
- TVA sample number for the duplicate sample
- names for all target analytes
- analyte activity, uncertainty, and MDC observed in the original sample aliquot
- observed activity, uncertainty, and MDC for all target analytes in the duplicate sample analysis
- calculated RPD/Replicate Error Ratio (RER) for all target analytes
- control limits for RPD/RER
- concentration units

A.2.5 LCS Recovery Summary: The LCS recovery summaries will be arranged by instrument and method and must include the following:

- SDG number
- LCS identifier
- names for all target analytes

- true concentrations for all target analytes in the LCS solution
- observed concentrations for all target analytes in the LCS analysis
- calculated percent recoveries for all target analytes
- control limits for LCS recoveries
- concentration units

A.2.6 Calibration Verification Summary: The calibration verification summaries will be arranged by instrument and method and must include the following:

- SDG number
- names for all target analytes
- instrument identifier
- date the calibration verification was performed. For each method and analyte, the Contracted Laboratories will provide Calibration Verification summaries that include or bracket the analysis dates of the field and QC samples.
- acceptance limits for the calibration verification
- the following calibration verification summaries will be provided for Gas Flow Proportional Counter data
  a. Efficiency Checks
  b. Background Checks
- the following calibration verification summaries will be provided for Alpha Spectroscopy data
  a. Energy Calibration Checks
  b. Efficiency Checks
  c. Background Checks
  d. Resolution (FWHM) Checks
- the following calibration verification summaries will be provided for Alpha Scintillation data
  a. Daily Instrument Performance Checks
  b. Background Checks

A.2.7 Raw Data

For each reported value, the Contracted Laboratories will provide all raw data (instrument printouts) used to obtain that value. This applies to all required QA/QC measurements (including tracer/carrier recoveries) as well as all sample analysis results. Raw data must contain all instrument readouts and worksheets used for the sample results. An exhibit work sheet per method (including example calculations showing how sample activity, total propagated uncertainty [TPU] and minimum detectable activity [MDA] are calculated) will be provided.

A.2.8 Preparation Logs (by method)

A.2.9 Traceability Documents (by method)

Table A-2: Required Deliverables for Radiological Analyses

	Section	Radiological Parameters
Cover Letter/Letter of Transmittal	n/a	X
Case Narrative	n/a	X
Field and Internal (Laboratory) COC Records	n/a	X
Sample Receipt Documentation Log	n/a	X
Project Correspondence	n/a	X
Target Analyte Results Summary	A.2.1	X
Chemical Yield (Tracer/Carrier) Recovery Summary	A.2.2	X
Method Blank Summary	A.2.3	X
Duplicates Precision Summary	A.2.4	X
LCS Recovery Summary	A.2.5	X
Calibration Verification Summary	A.2.6	X
Raw Data	A.2.7	F
Preparation Logs	A.2.8	X
Traceability Documents	A.2.9	X

Notes:
X Required element for all deliverables levels
F Required additional element for full deliverables (in addition to elements required for all deliverables levels)

ATTACHMENT B

SAMPLING PROCEDURES LIST

The TVA Technical Instructions (TIs) and/or standard operating procedures (SOPs) associated with the JOF EIP are identified on Table B-1. Current versions of these documents are maintained on TVA's Accellion Workspace.

Table B-1: Applicable TIs and SOPs

Document Number	**Document Title**
EMA-TI-05.80.40	*Surface Water Sampling*
ENV-TI-05.80.02	*Sample Labeling and Custody*
ENV-TI-05.80.03	*Field Record Keeping*
ENV-TI-05.80.04	*Field Sampling Quality Control*
ENV-TI-05.80.05	*Field Sampling Equipment Cleaning and Decontamination*
ENV-TI-05.80.06	*Handling and Shipping of Samples*
ENV-TI-05.80.42	*Groundwater Sampling*
ENV-TI-05.80.44	*Groundwater Level and Well Depth Measurement*
ENV-TI-05.80.46	*Field Measurements Using a Multi-Parameter Sonde*
TVA-KIF-SOP-29	*Mayfly Sampling*
TVA-KIF-SOP-31	*Standard Operating Procedure for: Fish sampling with Gill Nets*
TVA-KIF-SOP-33	*Fish Sampling Using Boat-mounted Electro-shocker*
TVA-KIF-SOP-35	*Reservoir Benthic Macroinvertebrate Sampling*

ATTACHMENT C

EXAMPLE CHAIN OF CUSTODY RECORD

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed and accurate.

Page: ____ of ____
Cooler # ____ of ____

COC #

Task

Required Ship to Lab:		Required Project Information:				Required Sampler Information:			
Lab Name:		Site ID #:				Sampler			
Address:	#N/A	Project #	#N/A			Sampling Company			
						Address:			
		Site Address	#N/A			City/State		Phone #:	
Lab PM:	#N/A	City	#N/A	State, Zip	#N/A	Reimbursement project?		Non-reimbursement	Mark one
Phone/Fax:	#N/A	Site PM Name			#N/A	Send EDD to			
Lab PM email	#N/A	Phone/Fax:				CC Hardcopy report to			
Applicable Lab Quote #:		Site PM Email:				CC Hardcopy report to			

TAT: Standard		Rush		Mark One

Filtered / Preserve / Analysis

ITEM #	SAMPLE ID Samples IDs MUST BE UNIQUE	SAMPLE LOCATION	Sample Depth: Depth Unit: Start Depth	End Depth	MATRIX CODE	G=GRAB C=COMP	SAMPLE TYPE	SAMPLE DATE	SAMPLE TIME	#OF CONTAINERS	Comments/Lab Sample I.D.
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

Additional Comments/Special Instructions:

RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	Sample Receipt Conditions			
							Y / N	Y / N	Y / N
							Y / N	Y / N	Y / N
							Y / N	Y / N	Y / N
							Y / N	Y / N	Y / N

SHIPPING METHOD: (mark as appropriate)		SAMPLER NAME AND SIGNATURE		Temp in 0C	Samples on Ice?	Sample Intact?	Trip Blank?
UPS	COURIER \ FEDEX	PRINT Name of SAMPLER:					
US MAIL		SIGNATURE of SAMPLER:					

ATTACHMENT D

SAMPLE NOMENCLATURE

TVA - TDEC Order Sample Naming Conventions - Johnsonville Fossil Plant

Table A

Site (Plant) Name	Site Acronym	Sample Type (Matrix)	Sample Type Acronym	Location	Location ID	Depth Interval (If Applicable)	Quality Control/Quality Assurance Sample Type	Sample Type Acronym	Date of Sample	Example
Johnsonville Fossil Plant	JOF	Background Soil	BS	Soil Boring Number	BGXX	Feet/Feet	Equipment Rinsate Blank	EBXX	Year/Month/Day	JOF-BS-BGXX-6.0/8.0-20171220 JOF-BS-EBXX-20171220 JOF-BS-FBXX-20171220 JOF-BS-DUPXX-20171220
		Coal Combustion Residuals	CCR	Temporary Well Number	TWXX	Feet/Feet	Field Blank	FBXX	Year/Month/Day	JOF-CCR-TWXX-6.0/8.0-20171220 JOF-CCR-EBXX-20171220 JOF-CCR-FBXX-20171220 JOF-CCR-DUPXX-20171220
		Pore Water	PW	Temporary Well Number	TWXX	Feet Below Top of Casing	Matrix Spike/Matrix Spike Duplicate *For MS/MSD note applicable sample on COC	MS/MSD	Year/Month/Day	JOF-PW-TWXX-20171220 JOF-PW-EBXX-20171220 JOF-PW-FBXX-20171220 JOF-PW-FLBXX-20171220 JOF-PW-DUPXX-20171220
		Water Supply	WS	Well ID # or Property Owner Name	State or USGS Well # or Property Owner Name	NA	Filter Blank	FLBXX	Year/Month/Day	JOF-WS-TN0001-20171220 JOF-WS-JOHNDOE-20171220 JOF-WS-EBXX-20171220 JOF-WS-FBXX-20171220 JOF-WS-FLBXX-20171220 JOF-WS-DUPXX-20171220
		Groundwater	GW	Monitoring Well Number	MWXX or Existing Name	NA	Field Duplicate	DUPXX	Year/Month/Day	JOF-GW-MWXX-20171220 JOF-GW-JOF201-20171220 JOF-GW-EBXX-20171220 JOF-GW-FBXX-20171220 JOF-GW-FLBXX-20171220 JOF-GW-DUPXX-20171220
		Seep Soil	SeS	Seep Number	XX	NA			Year/Month/Day	JOF-SeS-XX-20171220 JOF-SeS-EBXX-20171220 JOF-SeS-FBXX-20171220 JOF-SeS-DUPXX-20171220
		Seep Water	SeW	Seep Number	XX	NA			Year/Month/Day	JOF-SeW-XX-20171220 JOF-SeW-EBXX-20171220 JOF-SeW-FBXX-20171220 JOF-SeW-FLBXX-20171220 JOF-SeW-DUPXX-20171220

TVA - TDEC Order Sample Naming Conventions - Johnsonville Fossil Plant

Table A (Continued)

Johnsonville Fossil Plant	JOF		Surface Stream	STR		Water Body Acronym Spatial Location Number	TR = Tennessee River IC = Intake Channel BH = Boat Harbor		Not Stratified: SUR = Water Surface MID = Mid Column BOT = Epibenthic Stratified: SUR = Near Surface ME = Mid-Epillimnion MH = Mid-Hypolimnion BOT = Near Bottom		Year/Month/Day		JOF-STR-TRXX-SUR-20171221 JOF-STR-TRXX-MID-20171221 JOF-STR-TRXX-BOT-20171221 JOF-STR-TRXX-SUR-20171221 JOF-STR-TRXX-ME-20171221 JOF-STR-TRXX-MH-20171221 JOF-STR-TRXX-BOT-20171221 JOF-STR-ICXX-SUR-20171221 JOF-STR-ICXX-MID-20171221 JOF-STR-ICXX-BOT-20171221 JOF-STR-ICXX-SUR-20171221 JOF-STR-ICXX-ME-20171221 JOF-STR-ICXX-MH-20171221 JOF-STR-ICXX-BOT-20171221 JOF-STR-BHXX-SUR-20171221 JOF-STR-BHXX-MID-20171221 JOF-STR-BHXX-BOT-20171221 JOF-STR-BHXX-SUR-20171221 JOF-STR-BHX-ME-20171221 JOF-STR-BHX-MH-20171221 JOF-STR-BHX-BOT-20171221 JOF-STR-EBXX-20171221 JOF-STR-FBXX-20171221 JOF-STR-FLBXX-20171221 JOF-STR-DUPXX-20171221
			Fish	FH		See Table B							
			Adult Mayflies	MFA		See Table B							
			Purated Mayfly Nymphs	MFP		See Table B							
			Non-Purated Mayfly Nymphs	MFN		See Table B							
			Macro-invertebrate	MAC		See Table C							
			Sediment	SED		See Table C							

TVA - TDEC Order Fish & Mayfly Sample Naming Conventions - Johnsonville Fossil Plant
Table B

Site (Plant) Name	Site Acronym	Sample Type (Matrix)	Biota Matrix Code	Species Identifier	Species Identifier Acronym	River & River Mile Collection Location	Environmental Medium Identifier	Quality Control/Quality Assurance Sample Type	Sample Type Acronym	Date of Sample	Example
Johnsonville Fossil Plant	JOF	Adult Mayflies	MFA	NA	NA	TRD: Tennessee River Downstream Reach (Approximately TRRM 94.5 - 97.0)	NA	Field Duplicate	DUPXX	Year/Month/Day	JOF-MFA-TRD-20171220 JOF-MFA-DUPXX-20171220 JOF-MFA-EBXX-20171220
		Purated Mayfly Nymphs	MFP	NA	NA	TRU: Tennessee River Upstream Reach (Approximately TRRM 99.5 - 100.5)	NA	Equipment Rinsate Blank	EBXX	Year/Month/Day	JOF-MFP-TRU-20171220 JOF-MFP-EBXX-20171220 JOF-MFP-EBXX-20171220
		Non-Purated Mayfly Nymphs	MFN	NA	NA	TRA: Tennessee River Adjacent Reach (Approximately KLRM 99.5 - 100.5)	NA			Year/Month/Day	JOF-MFN-TRA-20171220 JOF-MFN-DUPXX-20171220 JOF-MFN-EBXX-20171220
		Fish	FH	Blue Gill	BG	BH: Boat Harbor Channel (Not Applicable)	F = Fillet tissue sample O = Ovary tissue sample L = Liver tissue sample			Year/Month/Day	JOF-FH-BG-BH-F-20171220 JOF-FH-BG-BH-O-20171220 JOF-FH-BG-BH-L-20171220 JOF-FH-BG-F-DUPXX-20171220 JOF-FH-BG-F-EBXX-20171220
				Channel Catfish	CC	IC: Intake Channel (Not Applicable)	F = Fillet tissue sample O = Ovary tissue sample L = Liver tissue sample			Year/Month/Day	JOF-FH-CC-IC-F-20171220 JOF-FH-CC-IC-O-20171220 JOF-FH-CC-IC-L-20171220 JOF-FH-CC-O-DUPXX-20171220 JOF-FH-CC-O-EBXX-20171220
				Largemouth Bass	LB		F = Fillet tissue sample O = Ovary tissue sample L = Liver tissue sample			Year/Month/Day	JOF-FH-LB-TRD-F-20171220 JOF-FH-LB-TRD-O-20171220 JOF-FH-LB-TRD-L-20171220 JOF-FH-LB-L-DUPXX-20171220 JOF-FH-LB-L-EBXX-20171220
				Redear Sunfish	RS		F = Fillet tissue sample O = Ovary tissue sample L = Liver tissue sample			Year/Month/Day	JOF-FH-RS-TRU-F-20171220 JOF-FH-RS-TRU-O-20171220 JOF-FH-RS-TRU-L-20171220 JOF-FH-RS-F-DUPXX-20171220 JOF-FH-RS-F-EBXX-20171220
				Shad	SH		WF = Whole Fish			Year/Month/Day	JOF-FH-SH-TRA-WF-20171220 JOF-FH-SH-WF-DUPXX-20171220 JOF-FH-SH-WF-EBXX-20171220

TVA - TDEC Order Benthic Sample Naming Conventions - Johnsonville Fossil Plant

Table C

Site (Plant) Name	Site Acronym	Sample Type (Matrix)	Matrix Code	Location	Location ID	Transect Number	Sample Number	Depth Interval (If Applicable)	Quality Control/Quality Assurance Sample Type	Sample Type Acronym	Date of Sample	Example
Johnsonville Fossil Plant	JOF	Macroinvertebrate	MAC	Water Body Acronym	TR = Tennessee River	TRXX	BENXX	Feet/Feet	NA	NA	Year/Month/Day	JOF-MAC-TRXX-BENXX-0.0/0.5-20171220 JOF-MAC-CV01-BENXX-0.0/0.5-20171220 JOF-MAC-CV02-BENXX-0.0/0.5-20171220 JOF-MAC-CV03-BENXX-0.0/0.5-20171220 JOF-MAC-ICXX-BENXX-0.0/0.5-20171220 JOF-MAC-BHXX-BENXX-0.0/0.5-20171220
		Sediment	Sed	Water Body Acronym	CV01 = Cove 01 CV02 = Cove 02 CV03 = Cove 03	NA	CORXX	Feet/Feet	Equipment Rinsate Blank	EBXX	Year/Month/Day	JOF-SED-TRXX-CORXX-0.0/0.5-20171220 JOF-SED-CV01-CORXX-0.0/0.5-20171220 JOF-SED-CV02-CORXX-0.0/0.5-20171220 JOF-SED-CV03-CORXX-0.0/0.5-20171220 JOF-SED-TRXX-EBXX-20171220 JOF-SED-TRXX-FBXX-20171220 JOF-SED-TRXX-DUPXX-20171220 JOF-SED-CV01-EBXX-20171220 JOF-SED-CV01-FBXX-20171220 JOF-SED-CV01-DUPXX-20171220 JOF-SED-CV02-EBXX-20171220 JOF-SED-CV02-FBXX-20171220 JOF-SED-CV02-DUPXX-20171220 JOF-SED-CV03-EBXX-20171220 JOF-SED-CV03-FBXX-20171220 JOF-SED-CV03-DUPXX-20171220
					IC = Intake Channel BH = Boat Harbor	ICXX BHXX			Field Blank	FBXX	Year/Month/Day	JOF-SED-ICXX-CORXX-0.0/0.5-20171220 JOF-SED-BHXX-CORXX-0.0/0.5-20171220 JOF-SED-ICXX-EBXX-20171220 JOF-SED-ICXX-FBXX-20171220 JOF-SED-ICXX-DUPXX-20171220 JOF-SED-BHXX-EBXX-20171220 JOF-SED-BHXX-FBXX-20171220 JOF-SED-BHXX-DUPXX-20171220
									Field Duplicate	DUPXX		
									Matrix Spike/Matrix Spike Duplicate *For MS/MSD note applicable sample on COC	MS/MSD		

ATTACHMENT E

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

BACKGROUND SOIL SAMPLING

Table E-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation	Holding Time
Solid	Metals	4-oz glass	5 g	Cool to < 6°C	180 days
	Mercury				28 days
	Radiological Parameters	16-oz glass	20 g	NA	180 days
	Anions (Chloride, Fluoride, and Sulfate)	4-oz glass	5 g	Cool to < 6°C	28 days
	pH				NA*
	Percent Ash	4-oz glass	5 g	NA	NA
Aqueous Blanks	Metals	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury				28 days
	Anions (Chloride, Fluoride, and Sulfate)	250-mL HDPE	250 mL	Cool to < 6°C	28 days
	Radiological Parameters	3× 1-L HDPE	3000 mL	HNO_3 to pH < 2	180 days

Notes:

oz - ounce
g - grams
mL - milliliter
L - liter
HDPE - High Density Polyethylene
NA - Not applicable

* Soil samples will be tested in the field using field pH test kits, 10% of the sample locations will have confirmation samples submitted for laboratory analysis of pH and will have paste prepared in the laboratory so that analysis can be completed within the holding time (15 minutes following creation of soil paste).

Table E-2: Analytes, Methods, and Reporting Limits – Solid Matrices

Parameter	CAS No.	Method	Reporting Limit[1]	Units
Antimony	7440-36-0	SW-846 6020A	0.200	mg/kg
Arsenic	7440-38-2	SW-846 6020A	0.100	mg/kg
Barium	7440-39-3	SW-846 6020A	1.00	mg/kg
Beryllium	7440-41-7	SW-846 6020A	0.100	mg/kg
Boron	7440-42-8	SW-846 6020A	8.0	mg/kg
Cadmium	7440-43-9	SW-846 6020A	0.100	mg/kg
Calcium	7440-70-2	SW-846 6020A	50.0	mg/kg
Chromium	7440-47-3	SW-846 6020A	0.200	mg/kg
Cobalt	7440-48-4	SW-846 6020A	0.0500	mg/kg
Copper	7440-50-8	SW-846 6020A	0.200	mg/kg
Lead	7439-92-1	SW-846 6020A	0.100	mg/kg
Lithium	7439-93-2	SW-846 6020A	0.500	mg/kg
Mercury	7487-94-7	SW-846 7471B	0.0330	mg/kg
Molybdenum	7439-98-7	SW-846 6020A	0.500	mg/kg
Nickel	7440-02-0	SW-846 6020A	0.100	mg/kg
Selenium	7782-49-2	SW-846 6020A	0.500	mg/kg
Silver	7440-22-4	SW-846 6020A	0.100	mg/kg
Thallium	7440-28-0	SW-846 6020A	0.100	mg/kg
Vanadium	7440-62-2	SW-846 6020A	0.100	mg/kg
Zinc	7440-66-6	SW-846 6020A	0.500	mg/kg
Radium-226	13982-63-3	EPA 901.1	1.00	pCi/g
Radium-228	15262-20-1	EPA 901.1	1.00	pCi/g
Radium-226+228	RA226/228	CALC	1.00	pCi/g
Percent Ash	%ASH	R.J. Lee SOP OPT23.02	1	%
Chloride	16887-00-6	SW-846 9056A Modified	10.0	mg/kg
Fluoride	16984-48-8	SW-846 9056A Modified	1.0	mg/kg
Sulfate	14808-79-8	SW-846 9056A Modified	10.0	mg/kg
pH[2]	PH	SW-846 9045D Modified (laboratory-based definitive analysis)	0.1	pH units

Notes:

CAS No. - Chemical Abstracts Service registry number
mg/kg - milligrams per kilogram
pCi/g - picoCuries per gram
CALC - Parameter determined by calculation.

1 Samples will be reported on a dry-weight basis; sample-specific reporting limits will vary based on sample mass, dilution factors, and percent moisture.

2 Soil samples will be tested in the field using field pH test kits, 10% of the sample locations will have confirmation samples submitted for laboratory analysis of pH and will have paste prepared in the laboratory so that analysis can be completed within the holding time (15 minutes following creation of soil paste).

Table E-3: Quantitative QA Objectives – Soil Samples

Analyte/ Parameter Group	Method	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals	SW-846 6020A	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Mercury	SW-846 7471B	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Radium-226	EPA 901.1	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 901.1	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Anions	SW-846 9056A Modified	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Percent Ash	R.J. Lee SOP OPT23.02	< RL	NA	NA	NA	NA	±10%	RPD < 35% difference < 2× the RL
pH	SW-846 9045D Modified (laboratory-based definitive analysis)	pH 6-8 for laboratory-supplied deionized water	NA	NA	NA	NA	±0.2 pH units	±0.5 pH units

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RER - Relative Error
RL - Reporting Limit
%R - Percent Recovery

ATTACHMENT F

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

CCR MATERIAL CHARACTERISTIC SAMPLING

Table F-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation[1]	Holding Time
CCR Material	Metals	4-oz glass	5 g	Cool to < 6°C	180 days
	Mercury				28 days
	Radiological Parameters	16-oz glass	20 g	NA	180 days
	Anions (Chloride, Fluoride, and Sulfate)	4-oz glass	5 g	Cool to < 6°C	28 days
	pH				NA*
	Total Organic Carbon	8-oz glass	10 g	Cool to <6°C	28 days
	SPLP	16-oz glass	100 g MINIMUM	Cool to <6°C	28 days
SPLP Leachates	Metals	NA	NA; generated in laboratory	Cool to < 6°C	180 days
	Mercury			Cool to <6°C	28 days
	Radiological Parameters			NA	180 days
	Anions (Chloride, Fluoride, and Sulfate)			Cool to < 6°C	28 days
Pore Water	Metals (Total)	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury (Total)				28 days
	Metals (Dissolved)	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury (Dissolved)				28 days
	Anions (Chloride, Fluoride, and Sulfate)	250-mL HDPE	250 mL	Cool to < 6°C	28 days
	Radiological Parameters	3× 1-L HDPE	3000 mL	HNO_3 to pH < 2	180 days
	Total Dissolved Solids (TDS)[2]	250-mL HDPE	100 mL (unfiltered)	Cool to < 6°C	7 days
	Total Organic Carbon	250-mL amber glass or 2x 40-mL VOA Vial	250 mL or 80 mL	Cool to ≤ 6°C H2SO4 to pH < 2	28 days
	pH (field measurement)	NA	NA	NA	15 minutes

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation[1]	Holding Time
Aqueous Blanks	Metals	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury				28 days
	Metals (Dissolved)	250-mL HDPE	250 mL	HNO_3 to pH < 2 after filtration Cool to < 6°C	180 days
	Mercury (Dissolved)				28 days
	Anions (Chloride, Fluoride, and Sulfate)	250-mL HDPE	250 mL	Cool to < 6°C	28 days
	Radiological Parameters	3× 1-L HDPE	3000 mL	HNO_3 to pH < 2	180 days
	Total Dissolved Solids (TDS)[2]	250-mL HDPE	100 mL (unfiltered)	Cool to < 6°C	7 days
	Total Organic Carbon	250-mL amber glass or 2x 40-mL VOA Vial	250 mL or 80 mL	Cool to ≤ 6°C H2SO4 to pH < 2	28 days

Notes:

mL - milliliters
L - Liters
HDPE - High Density Polyethylene
NA - Not applicable

[1] Filtered samples requiring chemical preservation will be preserved after field filtration.

[2] TDS will be performed for unfiltered sample volume only.

* Soil samples will be tested in the field using field pH test kits, 10% of the sample locations will have confirmation samples submitted for laboratory analysis of pH and will have paste prepared in the laboratory so that analysis can be completed within the holding time (15 minutes following creation of soil paste).

Table F-2: Analytes, Methods, and Reporting Limits – CCR Material

Parameter	CAS No.	Method	Reporting Limit [1]	Units
Antimony	7440-36-0	SW-846 6020A	0.200	mg/kg
Arsenic	7440-38-2	SW-846 6020A	0.100	mg/kg
Barium	7440-39-3	SW-846 6020A	1.00	mg/kg
Beryllium	7440-41-7	SW-846 6020A	0.100	mg/kg
Boron	7440-42-8	SW-846 6020A	8.0	mg/kg
Cadmium	7440-43-9	SW-846 6020A	0.100	mg/kg
Calcium	7440-70-2	SW-846 6020A	50.0	mg/kg
Chromium	7440-47-3	SW-846 6020A	0.200	mg/kg
Cobalt	7440-48-4	SW-846 6020A	0.0500	mg/kg
Copper	7440-50-8	SW-846 6020A	0.200	mg/kg
Iron	7439-89-6	SW-846 6020A	5.00	mg/kg
Lead	7439-92-1	SW-846 6020A	0.100	mg/kg
Lithium	7439-93-2	SW-846 6020A	0.500	mg/kg
Mercury	7487-94-7	SW-846 7471B	0.0330	mg/kg
Manganese	7439-96-5	SW-846 6020A	0.500	mg/kg
Molybdenum	7439-98-7	SW-846 6020A	0.500	mg/kg
Nickel	7440-02-0	SW-846 6020A	0.100	mg/kg
Selenium	7782-49-2	SW-846 6020A	0.500	mg/kg
Silver	7440-22-4	SW-846 6020A	0.100	mg/kg
Thallium	7440-28-0	SW-846 6020A	0.100	mg/kg
Vanadium	7440-62-2	SW-846 6020A	0.100	mg/kg
Zinc	7440-66-6	SW-846 6020A	0.500	mg/kg
Radium-226	13982-63-3	EPA 901.1	1.00	pCi/g
Radium-228	15262-20-1	EPA 901.1	1.00	pCi/g
Radium-226+228	RA226/228	CALC	1.00	pCi/g
Total Organic Carbon	7440-44-0	Lloyd Kahn or SW-846 9060A	1000	mg/kg
Chloride	16887-00-6	SW-846 9056A Modified	10.0	mg/kg
Fluoride	16984-48-8	SW-846 9056A Modified	1.0	mg/kg
Sulfate	14808-79-8	SW-846 9056A Modified	10.0	mg/kg
pH	PH	SW-846 9045D Modified (laboratory-based definitive analysis)	0.1	pH units

Notes:

CAS No. - Chemical Abstracts Service registry number
mg/kg - milligrams per kilogram
pCi/g - picoCuries per gram
CALC - Parameter determined by calculation

1 Samples will be reported on a dry-weight basis; sample-specific reporting limits will vary based on sample mass, dilution factors, and percent moisture.

Table F-3: Analytes, Methods, and Reporting Limits – SPLP Leachates

Parameter	CAS No.	Method	Reporting Limit	Units
Chloride	7647-14-5	EPA 300.0/ SW-846 9056	1.00	mg/L
Fluoride	16984-48-8	EPA 300.0/ SW-846 9056	0.10	mg/L
Sulfate	7757-82-6	EPA 300.0/ SW-846 9056	1.00	mg/L
Antimony	7440-36-0	SW-846 6020A	2.00	µg/L
Arsenic	7440-38-2	SW-846 6020A	1.00	µg/L
Barium	7440-39-3	SW-846 6020A	10.0	µg/L
Beryllium	7440-41-7	SW-846 6020A	1.00	µg/L
Boron	7440-42-8	SW-846 6020A	80.0	µg/L
Cadmium	7440-43-9	SW-846 6020A	1.00	µg/L
Calcium	7440-70-2	SW-846 6020A	500	µg/L
Chromium	7440-47-3	SW-846 6020A	2.00	µg/L
Cobalt	7440-48-4	SW-846 6020A	0.500	µg/L
Copper	7440-50-8	SW-846 6020A	2.00	µg/L
Iron	7439-89-6	SW-846 6020A	50.0	µg/L
Lead	7439-92-1	SW-846 6020A	1.00	µg/L
Lithium	7439-93-2	SW-846 6020A	5.00	µg/L
Manganese	7439-96-5	SW-846 6020A	5.00	µg/L
Mercury	7487-94-7	SW-846 7470A	0.200	µg/L
Molybdenum	7439-98-7	SW-846 6020A	5.00	µg/L
Nickel	7440-02-0	SW-846 6020A	10.00	µg/L
Selenium	7782-49-2	SW-846 6020A	5.00	µg/L
Silver	7440-22-4	SW-846 6020A	1.00	µg/L
Thallium	7440-28-0	SW-846 6020A	1.00	µg/L
Vanadium	7440-62-2	SW-846 6020A	1.00	µg/L

Parameter	CAS No.	Method	Reporting Limit	Units
Zinc	7440-66-6	SW-846 6020A	5.00	µg/L
Radium-226	13982-63-3	EPA 903.0	1	pCi/L
Radium-228	15262-20-1	EPA 904.0	1	pCi/L
Radium-226+228	RA226/228	CALC	1	pCi/L
Total Organic Carbon	7440-44-0	SM 5310C	1.00	mg/L

Notes:

CAS No.	-	Chemical Abstracts Service registry number
mg/L	-	milligrams per liter
µg/L	-	micrograms per liter
pCi/L	-	picoCuries per liter
CALC	-	Parameter determined by calculation.

Table F-4: Analytes, Methods, and Reporting Limits – Pore Water Samples

Parameter	CAS No.	Method	Reporting Limit	Units
Chloride	7647-14-5	EPA 300.0/ SW-846 9056	1.00	mg/L
Fluoride	16984-48-8	EPA 300.0/ SW-846 9056	0.10	mg/L
Sulfate	7757-82-6	EPA 300.0/ SW-846 9056	1.00	mg/L
Total Dissolved Solids	TDS	SM2540C	10.0	mg/L
pH	pH	SW-846 Method 9040C	0.1	pH units
Antimony (Total and Dissolved)	7440-36-0	SW-846 6020A	2.00	µg/L
Arsenic (Total and Dissolved)	7440-38-2	SW-846 6020A	1.00	µg/L
Barium (Total and Dissolved)	7440-39-3	SW-846 6020A	10.0	µg/L
Beryllium (Total and Dissolved)	7440-41-7	SW-846 6020A	1.00	µg/L
Boron (Total and Dissolved)	7440-42-8	SW-846 6020A	80.0	µg/L
Cadmium (Total and Dissolved)	7440-43-9	SW-846 6020A	1.00	µg/L
Calcium (Total and Dissolved)	7440-70-2	SW-846 6020A	500	µg/L
Chromium (Total and Dissolved)	7440-47-3	SW-846 6020A	2.00	µg/L
Cobalt (Total and Dissolved)	7440-48-4	SW-846 6020A	0.500	µg/L
Copper (Total and Dissolved)	7440-50-8	SW-846 6020A	2.00	µg/L
Iron (Total and Dissolved)	7439-89-6	SW-846 6020A	50.0	µg/L
Lead (Total and Dissolved)	7439-92-1	SW-846 6020A	1.00	µg/L
Lithium (Total and Dissolved)	7439-93-2	SW-846 6020A	5.00	µg/L
Manganese (Total and Dissolved)	7439-96-5	SW-846 6020A	5.00	µg/L

Parameter	CAS No.	Method	Reporting Limit	Units
Mercury (Total and Dissolved)	7487-94-7	SW-846 7470A	0.200	µg/L
Molybdenum (Total and Dissolved)	7439-98-7	SW-846 6020A	5.00	µg/L
Nickel (Total and Dissolved)	7440-02-0	SW-846 6020A	10.00	µg/L
Selenium (Total and Dissolved)	7782-49-2	SW-846 6020A	5.00	µg/L
Silver (Total and Dissolved)	7440-22-4	SW-846 6020A	1.00	µg/L
Thallium (Total and Dissolved)	7440-28-0	SW-846 6020A	1.00	µg/L
Vanadium (Total and Dissolved)	7440-62-2	SW-846 6020A	1.00	µg/L
Zinc (Total and Dissolved)	7440-66-6	SW-846 6020A	5.00	µg/L
Radium-226	13982-63-3	EPA 903.0	1	pCi/L
Radium-228	15262-20-1	EPA 904.0	1	pCi/L
Radium-226+228	RA226/228	CALC	1	pCi/L
Total Organic Carbon	7440-44-0	SM 5310C	1.00	mg/L

Notes:

CAS No.	-	Chemical Abstracts Service registry number
mg/L	-	milligrams per liter
pCi/L	-	picoCuries per liter
CALC	-	Parameter determined by calculation.

Table F-5: Quantitative QA Objectives – CCR Material

Analyte/ Parameter Group	Method	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% Recovery)	MS/MSD Accuracy (% Recovery)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals	SW-846 6020A	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Mercury	SW-846 7471B	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Radium-226	EPA 901.1	< RL	75-125	NA	RER<2	NA	RER<2	RER<2
Radium-228	EPA 901.1	< RL	75-125	NA	RER<2	NA	RER<2	RER<2
Total Organic Carbon	Lloyd Kahn or SW-846 9060A	< RL	80-120	75-125	35	35	20	RPD < 35% difference < 2× the RL
pH	SW-846 9045D Modified	pH 6-8 for laboratory-supplied deionized water	NA	NA	NA	NA	±0.2 pH units	±0.5 pH units
% Ash	RJ Lee SOP OPT-23.2	NA	NA	NA	NA	NA	±10%	RPD < 10%

Notes:

[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
MS/MSD - Matrix Spike/Matrix Spike Duplicate
RPD - Relative Percent Difference
RER - Relative Error

Table F-6: Quantitative QA Objectives – SPLP Leachates

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries/ Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals	SW-846 6020A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Mercury	SW-846 7470A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Total Dissolved Solids	SM 2540C	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Anions (Chloride, Fluoride, Sulfate)	SW-846 9056A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Total Organic Carbon	SM 5310C	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
pH	SW-846 Method 9040C	NA	NA	NA	NA	NA	NA	NA	±0.5 pH units
Radium-226	EPA 903.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 904.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RER - Relative Error
RL - Reporting Limit
%R - Percent Recovery

Table F-7: Quantitative QA Objectives – Pore Water

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries/ Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals (Total and Dissolved)	SW-846 6020A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Mercury (Total and Dissolved)	SW-846 7470A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Total Dissolved Solids	SM 2540C	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Anions (Chloride, Fluoride, Sulfate)	SW-846 9056A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Total Organic Carbon	SM 5310C	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
pH	SW-846 Method 9040C	NA	NA	NA	NA	NA	NA	NA	±0.5 pH units
Radium-226	EPA 903.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 904.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RER - Relative Error
RL - Reporting Limit
%R - Percent Recovery

ATTACHMENT G

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

WATER USE SURVEY SAMPLING

Table G-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation	Holding Time
Water Supply Well Samples	Metals (Total)	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury (Total)				28 days
	Metals (Dissolved)	250-mL HDPE	250 mL	HNO_3 to pH < 2 after laboratory filtration Cool to < 6°C	180 days
	Mercury (Dissolved)				28 days
	Anions (Chloride, Fluoride, and Sulfate)	250-mL HDPE	250 mL	Cool to < 6°C	28 days
	Radiological Parameters	3× 1-L HDPE	3000 mL	HNO_3 to pH < 2	180 days
	Alkalinity (Total, Carbonate, and Bicarbonate)	250-mL HDPE	50-mL	Cool to < 6°C	14 days
	Total Dissolved Solids (TDS)[1]	250-mL HDPE	100 mL (unfiltered)	Cool to < 6°C	7 days
	pH	NA	NA	NA	15 minutes

Notes:

mL - milliliter
L - liter
HDPE - High Density Polyethylene
NA - Not applicable

[1] TDS will be performed for unfiltered sample volume only.

Table G-2: Analytes, Methods, and Reporting Limits – Water Supply Well Samples

Parameter	CAS No.	Method	Reporting Limit	Units
Chloride	7647-14-5	EPA 300.0	1.00	mg/L
Fluoride	16984-48-8	EPA 300.0	0.10	mg/L
Sulfate	7757-82-6	EPA 300.0	1.00	mg/L
Total Dissolved Solids	TDS	SM2540C	10.0	mg/L
pH	pH	SW-846 Method 9040C	0.1	pH units
Antimony (Total and Dissolved)	7440-36-0	EPA 200.8	2.00	µg/L
Arsenic (Total and Dissolved)	7440-38-2	EPA 200.8	1.00	µg/L
Barium (Total and Dissolved)	7440-39-3	EPA 200.8	10.0	µg/L
Beryllium (Total and Dissolved)	7440-41-7	EPA 200.8	1.00	µg/L
Boron (Total and Dissolved)	7440-42-8	EPA 200.8	80.0	µg/L
Cadmium (Total and Dissolved)	7440-43-9	EPA 200.8	1.00	µg/L
Calcium (Total and Dissolved)	7440-70-2	EPA 200.8	500	µg/L
Chromium (Total and Dissolved)	7440-47-3	EPA 200.8	2.00	µg/L
Cobalt (Total and Dissolved)	7440-48-4	EPA 200.8	0.5	µg/L
Copper (Total and Dissolved)	7440-50-8	EPA 200.8	2.00	µg/L
Lead (Total and Dissolved)	7439-92-1	EPA 200.8	1.00	µg/L
Lithium (Total and Dissolved)	7439-93-2	EPA 200.8	5.00	µg/L
Magnesium (Total and Dissolved)	7439-95-4	EPA 200.8	500	µg/L

Parameter	CAS No.	Method	Reporting Limit	Units
Mercury (Total and Dissolved)	7487-94-7	EPA 245.1	0.200	µg/L
Molybdenum (Total and Dissolved)	7439-98-7	EPA 200.8	5.00	µg/L
Nickel (Total and Dissolved)	7440-02-0	EPA 200.8	10.0	µg/L
Potassium (Total and Dissolved)	7440-09-7	EPA 200.8	500	µg/L
Selenium (Total and Dissolved)	7782-49-2	EPA 200.8	5.00	µg/L
Silver (Total and Dissolved)	7440-22-4	EPA 200.8	1.00	µg/L
Sodium (Total and Dissolved)	7440-23-5	EPA 200.8	500	µg/L
Thallium (Total and Dissolved)	7440-28-0	EPA 200.8	1.00	µg/L
Vanadium (Total and Dissolved)	7440-62-2	EPA 200.8	1.00	µg/L
Zinc (Total and Dissolved)	7440-66-6	EPA 200.8	5.00	µg/L
Radium-226	13982-63-3	EPA 903.0	1	pCi/L
Radium-228	15262-20-1	EPA 904.0	1	pCi/L
Radium-226+228	RA226/228	CALC	1	pCi/L
Alkalinity, Total	ALK	SM2320B	5.0	mg/L
Alkalinity, Carbonate	CARB	SM2320B	5.0	mg/L
Alkalinity, Bicarbonate	BICARB	SM2320B	5.0	mg/L

Notes:

CAS No. - Chemical Abstracts Service registry number
mg/L - milligrams per liter
pCi/L - picoCuries per liter
CALC - Parameter determined by calculation.

Table G-3: Quantitative QA Objectives – Water Supply Well Sampling

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries/ Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals (Total and Dissolved)	EPA 200.8	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Mercury (Total and Dissolved)	EPA 245.1	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Total Dissolved Solids	SM 2540C	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Anions (Chloride, Fluoride, Sulfate)	EPA 300.0	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
pH	SW-846 Method 9040C	NA	NA	NA	NA	NA	NA	NA	±0.5 pH units
Alkalinity (Total, Carbonate, and Bicarbonate)	SM2320B	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Radium-226	EPA 903.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 904.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RER - Relative Error
RL - Reporting Limit
%R - Percent Recovery

ATTACHMENT H

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

GROUNDWATER INVESTIGATION SAMPLING

Table H-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation[1]	Holding Time
Groundwater	Metals (Total)	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury (Total)				28 days
	Metals (Dissolved)	250-mL HDPE	250 mL	HNO_3 to pH < 2 after filtration Cool to < 6°C	180 days
	Mercury (Dissolved)				28 days
	Anions (Chloride, Fluoride, and Sulfate)	250-mL HDPE	250 mL	Cool to < 6°C	28 days
	Radiological Parameters	3× 1-L HDPE	3000 mL	HNO_3 to pH < 2	180 days
	Total Dissolved Solids (TDS)[2]	250-mL HDPE	100 mL (unfiltered)	Cool to < 6°C	7 days
	Alkalinity (Total, Carbonate, and Bicarbonate)	250 mL HDPE	50-mL	Cool to < 6°C	14 days
	pH (field measurement)	NA	NA	NA	15 minutes

Notes:

HDPE - High Density Polyethylene
mL - milliliters
L - liters
NA - Not applicable.

1 Filtered samples requiring chemical preservation will be preserved after field filtration.

2 TDS will be performed for unfiltered sample volume only.

Table H-2: Analytes, Methods, and Reporting Limits – Groundwater Samples

Parameter	CAS No.	Method	Reporting Limit	Units
Chloride	7647-14-5	EPA 300.0/ SW-846 9056	1.00	mg/L
Fluoride	16984-48-8	EPA 300.0/ SW-846 9056	0.10	mg/L
Sulfate	7757-82-6	EPA 300.0/ SW-846 9056	1.00	mg/L
Total Dissolved Solids	TDS	SM2540C	10.0	mg/L
pH	pH	SW-846 Method 9040C	0.1	pH units
Antimony (Total and Dissolved)	7440-36-0	SW-846 6020A	2.00	µg/L
Arsenic (Total and Dissolved)	7440-38-2	SW-846 6020A	1.00	µg/L
Barium (Total and Dissolved)	7440-39-3	SW-846 6020A	10.0	µg/L
Beryllium (Total and Dissolved)	7440-41-7	SW-846 6020A	1.00	µg/L
Boron (Total and Dissolved)	7440-42-8	SW-846 6020A	80	µg/L
Cadmium (Total and Dissolved)	7440-43-9	SW-846 6020A	1.00	µg/L
Calcium (Total and Dissolved)	7440-70-2	SW-846 6020A	500	µg/L
Chromium (Total and Dissolved)	7440-47-3	SW-846 6020A	2.00	µg/L
Cobalt (Total and Dissolved)	7440-48-4	SW-846 6020A	0.5	µg/L
Copper (Total and Dissolved)	7440-50-8	SW-846 6020A	2.00	µg/L
Lead (Total and Dissolved)	7439-92-1	SW-846 6020A	1.00	µg/L
Lithium (Total and Dissolved)	7439-93-2	SW-846 6020A	5.00	µg/L
Magnesium (Total and Dissolved)	7439-95-4	SW-846 6020A	500	µg/L

Parameter	CAS No.	Method	Reporting Limit	Units
Mercury (Total and Dissolved)	7487-94-7	SW-846 7470A	0.200	µg/L
Molybdenum (Total and Dissolved)	7439-98-7	SW-846 6020A	5.00	µg/L
Nickel (Total and Dissolved)	7440-02-0	SW-846 6020A	10.0	µg/L
Potassium (Total and Dissolved)	7440-09-7	SW-846 6020A	500	µg/L
Selenium (Total and Dissolved)	7782-49-2	SW-846 6020A	5.00	µg/L
Silver (Total and Dissolved)	7440-22-4	SW-846 6020A	1.00	µg/L
Sodium (Total and Dissolved)	7440-23-5	SW-846 6020A	500	µg/L
Thallium (Total and Dissolved)	7440-28-0	SW-846 6020A	1.00	µg/L
Vanadium (Total and Dissolved)	7440-62-2	SW-846 6020A	1.00	µg/L
Zinc (Total and Dissolved)	7440-66-6	SW-846 6020A	5.00	µg/L
Radium-226	13982-63-3	EPA 903.0	1	pCi/L
Radium-228	15262-20-1	EPA 904.0	1	pCi/L
Radium-226+228	RA226/228	CALC	1	pCi/L
Alkalinity, Total	ALK	SM2320B	5.0	mg/L
Alkalinity, Carbonate	CARB	SM2320B	5.0	mg/L
Alkalinity, Bicarbonate	BICARB	SM2320B	5.0	mg/L

Notes:

CAS No. - Chemical Abstracts Service registry number
mg/L - milligrams per liter
pCi/L - picoCuries per liter
CALC - Parameter determined by calculation.

Table H-3: Quantitative QA Objectives – Groundwater

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries/ Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Filter Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals (Total and Dissolved)	SW-846 6020A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Mercury (Total and Dissolved)	SW-846 7470A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Total Dissolved Solids	SM 2540C	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Anions (Chloride, Fluoride, Sulfate)	SW-846 9056A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
pH	SW-846 Method 9040C	NA	NA	NA	NA	NA	NA	NA	±0.5 pH units
Alkalinity (Total, Carbonate, and Bicarbonate)	SM2320B	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Radium-226	EPA 903.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 904.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2

Notes:

[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS/LCSD - Laboratory Control Sample/Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
RPD - Relative Percent Difference
RER - Relative Error
RL - Reporting Limit
%R - Percent Recovery

ATTACHMENT I

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

SURFACE STREAM SAMPLING

Table I-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation	Holding Time
Surface Water	Metals (Total)	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury (Total)				28 days
	Metals (Dissolved)	250-mL HDPE	250 mL	HNO_3 to pH < 2 after filtration Cool to < 6°C	180 days
	Mercury (Dissolved)				28 days
	Anions (Chloride, Fluoride, and Sulfate)	250-mL HDPE	250 mL	Cool to < 6°C	28 days
	Radiological Parameters	3× 1-L HDPE	3000 mL	HNO_3 to pH < 2	180 days
	pH (field measurement)	NA	NA	NA	15 minutes
	Total Dissolved Solids (TDS)	250-mL HDPE	100 mL (unfiltered)	Cool to < 6°C	7 days
	Total Suspended Solids (TSS)	1 L HDPE	1000 mL (unfiltered)	Cool to < 6°C	7 days

Notes:

mL - milliliter
L - liter
HDPE - High Density Polyethylene
NA - Not applicable

Table I-2: Analytes, Methods, and Reporting Limits – Surface Water Samples

Parameter	CAS No.	Method	Reporting Limit	Units
Chloride	7647-14-5	EPA 300.0/ SW-846 9056	1.00	mg/L
Fluoride	16984-48-8	EPA 300.0/ SW-846 9056	0.10	mg/L
Sulfate	7757-82-6	EPA 300.0/ SW-846 9056	1.00	mg/L
Total Dissolved Solids	TDS	SM2540C	10.0	mg/L
Total Suspended Solids	TSS	SM2540D	10.0	mg/L
pH	pH	SW-846 Method 9040C	0.1	pH units
Antimony (Total and Dissolved)	7440-36-0	SW-846 6020A	2.00	μg/L
Arsenic (Total and Dissolved)	7440-38-2	SW-846 6020A	1.00	μg/L
Barium (Total and Dissolved)	7440-39-3	SW-846 6020A	10.0	μg/L
Beryllium (Total and Dissolved)	7440-41-7	SW-846 6020A	1.00	μg/L
Boron (Total and Dissolved)	7440-42-8	SW-846 6020A	80	μg/L
Cadmium (Total and Dissolved)	7440-43-9	SW-846 6020A	1.00	μg/L
Calcium (Total and Dissolved)	7440-70-2	SW-846 6020A	500	μg/L
Chromium (Total and Dissolved)	7440-47-3	SW-846 6020A	2.00	μg/L
Cobalt (Total and Dissolved)	7440-48-4	SW-846 6020A	0.5	μg/L
Copper (Total and Dissolved)	7440-50-8	SW-846 6020A	2.00	μg/L
Iron (Total and Dissolved)	7439-89-6	SW-846 6020A	5.00	μg/L
Lead (Total and Dissolved)	7439-92-1	SW-846 6020A	1.00	μg/L

Parameter	CAS No.	Method	Reporting Limit	Units
Lithium (Total and Dissolved)	7439-93-2	SW-846 6020A	5.00	µg/L
Magnesium (Total and Dissolved)	7439-95-4	SW-846 6020A	500	µg/L
Manganese (Total and Dissolved)	7439-96-5	SW-846 6020A	5.00	µg/L
Mercury (Total and Dissolved)	7487-94-7	SW-846 7470A	0.200	µg/L
Molybdenum (Total and Dissolved)	7439-98-7	SW-846 6020A	5.00	µg/L
Nickel (Total and Dissolved)	7440-02-0	SW-846 6020A	10.0	µg/L
Selenium (Total and Dissolved)	7782-49-2	SW-846 6020A	5.00	µg/L
Silver (Total and Dissolved)	7440-22-4	SW-846 6020A	1.00	µg/L
Thallium (Total and Dissolved)	7440-28-0	SW-846 6020A	1.00	µg/L
Vanadium (Total and Dissolved)	7440-62-2	SW-846 6020A	1.00	µg/L
Zinc (Total and Dissolved)	7440-66-6	SW-846 6020A	5.00	µg/L
Radium-226	13982-63-3	EPA 903.0	1	pCi/L
Radium-228	15262-20-1	EPA 904.0	1	pCi/L
Radium-226+228	RA226/228	CALC	1	pCi/L

Notes:

CAS No.	-	Chemical Abstracts Service registry number
mg/L	-	milligrams per liter
pCi/L	-	picoCuries per liter
CALC	-	Parameter determined by calculation.

Table I-3: Quantitative QA Objectives – Surface Water

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries/ Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Filter Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals (Total and Dissolved)	SW-846 6020A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Mercury (Total and Dissolved)	SW-846 7470A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Total Dissolved Solids	SM 2540C	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Total Suspended Solids	SM 2540D	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Anions (Chloride, Fluoride, Sulfate)	SW-846 9056A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
pH	SW-846 Method 9040C	NA	NA	NA	NA	NA	NA	NA	±0.5 pH units
Radium-226	EPA 903.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 904.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2

Notes:

[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RER - Relative Error
RL - Reporting Limit
%R - Percent Recovery

ATTACHMENT J

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

BENTHIC INVERTEBRATE SAMPLING

Table J-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation	Holding Time
Sediment	Metals	4-oz glass	5 g	Cool to < 6°C	180 days
	Mercury				28 days
	Radiological Parameters	16-oz glass	20 g	NA	180 days
	Anions (Chloride, Fluoride, and Sulfate)	4-oz glass	5 g	Cool to < 6°C	28 days
	pH				NA*
	Percent Ash	4-oz glass	5 g	NA	NA
Mayflies and Benthic Invertebrates	Metals	4-oz glass	5 g	Frozen < -10°C	1 year
	Mercury		1 g		
	Percent Moisture		5 g (2 g minimum)		
Aqueous Blanks[1]	Metals	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury				28 days
	Anions (Chloride, Fluoride, and Sulfate)	250-mL HDPE	250 mL	Cool to < 6°C	28 days
	Radiological Parameters	3× 1-L HDPE	3000 mL	HNO_3 to pH < 2	180 days

Notes:

oz - ounce
WM - wide-mouth
g - grams
HDPE - High Density Polyethylene
NA - Not applicable.

1 Aqueous equipment blanks will be analyzed for the same parameters as the associated investigatory samples.

* Soil samples will be tested in the field using field pH test kits, 10% of the sample locations will have confirmation samples submitted for laboratory analysis of pH and will have paste prepared in the laboratory so that analysis can be completed within the holding time (15 minutes following creation of soil paste).

Table J-2: Analytes, Methods, and Reporting Limits – Sediment Samples

Parameter	CAS No.	Method	Reporting Limit[1]	Units
Antimony	7440-36-0	SW-846 6020A	0.200	mg/kg
Arsenic	7440-38-2	SW-846 6020A	0.100	mg/kg
Barium	7440-39-3	SW-846 6020A	1.00	mg/kg
Beryllium	7440-41-7	SW-846 6020A	0.100	mg/kg
Boron	7440-42-8	SW-846 6020A	8.0	mg/kg
Cadmium	7440-43-9	SW-846 6020A	0.100	mg/kg
Calcium	7440-70-2	SW-846 6020A	50.0	mg/kg
Chromium	7440-47-3	SW-846 6020A	0.200	mg/kg
Cobalt	7440-48-4	SW-846 6020A	0.0500	mg/kg
Copper	7440-50-8	SW-846 6020A	0.200	mg/kg
Lead	7439-92-1	SW-846 6020A	0.100	mg/kg
Lithium	7439-93-2	SW-846 6020A	0.500	mg/kg
Mercury	7487-94-7	SW-846 7471B	0.0330	mg/kg
Molybdenum	7439-98-7	SW-846 6020A	0.500	mg/kg
Nickel	7440-02-0	SW-846 6020A	0.100	mg/kg
Selenium	7782-49-2	SW-846 6020A	0.500	mg/kg
Silver	7440-22-4	SW-846 6020A	0.100	mg/kg
Strontium	7440-24-6	SW-846 6020A	0.5	mg/kg
Thallium	7440-28-0	SW-846 6020A	0.100	mg/kg
Vanadium	7440-62-2	SW-846 6020A	0.100	mg/kg
Zinc	7440-66-6	SW-846 6020A	0.500	mg/kg
Radium-226	13982-63-3	EPA 901.1	1.00	pCi/g
Radium-228	15262-20-1	EPA 901.1	1.00	pCi/g
Radium-226+228	RA226/228	CALC	1.00	pCi/g
Percent Ash	%ASH	R.J. Lee SOP OPT23.02	1	%
Chloride	16887-00-6	SW-846 9056A Modified	10.0	mg/kg
Fluoride	16984-48-8	SW-846 9056A Modified	1.0	mg/kg
Sulfate	14808-79-8	SW-846 9056A Modified	10.0	mg/kg
pH	PH	SW-846 9045D Modified (laboratory-based definitive analysis)	0.1	pH units

Notes:

CAS No. - Chemical Abstracts Service registry number
mg/kg - milligrams per kilogram
pCi/g - picoCuries per gram
CALC - Parameter determined by calculation

1 Samples will be reported on a dry-weight basis; sample-specific reporting limits will vary based on sample mass, dilution factors, and percent moisture.

Table J-3: Analytes, Methods, and Reporting Limits – Mayflies and Benthic Invertebrates

Parameter	CAS No.	Method	Reporting Limit[1]	Units
Antimony	7440-36-0	SW-846 6020A	0.5	mg/kg
Arsenic	7440-38-2	SW-846 6020A	0.5	mg/kg
Barium	7440-39-3	SW-846 6020A	0.5	mg/kg
Beryllium	7440-41-7	SW-846 6020A	0.5	mg/kg
Boron	7440-42-8	SW-846 6020A	0.5	mg/kg
Cadmium	7440-43-9	SW-846 6020A	0.5	mg/kg
Calcium	7440-70-2	SW-846 6020A	0.5	mg/kg
Chromium	7440-47-3	SW-846 6020A	0.5	mg/kg
Cobalt	7440-48-4	SW-846 6020A	0.5	mg/kg
Copper	7440-50-8	SW-846 6020A	0.5	mg/kg
Lead	7439-92-1	SW-846 6020A	0.5	mg/kg
Lithium	7439-93-2	SW-846 6020A	0.5	mg/kg
Mercury	7487-94-7	SW-846 7473	0.5	mg/kg
Molybdenum	7439-98-7	SW-846 6020A	0.5	mg/kg
Nickel	7440-02-0	SW-846 6020A	0.5	mg/kg
Selenium	7782-49-2	SW-846 6020A	0.5	mg/kg
Silver	7440-22-4	SW-846 6020A	0.5	mg/kg
Thallium	7440-28-0	SW-846 6020A	0.5	mg/kg
Vanadium	7440-62-2	SW-846 6020A	0.5	mg/kg
Zinc	7440-66-6	SW-846 6020A	0.5	mg/kg
Percent Moisture	MOISTURE	ASTM D2974-87	0.1	%

Notes:

CAS No. - Chemical Abstracts Service registry number
mg/kg - milligrams per kilogram

1 Samples will be reported on a wet-weight basis; sample-specific reporting limits will vary based on sample mass, dilution factors, and percent moisture.

Table J-4: Quantitative QA Objectives – Sediment Samples

Analyte/ Parameter Group	Method	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Percent Ash	R.J. Lee SOP OPT23.02	< RL	NA	NA	NA	NA	±10%	RPD < 35% difference < 2× the RL
Metals	SW-846 6020A	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Mercury	SW-846 7471B	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Radium-226	EPA 901.1	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 901.1	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Anions	SW-846 9056A Modified	< RL	80-120	75-125	35	35	20	RPD < 35% difference < 2× the RL
pH	SW-846 9045D Modified (laboratory-based definitive analysis)	pH 6-8 for laboratory-supplied DI water	NA	NA	NA	NA	±0.2 pH units	±0.5 pH units

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RER - Relative Error
RL - Reporting Limit
%R - Percent Recovery

Table J-5: Quantitative QA Objectives – Mayflies and Benthic Invertebrate Samples

Analyte/ Parameter Group	Method	Equipment Rinsate Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals	SW-846 6020A	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Mercury	SW-846 7473	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Percent Moisture	ASTM D2974-87	< RL	NA	NA	NA	NA	10	RPD < 35% difference < 2× the RL

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RL - Reporting Limit
%R - Percent Recovery

ATTACHMENT K

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

FISH TISSUE SAMPLING

Table K-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation	Holding Time
Fish Tissue	Metals	Resealable plastic bag or 8-oz WM jar for filets Resealable plastic bag or small WM jar (1 to 4-oz) for liver/ovary tissue	5 g	During sample collection and transportation to the laboratory, cool to < 6°C After receipt at the laboratory, freeze at < -20°C	1 year
	Mercury		1 g		
	Percent Moisture		2 g[1]		
Aqueous Blanks	Metals	250-mL HDPE	250 mL	HNO_3 to pH < 2 Cool to < 6°C	180 days
	Mercury				28 days

Notes:

oz - ounce
WM - wide-mouth
g - grams
HDPE - High Density Polyethylene
NA - Not applicable.

1 A minimum of 2 grams is required for moisture analysis when sufficient sample mass is available. For samples with limited mass (*e.g.*, liver or ovary tissue), moisture analysis will be performed on a minimum 1-gram mass.

Table K-2: Analytes, Methods, and Reporting Limits – Fish Tissue Samples

Parameter	CAS No.	Method	Reporting Limit[1]	Units
Antimony	7440-36-0	SW-846 6020A	0.5	mg/kg
Arsenic	7440-38-2	SW-846 6020A	0.5	mg/kg
Barium	7440-39-3	SW-846 6020A	1.0	mg/kg
Beryllium	7440-41-7	SW-846 6020A	0.5	mg/kg
Boron	7440-42-8	SW-846 6020A	0.5	mg/kg
Cadmium	7440-43-9	SW-846 6020A	0.5	mg/kg
Calcium	7440-70-2	SW-846 6020A	84	mg/kg
Chromium	7440-47-3	SW-846 6020A	0.5	mg/kg
Cobalt	7440-48-4	SW-846 6020A	0.5	mg/kg
Copper	7440-50-8	SW-846 6020A	0.5	mg/kg
Lead	7439-92-1	SW-846 6020A	0.5	mg/kg
Lithium	7439-93-2	SW-846 6020A	0.5	mg/kg
Mercury	7487-94-7	SW-846 7473	0.02	mg/kg
Molybdenum	7439-98-7	SW-846 6020A	0.5	mg/kg
Nickel	7440-02-0	SW-846 6020A	0.5	mg/kg
Selenium	7782-49-2	SW-846 6020A	0.5	mg/kg
Silver	7440-22-4	SW-846 6020A	0.5	mg/kg
Strontium	7440-24-6	SW-846 6020A	0.5	mg/kg
Thallium	7440-28-0	SW-846 6020A	0.5	mg/kg
Vanadium	7440-62-2	SW-846 6020A	0.5	mg/kg
Zinc	7440-66-6	SW-846 6020A	5.8	mg/kg
Percent Moisture	MOISTURE	ASTM D2974-87	0.1	%

Notes:

CAS No. - Chemical Abstracts Service registry number
mg/kg - milligrams per kilogram

1 Samples will be reported on a wet-weight basis; sample-specific reporting limits will vary based on sample mass, dilution factors, and percent moisture.

Table K-3: Quantitative QA Objectives – Fish Tissue Samples

Analyte/ Parameter Group	Method	Equipment Rinsate Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals	SW-846 6020A	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Mercury	SW-846 7473	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Percent Moisture	ASTM D2974-87	< RL	NA	NA	NA	NA	10	RPD < 35% difference < 2× the RL

Notes:

[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RL - Reporting Limit
%R - Percent Recovery

ATTACHMENT L

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

SEEP SAMPLING

Table L-1. Sample Containers, Mass, Preservation, and Holding Time Requirements

<table>
<tr><th>Matrix</th><th>Parameter(s)</th><th>Container Type</th><th>Recommended Sample Mass/Volume</th><th>Preservation[1]</th><th>Holding Time</th></tr>
<tr><td rowspan="8">Seep Water</td><td>Metals</td><td rowspan="2">250-mL HDPE</td><td rowspan="2">250 mL</td><td rowspan="2">HNO_3 to pH < 2
Cool to < 6°C</td><td>180 days</td></tr>
<tr><td>Mercury</td><td>28 days</td></tr>
<tr><td>Anions (Chloride, Fluoride, and Sulfate)</td><td>250-mL HDPE</td><td>250 mL</td><td>Cool to < 6°C</td><td>28 days</td></tr>
<tr><td>Radiological Parameters</td><td>3× 1-L HDPE</td><td>3000 mL</td><td>HNO_3 to pH < 2</td><td>180 days</td></tr>
<tr><td>pH (field measurement)</td><td>NA</td><td>NA</td><td>NA</td><td>15 minutes</td></tr>
<tr><td>Total Dissolved Solids (TDS)[2]</td><td>250-mL HDPE</td><td>100 mL (unfiltered)</td><td>Cool to < 6°C</td><td>7 days</td></tr>
<tr><td>Total Suspended Solids (TSS)</td><td>1 L HDPE</td><td>1000 mL (unfiltered)</td><td>Cool to < 6°C</td><td>7 days</td></tr>
<tr><td rowspan="6">Seep Soil</td><td>Metals</td><td rowspan="2">4-oz glass</td><td rowspan="2">5 g</td><td rowspan="2">Cool to < 6°C</td><td>180 days</td></tr>
<tr><td>Mercury</td><td>28 days</td></tr>
<tr><td>Radiological Parameters</td><td>16-oz glass</td><td>20 g</td><td>NA</td><td>180 days</td></tr>
<tr><td>Anions (Chloride, Fluoride, and Sulfate)</td><td rowspan="2">4-oz glass</td><td rowspan="2">5 g</td><td rowspan="2">Cool to < 6°C</td><td>28 days</td></tr>
<tr><td>pH</td><td>NA*</td></tr>
<tr><td>Percent Ash</td><td>4-oz glass</td><td>5 g</td><td>NA</td><td>NA</td></tr>
</table>

Notes:

HDPE - High Density Polyethylene.
g - grams
mL - milliliters
L - liters
NA - Not applicable.

[1] Filtered samples requiring chemical preservation will be preserved after field filtration.

[2] TDS will be performed using unfiltered sample volume.

*Holding time for soil pH samples is 15 minutes following creation of soil paste. Soil samples will be tested in the field using field pH test kits, 10% of the sample locations will have confirmation samples submitted for laboratory analysis of pH and will have paste prepared in the laboratory so that analysis can be completed within the holding time.

Table L-2: Analytes, Methods, and Reporting Limits – Seep Soil

Parameter	CAS No.	Method	Reporting Limit[1]	Units
Antimony	7440-36-0	SW-846 6020A	0.200	mg/kg
Arsenic	7440-38-2	SW-846 6020A	0.100	mg/kg
Barium	7440-39-3	SW-846 6020A	1.00	mg/kg
Beryllium	7440-41-7	SW-846 6020A	0.100	mg/kg
Boron	7440-42-8	SW-846 6020A	8.0	mg/kg
Cadmium	7440-43-9	SW-846 6020A	0.100	mg/kg
Calcium	7440-70-2	SW-846 6020A	50.0	mg/kg
Chromium	7440-47-3	SW-846 6020A	0.200	mg/kg
Cobalt	7440-48-4	SW-846 6020A	0.0500	mg/kg
Copper	7440-50-8	SW-846 6020A	0.200	mg/kg
Lead	7439-92-1	SW-846 6020A	0.100	mg/kg
Lithium	7439-93-2	SW-846 6020A	0.500	mg/kg
Mercury	7487-94-7	SW-846 7471B	0.0330	mg/kg
Molybdenum	7439-98-7	SW-846 6020A	0.500	mg/kg
Nickel	7440-02-0	SW-846 6020A	0.100	mg/kg
Selenium	7782-49-2	SW-846 6020A	0.500	mg/kg
Silver	7440-22-4	SW-846 6020A	0.100	mg/kg
Sodium	7440-23-5	SW-846 6020A	50.0	mg/kg
Thallium	7440-28-0	SW-846 6020A	0.100	mg/kg
Vanadium	7440-62-2	SW-846 6020A	0.100	mg/kg
Zinc	7440-66-6	SW-846 6020A	0.500	mg/kg
Radium-226	13982-63-3	EPA 901.1	1.00	pCi/g
Radium-228	15262-20-1	EPA 901.1	1.00	pCi/g
Radium-226+228	RA226/228	CALC	1.00	pCi/g
Percent Ash	%ASH	R.J. Lee SOP OPT23.02	1	%
Chloride	16887-00-6	SW-846 9056A Modified	10.0	mg/kg
Fluoride	16984-48-8	SW-846 9056A Modified	1.0	mg/kg
Sulfate	14808-79-8	SW-846 9056A Modified	10.0	mg/kg
pH	PH	SW-846 9045D Modified (laboratory-based definitive analysis)	0.1	pH units

Notes:

CAS No. - Chemical Abstracts Service registry number
mg/kg - milligrams per kilogram
pCi/g - picoCuries per gram
CALC - Parameter determined by calculation

1 Samples will be reported on a dry-weight basis; sample-specific reporting limits will vary based on sample mass, dilution factors, and percent moisture.

Table L-3: Analytes, Methods, and Reporting Limits – Seep Water Samples

Parameter	CAS No.	Method	Reporting Limit	Units
Chloride	7647-14-5	EPA 300.0/ SW-846 9056	1.00	mg/L
Fluoride	16984-48-8	EPA 300.0/ SW-846 9056	0.10	mg/L
Sulfate	7757-82-6	EPA 300.0/ SW-846 9056	1.00	mg/L
Total Dissolved Solids[1]	TDS	SM2540C	10.0	mg/L
Total Suspended Solids	TSS	SM2540D	10.0	mg/L
pH	pH	SW-846 Method 9040C	0.05	pH units
Antimony (Total and Dissolved)	7440-36-0	SW-846 6020A	2.00	µg/L
Arsenic (Total and Dissolved)	7440-38-2	SW-846 6020A	1.00	µg/L
Barium (Total and Dissolved)	7440-39-3	SW-846 6020A	10	µg/L
Beryllium (Total and Dissolved)	7440-41-7	SW-846 6020A	1.00	µg/L
Boron (Total and Dissolved)	7440-42-8	SW-846 6020A	80	µg/L
Cadmium (Total and Dissolved)	7440-43-9	SW-846 6020A	1.00	µg/L
Calcium (Total and Dissolved)	7440-70-2	SW-846 6020A	500	µg/L
Chromium (Total and Dissolved)	7440-47-3	SW-846 6020A	2.00	µg/L
Cobalt (Total and Dissolved)	7440-48-4	SW-846 6020A	0.5	µg/L
Copper (Total and Dissolved)	7440-50-8	SW-846 6020A	2.00	µg/L
Lead (Total and Dissolved)	7439-92-1	SW-846 6020A	1.00	µg/L
Lithium (Total and Dissolved)	7439-93-2	SW-846 6020A	5.00	µg/L
Mercury (Total and Dissolved)	7487-94-7	SW-846 7470A	0.200	µg/L
Molybdenum (Total and Dissolved)	7439-98-7	SW-846 6020A	5.00	µg/L
Nickel (Total and Dissolved)	7440-02-0	SW-846 6020A	10	µg/L
Selenium (Total and Dissolved)	7782-49-2	SW-846 6020A	5.00	µg/L
Silver (Total and Dissolved)	7440-22-4	SW-846 6020A	1.00	µg/L
Thallium (Total and Dissolved)	7440-28-0	SW-846 6020A	1.00	µg/L

Parameter	CAS No.	Method	Reporting Limit	Units
Vanadium (Total and Dissolved)	7440-62-2	SW-846 6020A	1.00	µg/L
Zinc (Total and Dissolved)	7440-66-6	SW-846 6020A	5.00	µg/L
Radium-226	13982-63-3	EPA 903.0	1	pCi/L
Radium-228	15262-20-1	EPA 904.0	1	pCi/L
Radium-226+228	RA226/228	CALC	1	pCi/L

Notes:

CAS No. - Chemical Abstracts Service registry number
mg/L - milligrams per liter
pCi/L - picoCuries per liter
CALC - Parameter determined by calculation

[1] TDS will be performed on unfiltered sample volume only.

Table L-4: Quantitative QA Objectives – Seep Soil Samples

Analyte/ Parameter Group	Method	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Percent Ash	R.J. Lee SOP OPT23.02	< RL	NA	NA	NA	NA	±10%	RPD < 35% difference < 2× the RL
Metals	SW-846 6020A	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Mercury	SW-846 7471B	< RL	80-120	75-125	35	35	35	RPD < 35% difference < 2× the RL
Radium-226	EPA 901.1	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 901.1	< RL	75-125	NA	RER < 2	NA	RER < 2	RER < 2
Anions	SW-846 9056A Modified	< RL	80-120	75-125	35	35	20	RPD < 35% difference < 2× the RL
pH	SW-846 9045D Modified (laboratory-based definitive analysis)	pH 6-8 for laboratory-supplied deionized water	NA	NA	NA	NA	±0.2 pH units	±0.5 pH units

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
LCSD - Laboratory Control Sample Duplicate
MS/MSD - Matrix Spike/Matrix Spike Duplicate
NA - Not Applicable
RPD - Relative Percent Difference
RER - Relative Error
RL - Reporting Limit
%R - Percent Recovery

Table L-5: Quantitative QA Objectives – Seep Water Samples

Analyte/ Parameter Group	Method	Surrogate Compound Recoveries/ Chemical Yield (%)	Equipment Rinsate Blank, Field Blank, Method Blank	LCS Accuracy (% R)	MS/MSD Accuracy (% R)	LCS/LCSD Precision (RPD)	MS/MSD Precision (RPD)	Laboratory Duplicate Precision (RPD)	Field Duplicate Precision[1]
Metals ((Total and Dissolved)	SW-846 6020A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Mercury (Total and Dissolved)	SW-846 7470	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
Total Dissolved Solids	SM 2540C	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Total Suspended Solids	SM 2540D	NA	< RL	80-120	NA	20	NA	20	RPD < 20% difference < the RL
Anions (Chloride, Fluoride, Sulfate)	SW-846 9056A	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < the RL
pH	SW-846 Method 9040C	NA	NA	NA	NA	NA	NA	NA	±0.5 pH units
Radium-226	EPA 903.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2
Radium-228	EPA 904.0	30-110	< RL	80-120	NA	RER < 2	NA	RER < 2	RER < 2

Notes:
[1] When both field duplicate results are > 5× the RL, the RPD must be < 20%. When at least one result is < 5× the RL, the difference must be < the RL

LCS - Laboratory Control Sample
MS/MSD - Matrix Spike/Matrix Spike Duplicate
RPD - Relative Percent Difference
RER - Relative Error

APPENDIX D
EXHIBITS

Exhibit No.
1

Title
Existing and Closed Wells
Johnsonville Fossil Plant

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

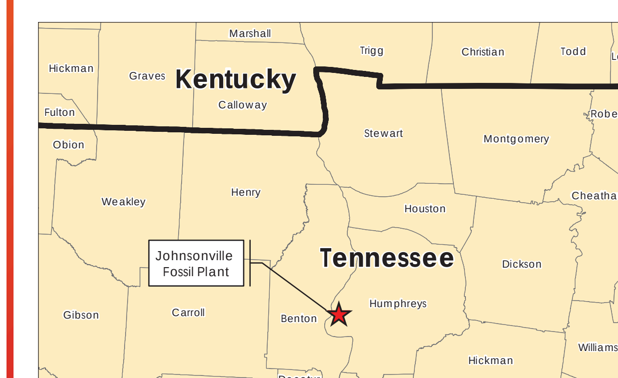
Project Location 175567296
New Johnsonville, Tennessee
Prepared by LMB on 2018-04-11
Technical Review by ZW on 2018-04-11

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

Legend

- Closed Well
- CCR Well
- CCR/State Monitoring Well
- State Compliance Monitoring Well
- Observation Well
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TVA (2017) & ESRI Basemaps



U:\175567296\gis\mxds\JOF_Existing_Closed_Wells.mxd Revised: 2018-04-11 By: TRink

Exhibit No.
2

Title
Proposed Groundwater Well Locations Johnsonville Fossil Plant

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

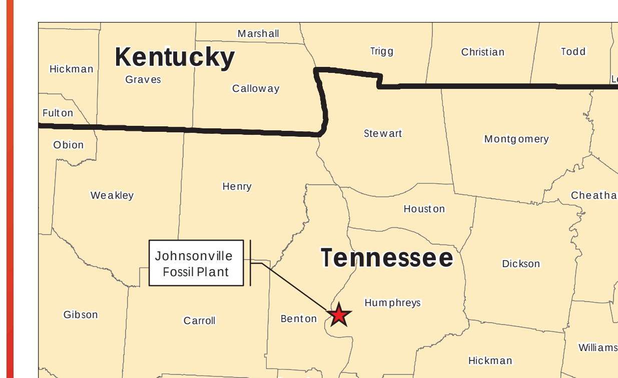
0 700 1,400 2,100 2,800 Feet
1:8,406 (At original document size of 22x34)

Legend

- Proposed Vibrating Wire Piezometer
- Proposed Groundwater Monitoring Well
- CCR Well
- CCR/State Monitoring Well
- State Compliance Monitoring Well
- Observation Well
- Surface Water Gauging Station
- TVA Property Boundary
- CCR Unit Boundary (Approximate)
- Coal Yard

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TVA (2017) & ESRI Basemaps
3. JOF-115 is a proposed alternate background monitoring well location.



Stantec

TVA

U:\TVA-EP\175567296\gis\mxds\JOF_Proposed_Groundwater_Wells_PZs.mxd Revised: 2018-12-06 By: mbough

Exhibit No.
3

Title **Existing Borings**
Ash Disposal Area 1, Coal Yard, & DuPont Road Dredge Cell

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-11
Technical Review by ZW on 2018-01-11

0 300 600 900 1,200 Feet

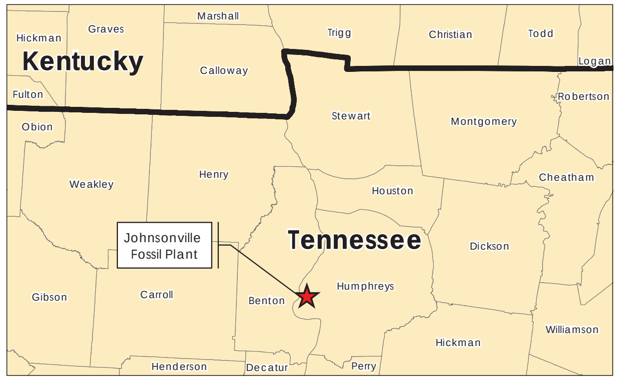
1:3,600 (At original document size of 22x34)

Legend

- Existing Boring
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

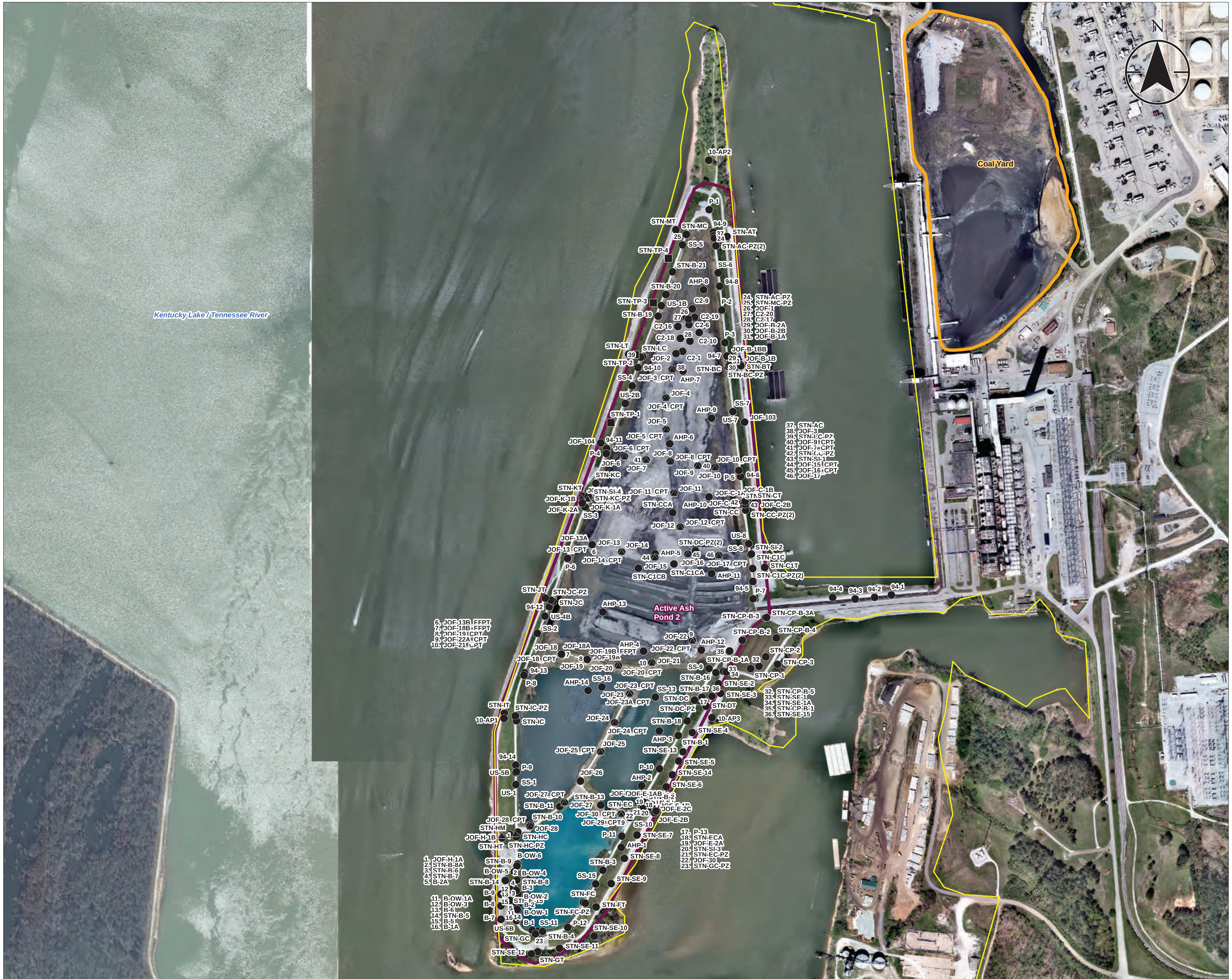
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec

TVA

V:\TVA-EIP\175567296\gis\mxds\JOF_Existing_Borings_AshArea1_CY_Dupont.mxd Revised: 2018-01-11 By: mbough



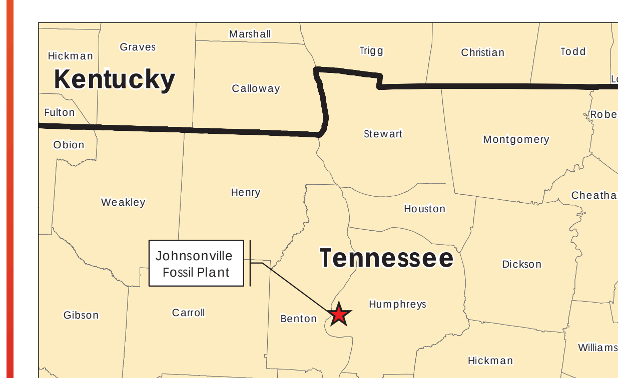


Exhibit No.

4

Title

Existing Borings
Active Ash Pond 2

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296

Prepared by LMB on 2017-12-19
Technical Review by ZW on 2017-12-19

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Existing Boring
- Existing CPT
- Existing Test Pit
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)

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Exhibit No.
5

Title
Existing Borings
South Rail Loop Area 4

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2017-12-19
Technical Review by ZW on 2017-12-19

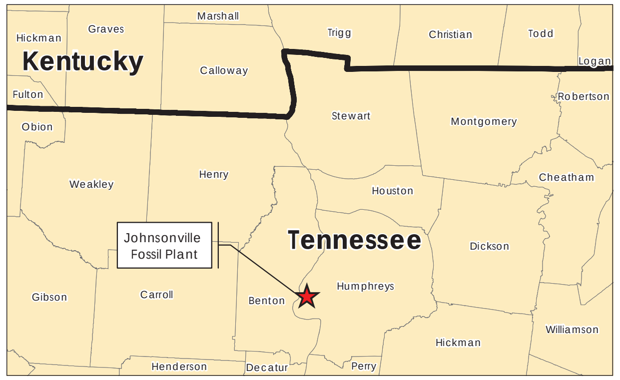
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Existing Boring
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

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Exhibit No.
6

Title
Existing CCR Thickness Boring Data Ash Disposal Area 1, Coal Yard, & DuPont Road Dredge Cell

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location 175567296

New Johnsonville, Tennessee

Prepared by LMB on 2018-01-05
Technical Review by ZW on 2018-01-05

0 300 600 900 1,200 Feet

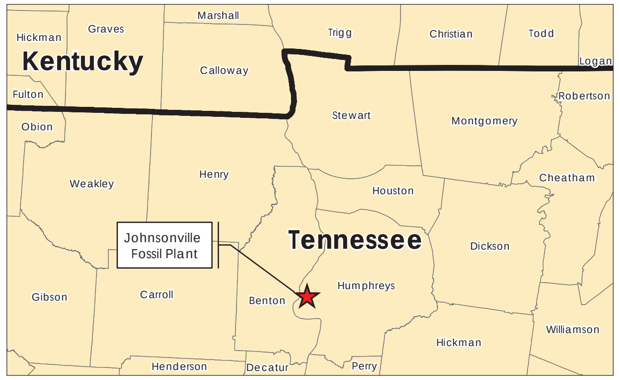
1:3,600 (At original document size of 22x34)

Legend

- Boring with CCR Thickness Data
- Boring - CCR Not Encountered (Coal Yard only)
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

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Exhibit No.
7

Title

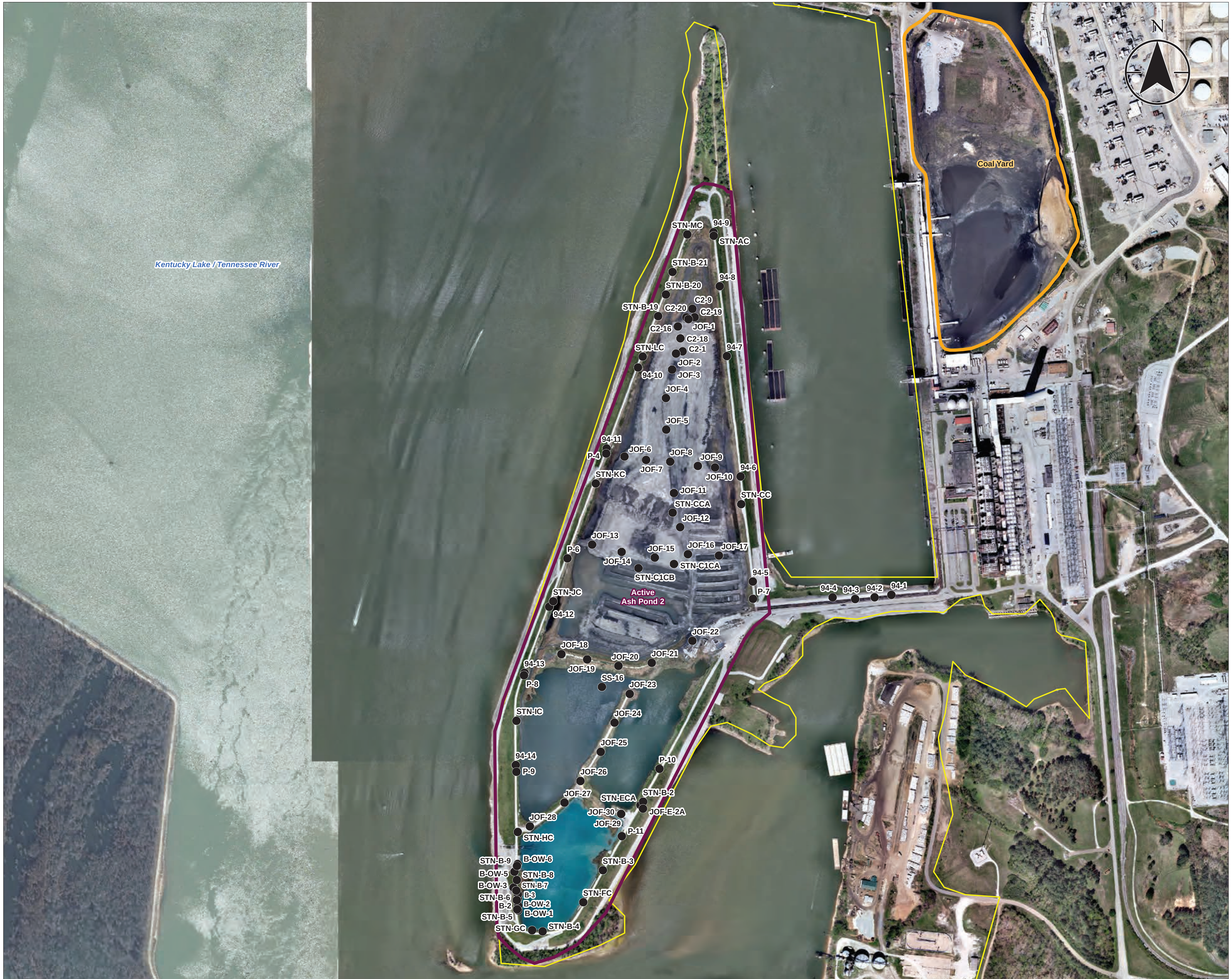
Existing CCR Thickness Boring Data Active Ash Pond 2

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location 175567296
New Johnsonville, Tennessee
Prepared by LMB on 2017-12-19
Technical Review by ZW on 2017-12-19

0 400 800 1,200 1,600 Feet
1:3,600 (At original document size of 22x34)

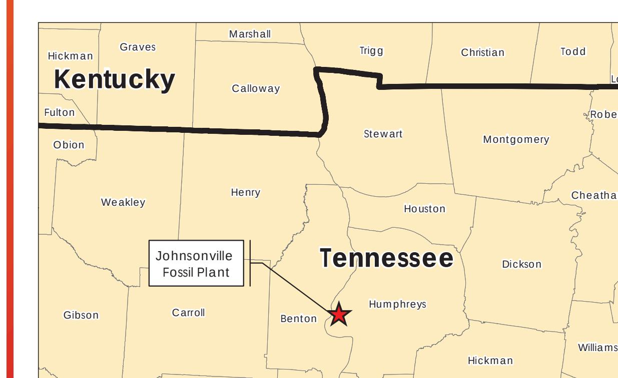


Legend

- Boring with CCR Thickness Data
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

U:\TVA-EP\175567296\gis\mxds\Dec_REV\JOF_CCR_AshPond2.mxd Revised: 2017-12-19 By: mbough

Exhibit No.
8

Title

Existing CCR Thickness Boring Data South Rail Loop Area 4

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296
Prepared by LMB on 2017-12-18
Technical Review by ZW on 2017-12-18

0 300 600 900 1,200 Feet

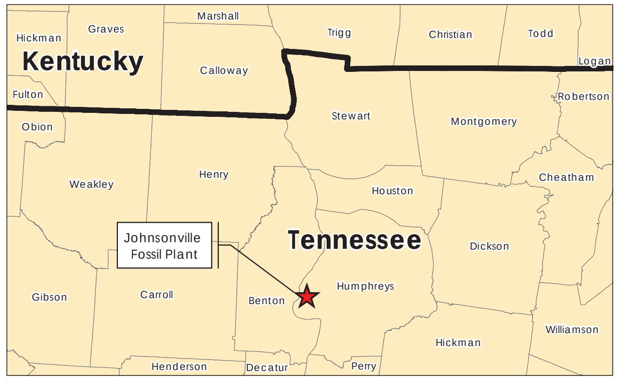
1:3,600 (At original document size of 22x34)

Legend

- Boring with CCR Thickness Data
- CCR Unit Boundary (Approximate)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

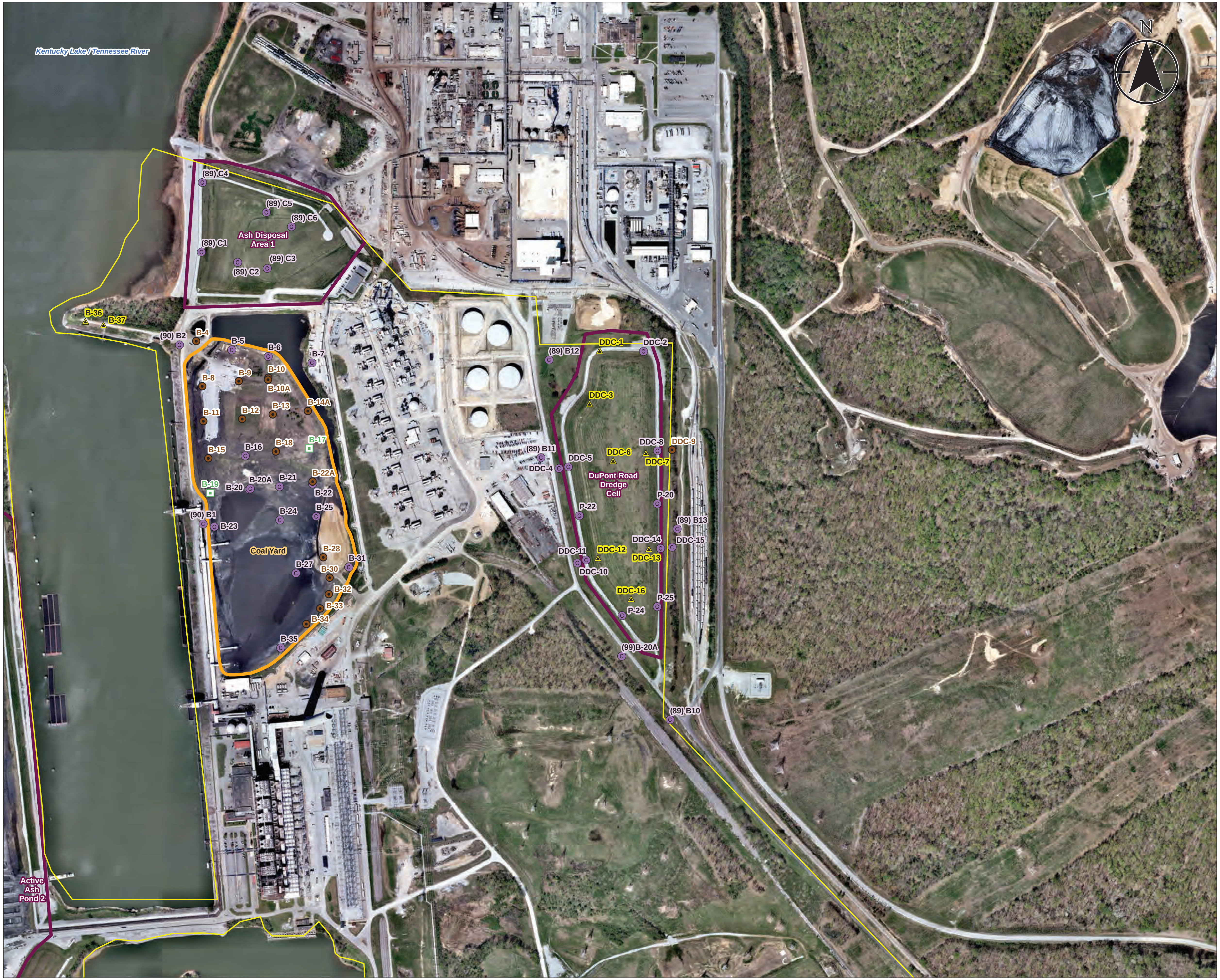


Exhibit No.
9

Title **Uppermost Foundation Soil Data Ash Disposal Area 1, Coal Yard, & DuPont Road Dredge Cell**

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location | 175567296
New Johnsonville, Tennessee

Prepared by LMB on 2018-01-05
Technical Review by ZW on 2018-01-05

0 300 600 900 1,200 Feet

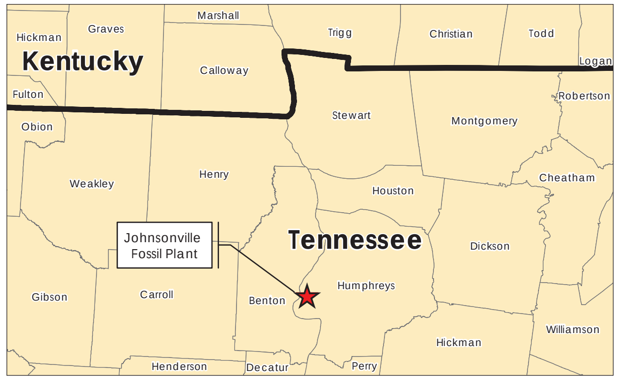
1:3,600 (At original document size of 22x34)

Legend

- Alluvial Clay and Silt — Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]
- Alluvial Sand and Gravel — Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]
- Bedrock — Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]
- Clayey Fill — Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec

TVA

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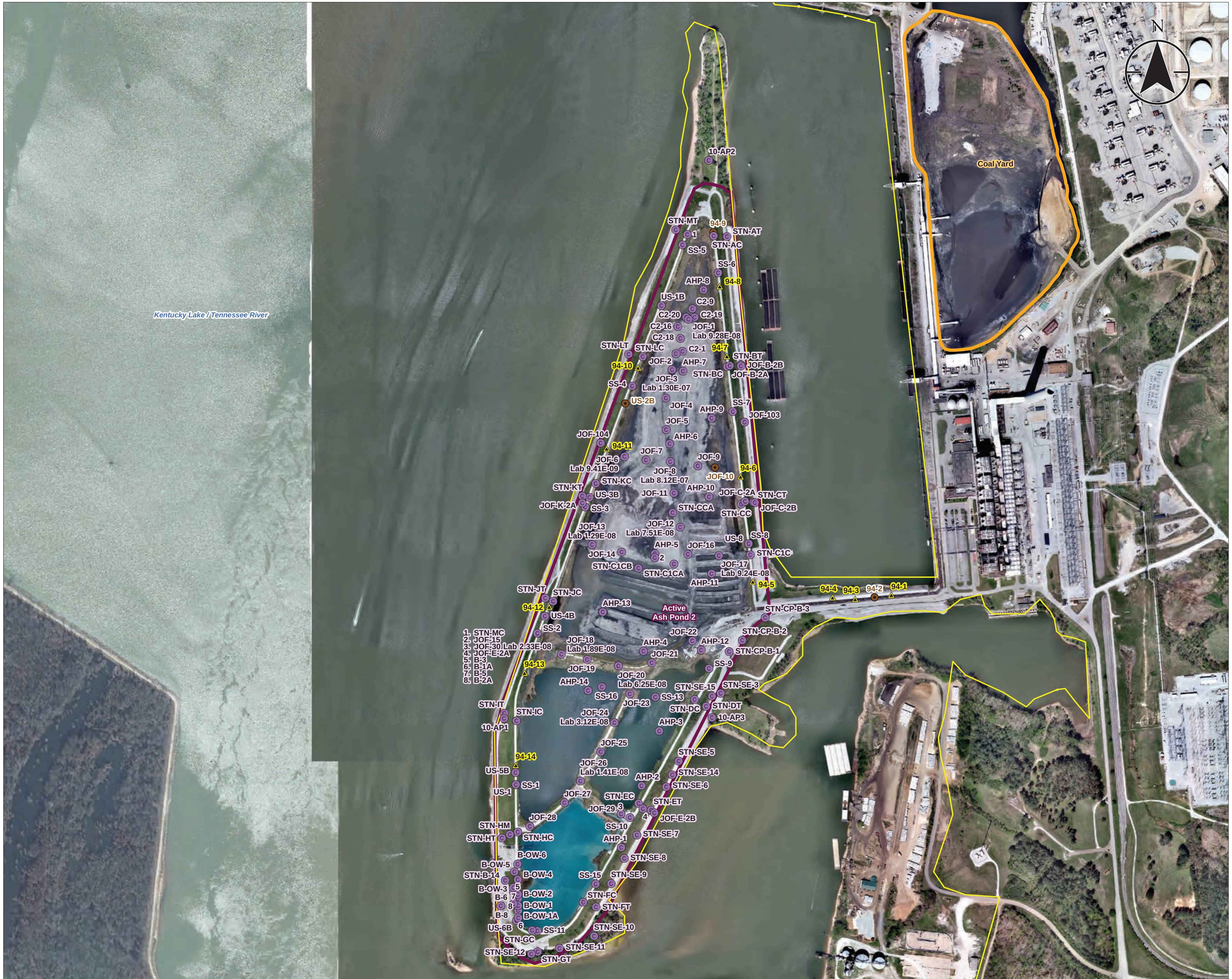

Exhibit No.
10

Title

Uppermost Foundation Soil Data Active Ash Pond 2

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2017-12-18
Technical Review by ZW on 2017-12-18

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

Legend

Alluvial Clay and Silt		*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Alluvial Sand and Gravel		*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Clayey Fill		*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*

CCR Unit Boundary (Approximate)
Coal Yard
TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)

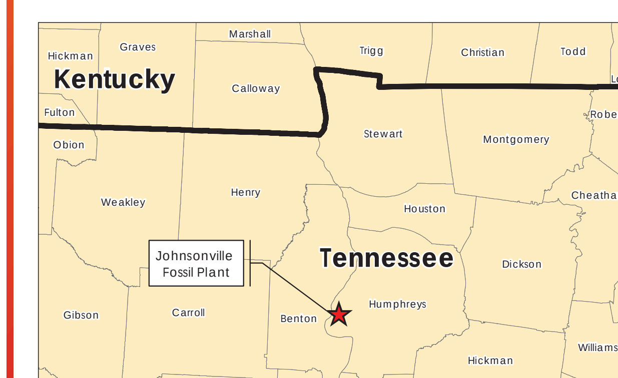

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Exhibit No.
11

Title
Uppermost Foundation Soil Data South Rail Loop Area 4

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2017-12-18
Technical Review by ZW on 2017-12-18

0 300 600 900 1,200
Feet

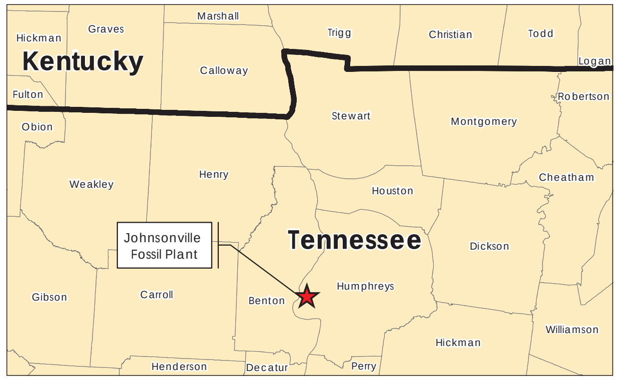
1:3,600 (At original document size of 22x34)

Legend

Alluvial Clay and Silt	●	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Alluvial Sand and Gravel	●	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
	CCR Unit Boundary (Approximate)	
	TVA Property Boundary	

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

U:\TVA-EIP\175567296\gis\mxds\Dec_REV\JOF_FoundationSoils_SouthRailLoop.mxd Revised: 2017-12-18 By: mbough

Exhibit No.
12

Title
Existing Top of Rock Elevation Boring Data Ash Disposal Area 1, Coal Yard, & DuPont Road Dredge Cell

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-05
Technical Review by ZW on 2018-01-05

0 300 600 900 1,200 Feet

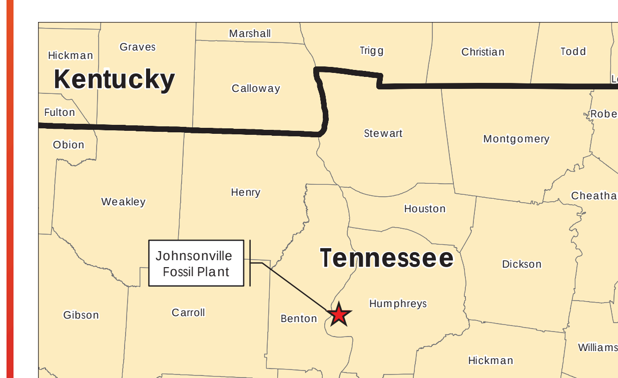
1:3,600 (At original document size of 22x34)

Legend

- Boring without Rock Core Data *[ID, TOR Elevation]*
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary
- D -Devonian Formations, includes Pegram Formation, Camden Formation, Harriman Formation, Flat Gap Limestone, and Ross Formation
- Mfp - Fort Payne Formation or Fort Payne Formation and Chattanooga Shale
- Msw - St. Louis Limestone and Warsaw Limestone
- Qal - Alluvial deposits

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)
3. Geologic Data downloaded from https://mrdata.usgs.gov/geology/state/state.php?state=TN



Stantec TVA

Exhibit No.

13

Title

Existing Top of Rock Elevation Boring Data Active Ash Pond 2

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296

Prepared by LMB on 2017-12-19
Technical Review by ZW on 2017-12-19

0 300 600 900 1,200 Feet

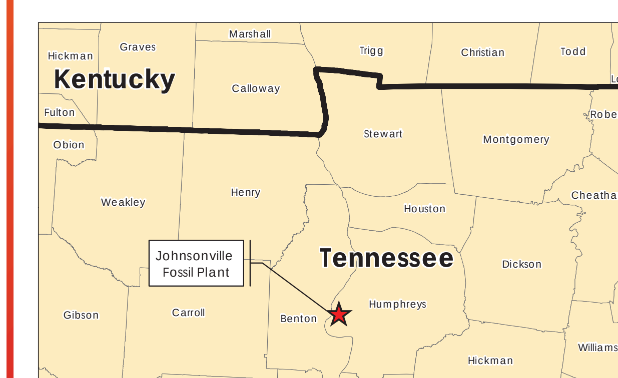
1:3,600 (At original document size of 22x34)

Legend

- Boring without Rock Core Data [ID, TOR Elevation]
- Boring with Rock Core Data
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary
- D -Devonian Formations, includes Pegram Formation, Camden Formation, Harriman Formation, Flat Gap Limestone, and Ross Formation
- Qal - Alluvial deposits

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)
3. Geologic Data downloaded from https://mrdata.usgs.gov/geology/state/state.php?state=TN



Stantec TVA

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Exhibit No.
14

Title

Existing Top of Rock Elevation Boring Data South Rail Loop Area 4

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2017-12-19
Technical Review by ZW on 2017-12-19

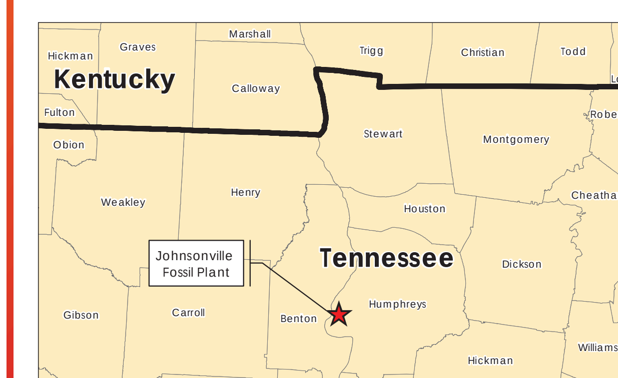
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Boring without Rock Core Data *[ID, TOR Elevation]*
- TVA Property Boundary
- CCR Unit Boundary (Approximate)
- D -Devonian Formations, includes Pegram Formation, Camden Formation, Harriman Formation, Flat Gap Limestone, and Ross Formation
- Mfp - Fort Payne Formation or Fort Payne Formation and Chattanooga Shale
- Msw - St. Louis Limestone and Warsaw Limestone
- Qal - Alluvial deposits

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)
3. Geologic Data downloaded from https://mrdata.usgs.gov/geology/state/state.php?state=TN



Stantec TVA

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Exhibit No.
15

Title **Proposed Slug Testing in Existing Piezometers and Monitoring Wells Active Ash Pond 2**

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-05-02
Technical Review by ZW on 2018-05-02

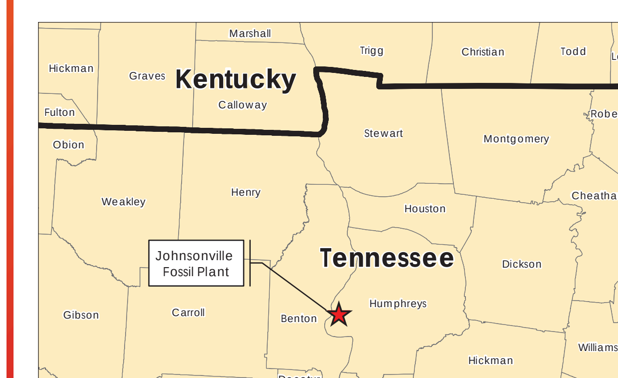
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Existing Piezometer Open Standpipe (Screened Interval)
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

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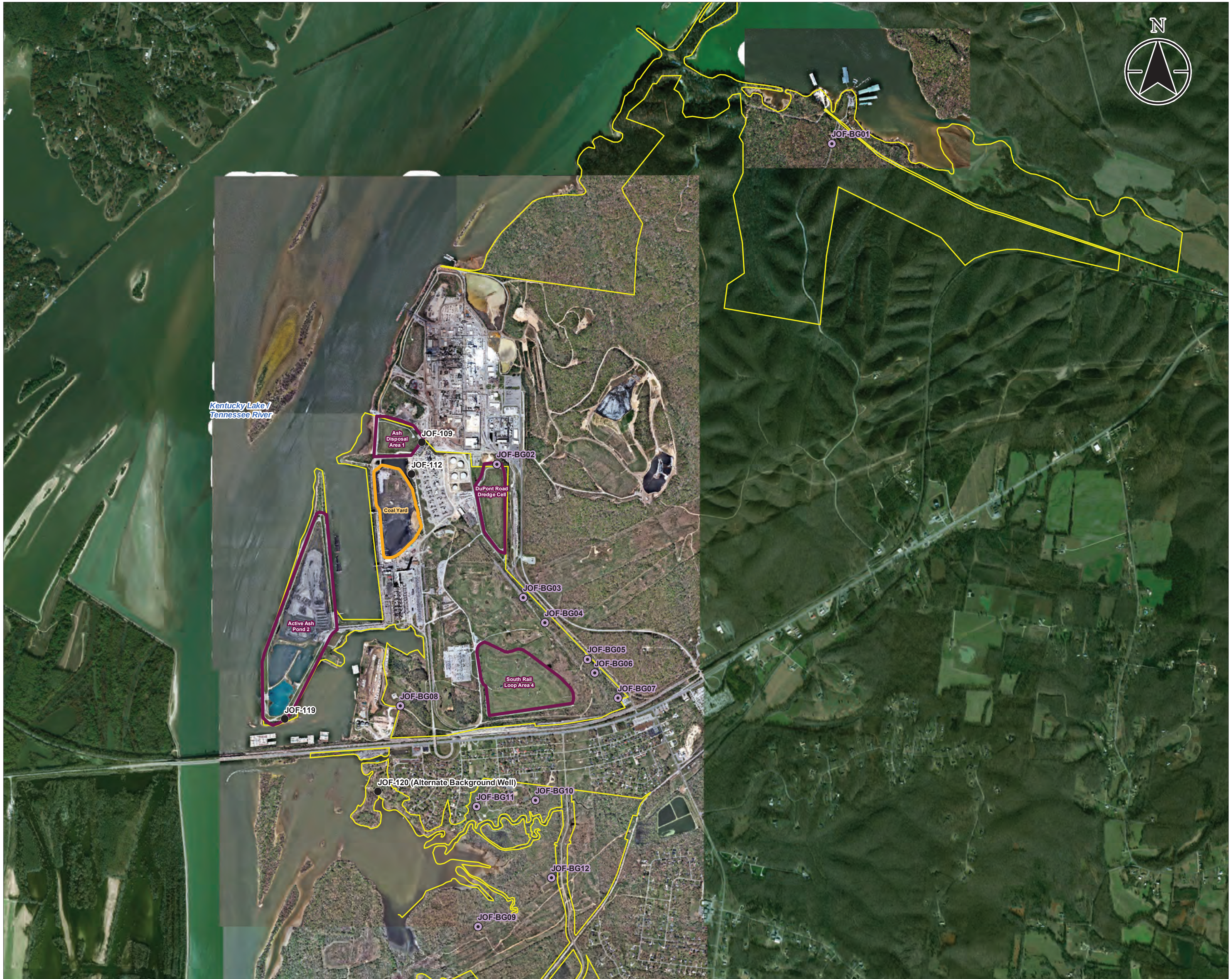


Exhibit No.

16

Title

Proposed Soil Sampling Locations

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296

Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

0 1,100 2,200 3,300 4,400 Feet

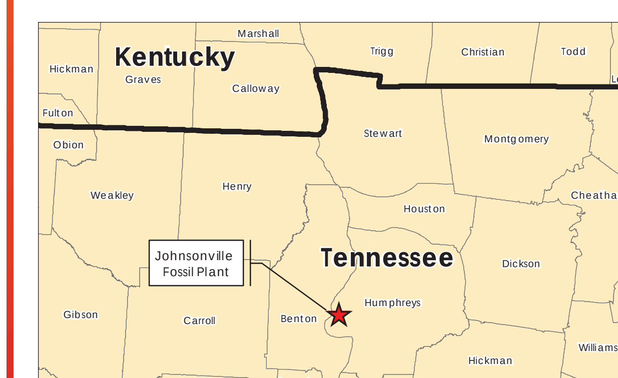
1:13,200 (At original document size of 22x34)

Legend

- Proposed Background Soil Sample Location
- Proposed Background Groundwater Monitoring Well
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TVA (2017) & ESRI Basemaps



Stantec

TVA

U:\TVA-EP\175567296\gis\mxds\JOF_Proposed_Soil_Sampling.mxd Revised: 2018-12-06 By: mbough

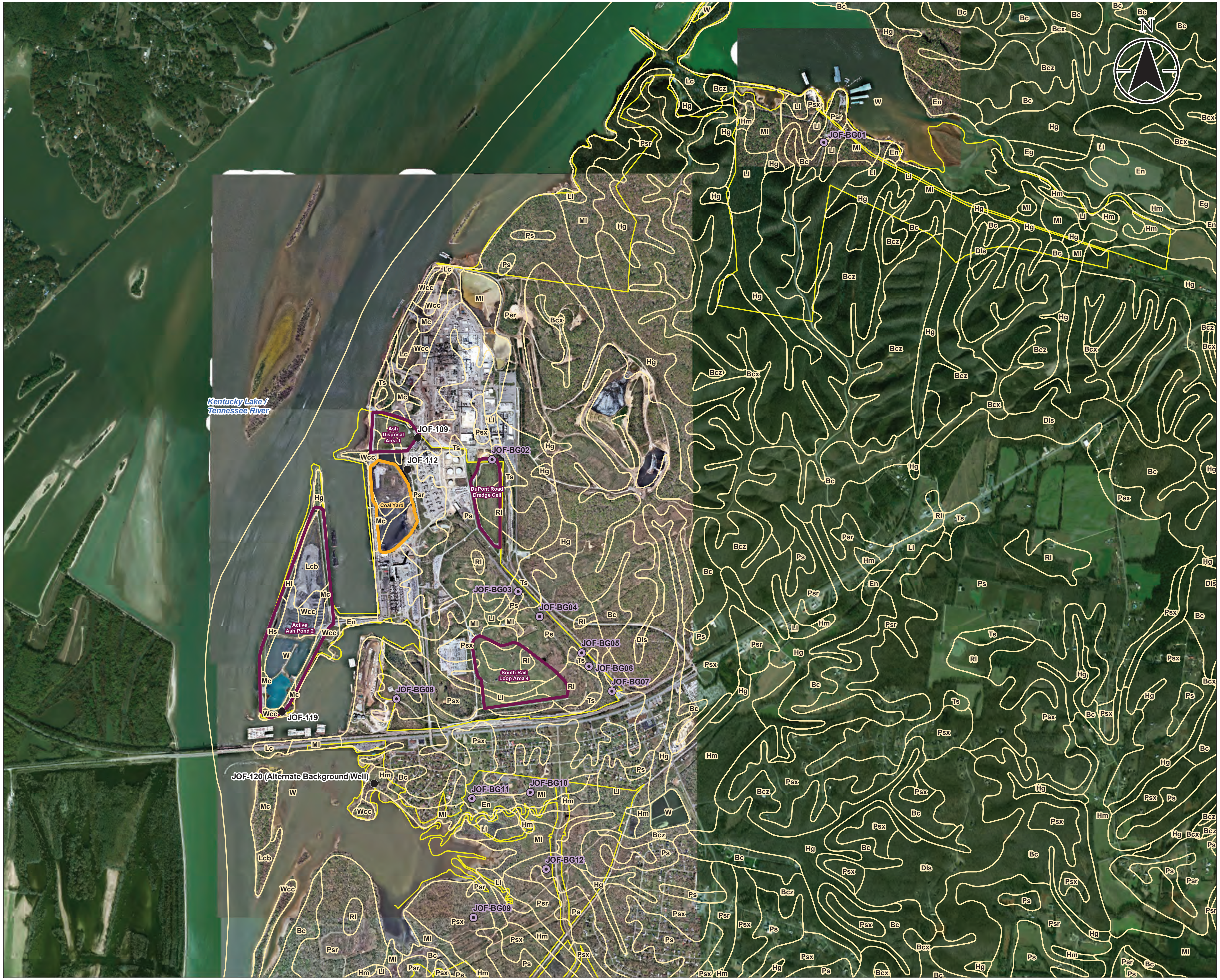


Exhibit No.

17

Title

Proposed Soil Sampling Locations

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296

Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

0 1,100 2,200 3,300 4,400 Feet

1:13,200 (At original document size of 22x34)

Legend

Proposed Background Soil Sample Location

Proposed Background Groundwater Monitoring Well

CCR Unit Boundary (Approximate)

Coal Yard

Soil Map Unit

TVA Property Boundary

Map Unit	Map Unit Name
Bc	Bodine gravelly silt loam, 12 to 20 percent slopes
Bcx	Bodine gravelly silt loam, 5 to 12 percent slopes
Bcz	Bodine gravelly silt loam, 20 to 40 percent slopes
Dls	Dickson silt loam, shallow
Eg	Ennis gravelly silt loam
En	Ennis silt loam
Hg	Humphreys gravelly silt loam, 2 to 5 percent slopes
Hl	Huntington silt loam
Hm	Humphreys silt loam
Hs	Huntington silty clay loam
Lc	Lindside silty clay loam
Lcb	Lindside silty clay loam, high-bottom
Ll	Lindside silt loam
Mc	Melvin silty clay loam
Ml	Melvin silt loam
Ps	Paden silt loam
Psr	Paden silt loam, eroded
Psx	Paden silt loam, slope
Rl	Robertsville silt loam
Ts	Taft silt loam, 0 to 2 percent slopes
W	Water
Wcc	Wolftever silty clay loam, compact

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TVA (2017) & ESRI Basemaps
3. Soils Data provided by US Department of Agriculture

Stantec TVA

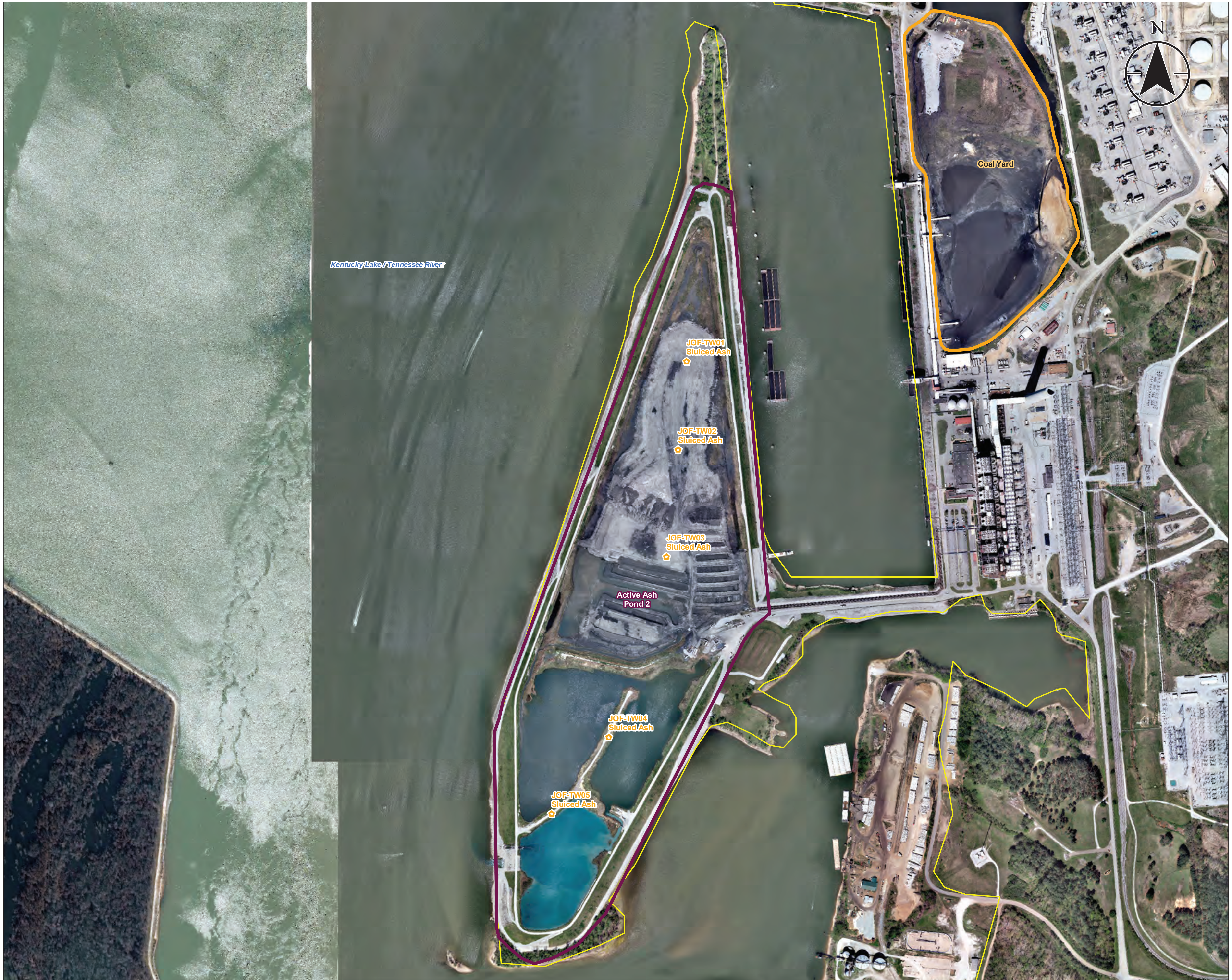


Exhibit No.
18

Title
Proposed Temporary Wells Active Ash Pond 2

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

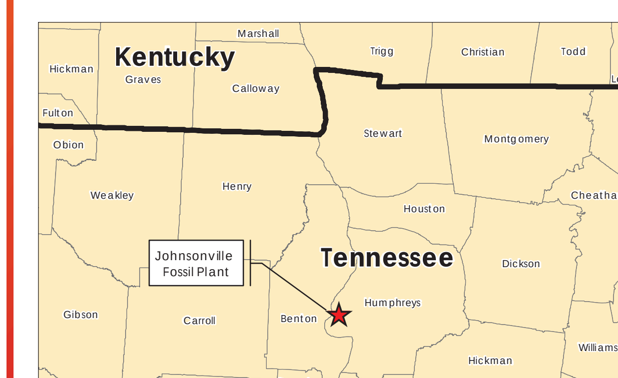
175567296
Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

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

Legend

Proposed Temporary Well (Screened Interval)
CCR Unit Boundary (Approximate)
Coal Yard
TVA Property Boundary

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

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U:\TVA-EP\175567296\gis\mxds\JOF_TempWells_AshArea1_CY_Dupont.mxd Revised: 2018-12-06 By: mbough

Exhibit No.
19

Title **Proposed Temporary Wells**
Ash Disposal Area 1, Coal Yard, &
DuPont Road Dredge Cell

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location 175567296
New Johnsonville, Tennessee
Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

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

Legend

- Proposed Boring with Piezometer Vibrating Wire
- Proposed Temporary Well (Screened Interval)
- Existing Piezometer Open Standpipe
- Existing Piezometer Vibrating Wire
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)

Stantec

TVA

Exhibit No.
20

Title

Proposed Borings
South Rail Loop Area 4

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Proposed Boring with Piezometer Vibrating Wire
- Proposed Temporary Well (Screened Interval)
- Existing Piezometer Open Standpipe
- Existing Piezometer Vibrating Wire
- Unit Boundary (Approximate)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)

Stantec

TVA

U:\TVA-EIP\175567296\gis\mxds\JOF_TempWells_SouthRailLoop.mxd Revised: 2018-12-06 By: mbough

Exhibit No.
21

Title
Completed & Proposed Stability Analyses Ash Disposal Area 1, Coal Yard, & DuPont Road Dredge Cell

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

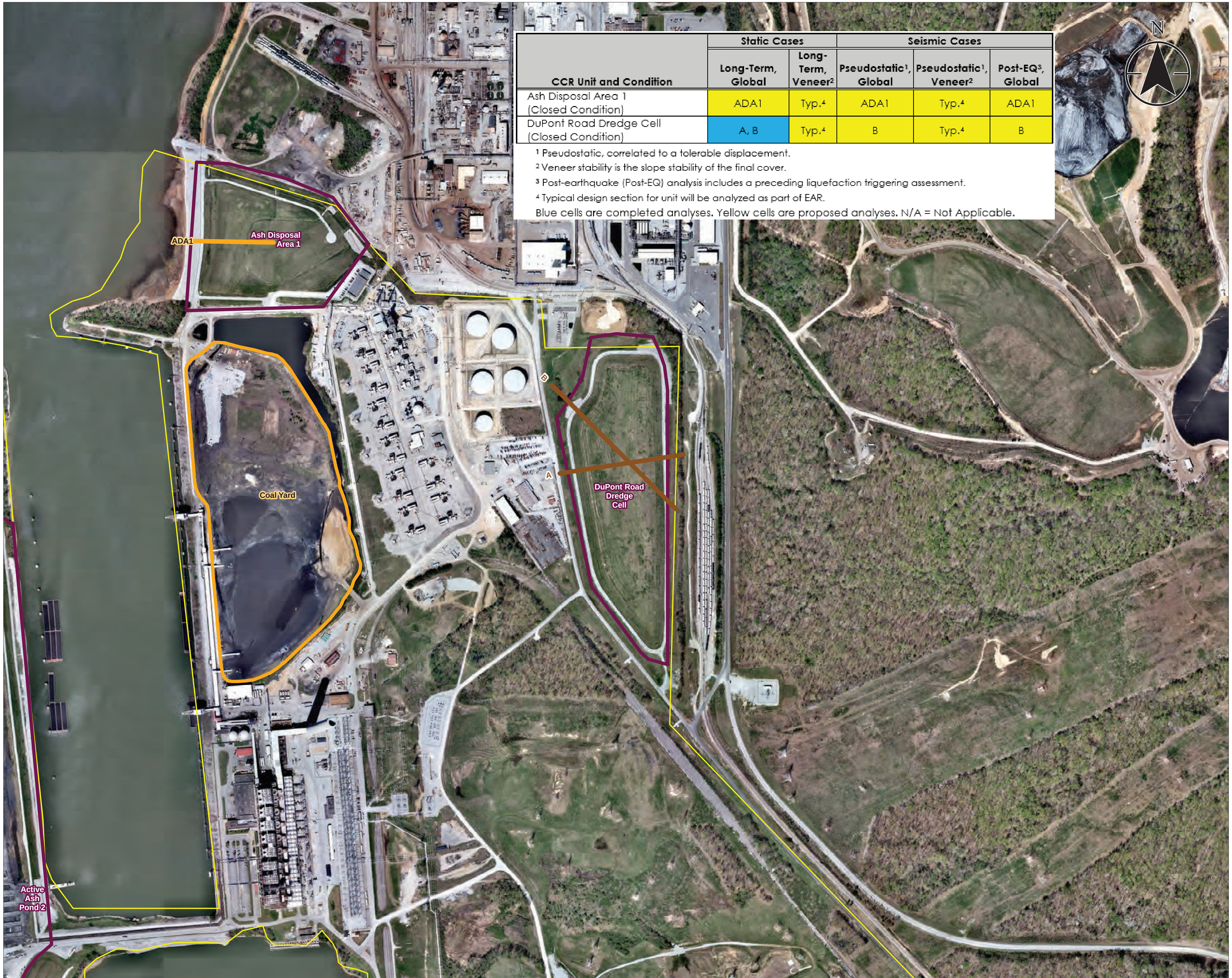
Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-05
Technical Review by ZW on 2018-01-05

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

CCR Unit and Condition	Static Cases		Seismic Cases		
	Long-Term, Global	Long-Term, Veneer[2]	Pseudostatic[1], Global	Pseudostatic[1], Veneer[2]	Post-EQ[3], Global
Ash Disposal Area 1 (Closed Condition)	ADA1	Typ.[4]	ADA1	Typ.[4]	ADA1
DuPont Road Dredge Cell (Closed Condition)	A, B	Typ.[4]	B	Typ.[4]	B

[1] Pseudostatic, correlated to a tolerable displacement.
[2] Veneer stability is the slope stability of the final cover.
[3] Post-earthquake (Post-EQ) analysis includes a preceding liquefaction triggering assessment.
[4] Typical design section for unit will be analyzed as part of EAR.
Blue cells are completed analyses. Yellow cells are proposed analyses. N/A = Not Applicable.

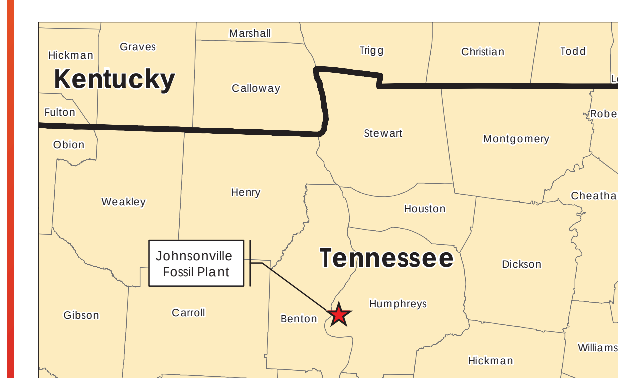


Legend

- Cross Section
- Proposed Cross Section
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec

TVA

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CCR Unit and Condition	Static Cases: Long-Term, Global	Static Cases: Long-Term, Veneer[2]	Seismic Cases: Pseudostatic[1], Global	Seismic Cases: Pseudostatic[1], Veneer[2]	Seismic Cases: Post-EQ[3], Global
Active Ash Pond 2 (Existing Condition)	A, B, C, C1, E, F, H, K, L, M, Station 12+00	N/A	B, C, E, H, K	N/A	B, C, E, H, K

[1] Pseudostatic, correlated to a tolerable displacement.
[2] Veneer stability is the slope stability of the final cover.
[3] Post-earthquake (Post-EQ) analysis includes a preceding liquefaction triggering assessment.
Blue cells are completed analyses. Yellow cells are proposed analyses. N/A = Not Applicable.

Exhibit No.
22

Title
Completed Stability Analyses Active Ash Pond 2

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

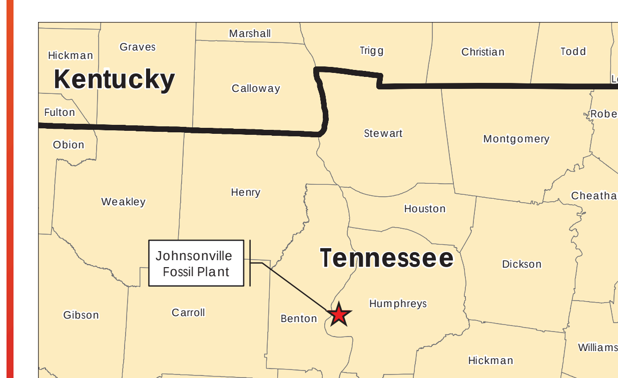
175567296
Prepared by LMB on 2018-01-05
Technical Review by ZW on 2018-01-05

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

Legend

- Cross Section
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

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CCR Unit and Condition	Static Cases		Seismic Cases		
	Long-Term, Global	Long-Term, Veneer[2]	Pseudostatic[1], Global	Pseudostatic[1], Veneer[2]	Post-EQ[3], Global
South Rail Loop Area 4 (Closed Condition)	RL1, RL2, RL3	RL2, RL3	RL1, RL2, RL3	RL2, RL3	RL1, RL2, RL3

[1] Pseudostatic, correlated to a tolerable displacement.
[2] Veneer stability is the slope stability of the final cover.
[3] Post-earthquake (Post-EQ) analysis includes a preceding liquefaction triggering assessment.
Blue cells are completed analyses. Yellow cells are proposed analyses. N/A = Not Applicable.

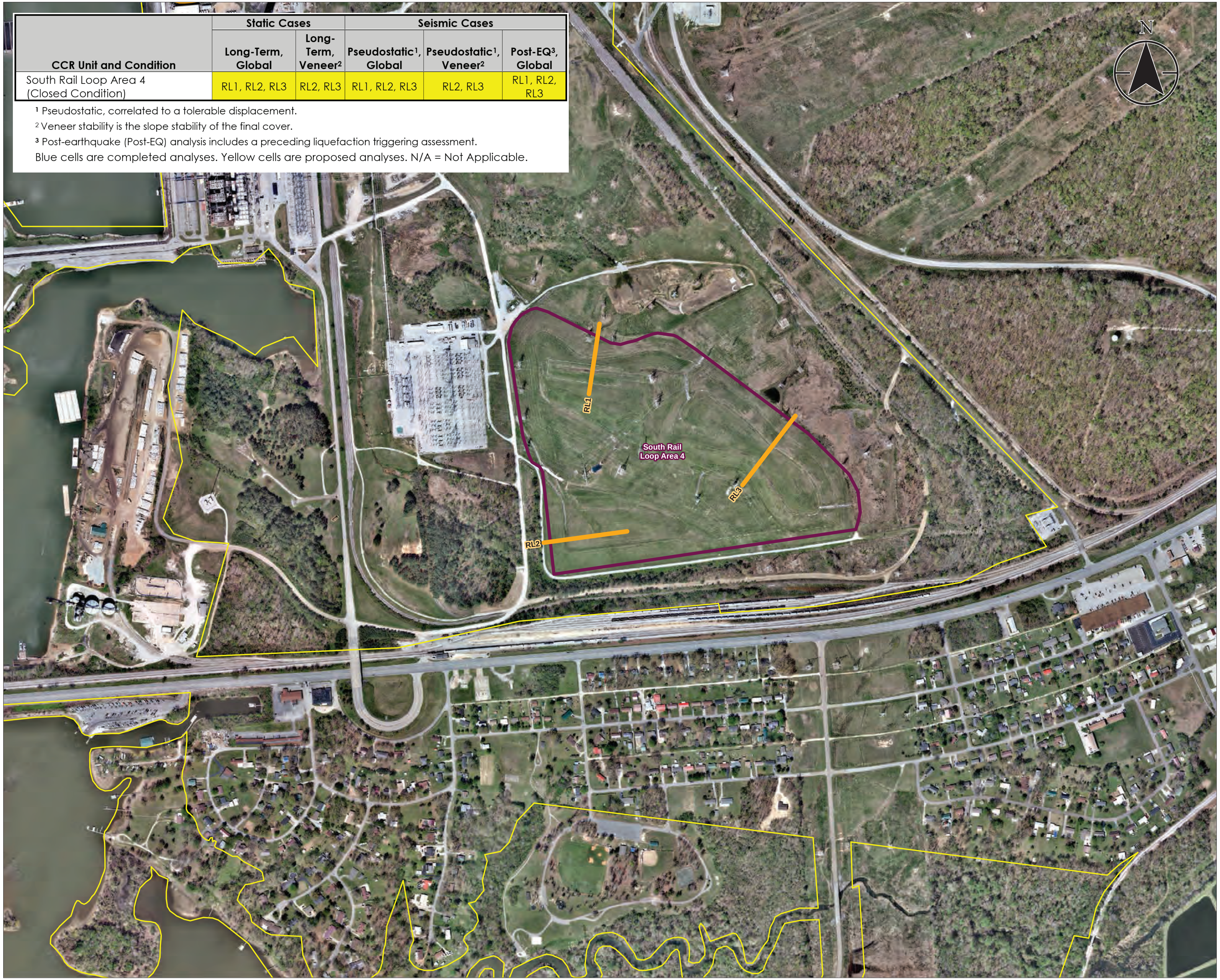


Exhibit No.
23

Title
Proposed Stability Analyses South Rail Loop Area 4

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2017-12-18
Technical Review by ZW on 2017-12-18

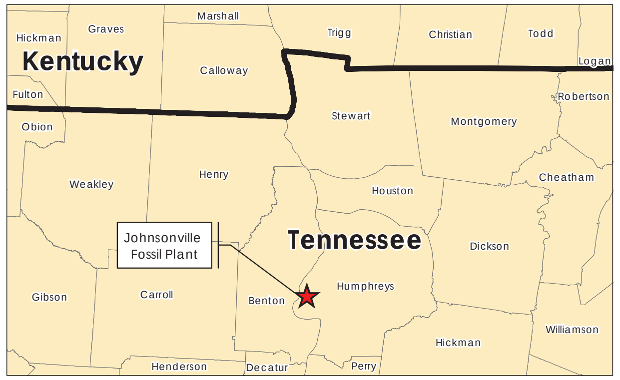
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Proposed Cross Section
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

Exhibit No.
24

Title

Sediment Sampling Locations

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

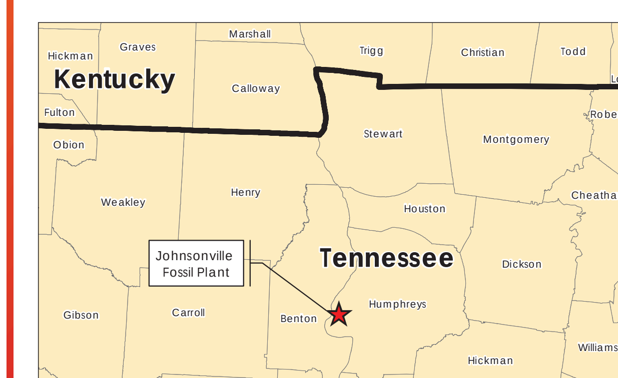
175567296
Prepared by LMB on 2018-01-09
Technical Review by ZW on 2018-01-09

Legend

Sediment Sampling Transect
CCR Unit Boundary (Approximate)
Coal Yard
TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemaps



Stantec

TVA

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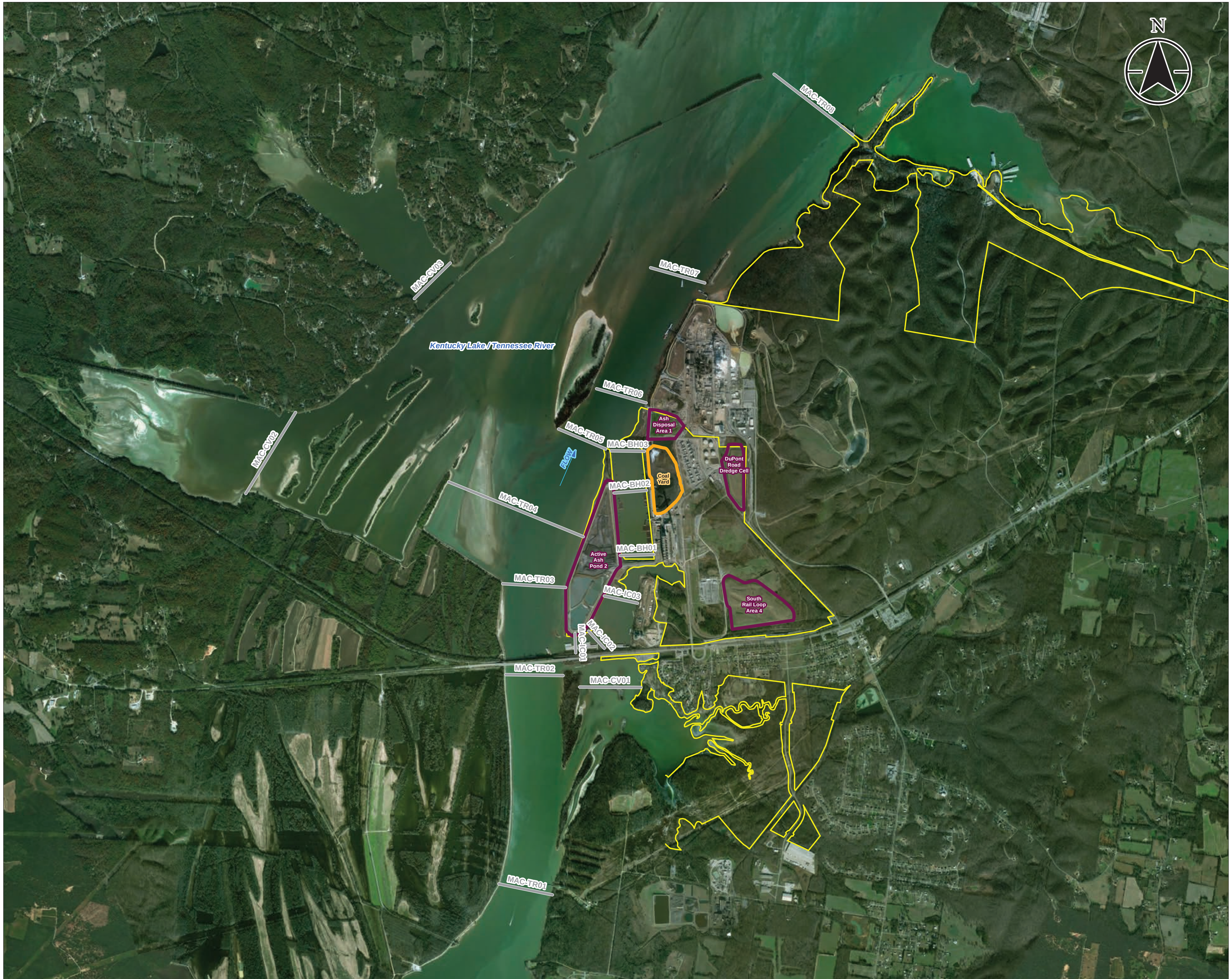


Exhibit No.
25

Title

Benthic Macroinvertebrates Sampling

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location 175567296

New Johnsonville, Tennessee

Prepared by LMB on 2018-01-09
Technical Review by ZW on 2018-01-09

0 1,500 3,000 4,500 6,000 Feet

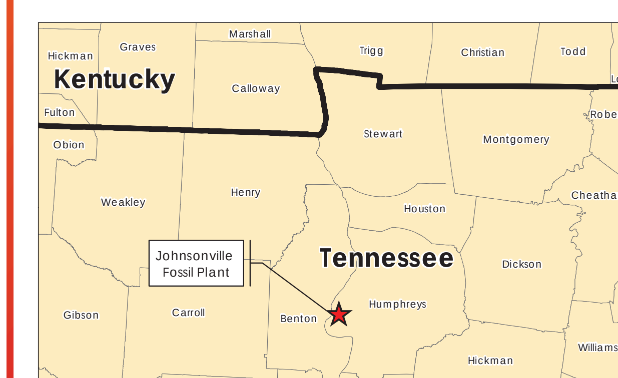
1:18,000 (At original document size of 22x34)

Legend

- Transect
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemaps



Stantec TVA

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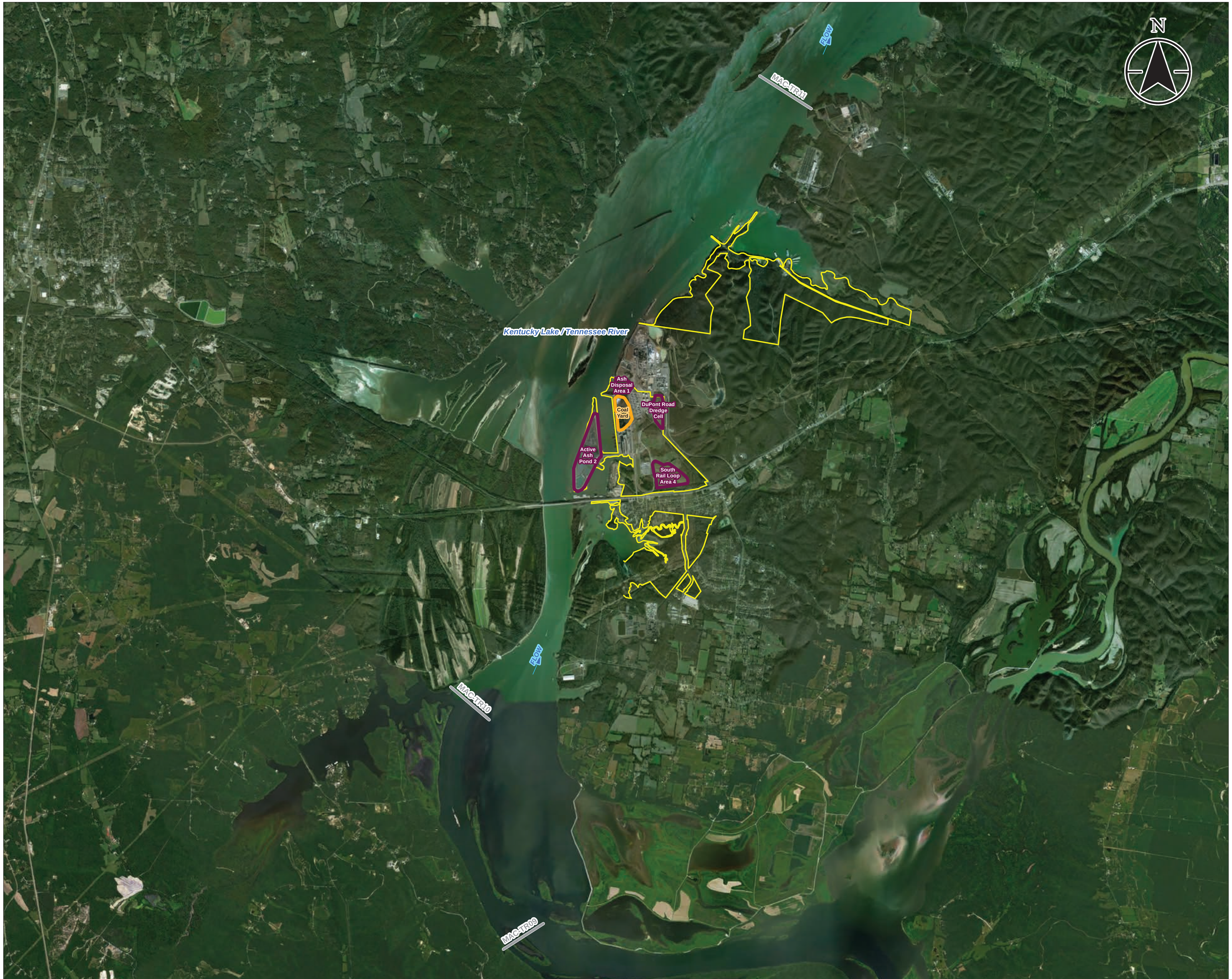


Exhibit No.
26

Title

Off-Site
Benthic Macroinvertebrates Sampling

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-09
Technical Review by ZW on 2018-01-09

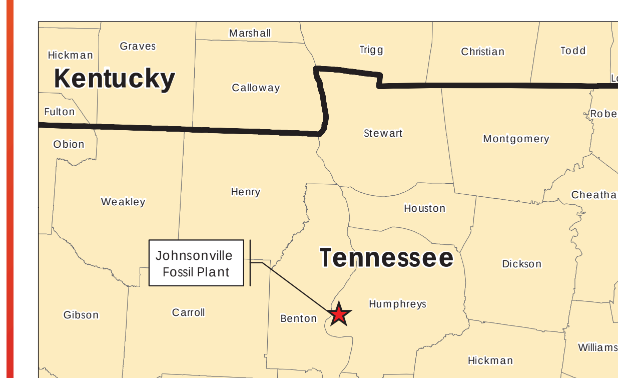
0 3,000 6,000 9,000 12,000 Feet
1:36,000 (At original document size of 22x34)

Legend

- Transects
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemaps



Stantec TVA

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Exhibit No.
27

Title **Mayfly Sampling**
Adult Mayflies, Purated Mayfly Nymphs,
& Non-Purated Mayfly Nymphs

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-10
Technical Review by ZW on 2018-01-10

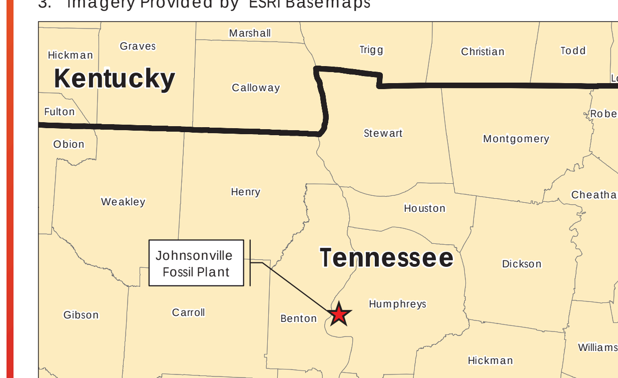
0 3,000 6,000 9,000 12,000
Feet
1:36,000 (At original document size of 22x34)

Legend

- Mayfly Sample Location
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. *** Adult Mayflies, Purated Mayfly Numphs, and Non-Purated Mayfly Nymphs; sampled at each location, samples at each location will have a unique ID sample Biota Matrix Code (MFA, MFP, MFN respectively).
2. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
3. Imagery Provided by ESRI Basemaps



Stantec

TVA

U:\TVA-EP\175567296\gis\mxds\JOF_Mayfly_Sampling.mxd Revised: 2018-01-10 By: mbough

Exhibit No.
28

Title
Surface Stream Sampling

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-09
Technical Review by RD on 2018-01-09

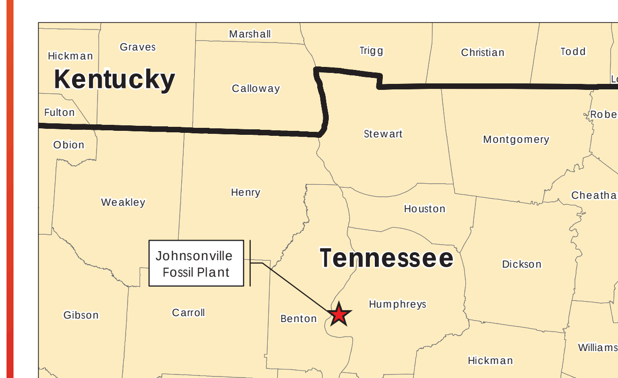
0 800 1,600 2,400 3,200 Feet
1:9,600 (At original document size of 22x34)

Legend

- Stream Sampling Transect
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemaps



Stantec TVA

U:\TVA-EP\175567296\gis\mxds\JOF_Surface_Stream.mxd Revised: 2018-01-09 By: mbough

Exhibit No.
29

Title
Fish Sampling

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-09
Technical Review by ZW on 2018-01-09

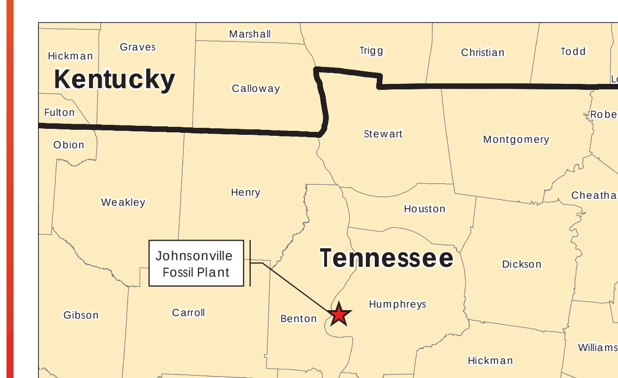
0 3,000 6,000 9,000 12,000 Feet
1:36,000 (At original document size of 22x34)

Legend

- Fish Sample Location
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemaps



Stantec TVA

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APPENDIX E
HYDROGEOLOGICAL INVESTIGATION SAP

Hydrogeological Investigation Sampling and Analysis Plan Johnsonville Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Johnsonville Fossil Plant
New Johnsonville, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 10, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	July 24, 2017
1	Addresses October 19, 2017 TDEC Review Comments and Issued for TDEC Review	January 12, 2018
2	Addresses March 9, 2018 TDEC Review Comments and Issued for TDEC Review	May 11, 2018
3	Addresses June 11, 2018 TDEC Review Comments and Issued for TDEC Review	July 20, 2018
4	Addresses comments and revisions from other EIPs and issued for TDEC review.	December 10, 2018

HYDROGEOLOGICAL INVESTIGATION
SAMPLING AND ANALYSIS PLAN
JOHNSONVILLE FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Hydrogeological Investigation
Sampling and Analysis Plan
Johnsonville Fossil Plant
Tennessee Valley Authority
New Johnsonville, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 10, 2018 Revision 4, Final

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager — Date: 12/6/18

TVA Investigation Field Lead — Date: 12/6/18

Health, Safety, and Environmental (HSE) Manager — Date: 12/05/2018

Investigation Project Manager — Date: 12/7/2018

Rock J. Vitale
Digitally signed by Rock J. Vitale
DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US
Date: 2018.12.03 11:50:25 -05'00'
QA Oversight Manager — Date

K. Ryan R. Jones
Laboratory Project Manager — Date: 12-05-18

Charles L. Head
TDEC Senior Advisor — Date

Robert Wilkinson
TDEC CCR Technical Manager — Date

Stantec

Table of Contents

LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order), to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Johnsonville Fossil Plant (JOF) on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management at JOF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC submitted a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 24, 2017, TVA submitted JOF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

TVA has developed this Hydrogeological Investigation Sampling and Analysis Plan (SAP) to install monitoring wells and a piezometer for measuring groundwater levels, and to provide monitoring well locations to collect groundwater samples. The plan provides procedures and methods necessary to conduct investigation activities at the JOF Plant.

2.0 OBJECTIVES

The objectives of this Hydrogeological Investigation SAP are to further characterize groundwater flow direction at the Plant and install monitoring wells to provide locations to collect groundwater samples for analysis of CCR constituents. Appendix C contains the Plant-specific Quality Assurance Project Plan (QAPP) which provides the procedures necessary to conduct investigation activities associated with the hydrogeological investigation.

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements, safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and will document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 MONITORING WELL LOCATIONS

TVA has investigative activities underway at JOF for the CCR Rule, TDEC permitting requirements and capital projects that will provide information that can be used to characterize the hydrogeology of JOF. Some of this work has been conducted, but final reports have not been produced and the results of those investigations are not yet available. However, TVA will incorporate pertinent data from these investigations that meet the Quality Assurance/Quality Control (QA/QC) requirements of the QAPP into the identification of proposed monitoring well locations. Monitoring wells and piezometers installed as part of the Environmental Investigation (EI) will be used to collect groundwater levels to characterize groundwater flow direction and rate. Monitoring wells will also be used to collect groundwater samples to characterize groundwater quality at the Plant. Sampling frequency and procedures are provided in the Groundwater Investigation SAP.

A geological investigation of the JOF site was undertaken in 1948 (TVA, 1948). Based on this information, the area is underlain by river alluvium, terrace deposits, Devonian age Chattanooga Shale and Camden Formations in order of descending lithology. The alluvium consists of sands, clays and silts and can be up to 100-feet thick in some areas (Stantec, 2010). Underlying the alluvium is older, coarser grained terrace deposits consisting of sands and gravels, which have a thickness of up to 33 feet. The Chattanooga Shale varies in thickness from 0 to 8 feet, and the Camden Formation consists of 1 to 3-inch thick beds of cherty limestone interbedded with thin clay layers.

At JOF, the overburden consists of alluvium and other unconsolidated materials overlying bedrock. Based on previous investigation activities conducted at JOF, groundwater is expected to be present in coarse grained materials above bedrock. However, these deposits may be thin or absent near the southern part of the coal yard or near Ash Disposal Area 1. As a result, groundwater may not be present in the overburden in these areas and installation of useful monitoring wells in the overburden may not be possible. If bedrock monitoring wells are required, then the data collected as part of the initial investigation phase will be reviewed to identify alternative monitoring well locations or well screen interval depths. The proposed well locations and rationale for construction details will be provided to TDEC for review and comment prior to installation.

TVA plans to install potential background monitoring wells at three or four preliminarily identified locations in the unconsolidated materials as part of this investigation. Table 1 shows the target depths and estimated screened intervals of the proposed wells. One location is proposed east of Ash Disposal Area 1 (JOF-109). This location is inferred to be up gradient of the Ash Disposal Area 1 CCR unit based on preliminary groundwater elevation contours that indicate the inferred flow is to the west, beneath the CCR unit to the Tennessee River. The second and third locations are proposed south of the Active Ash Disposal Area 2 (JOF-119 and alternate location JOF-120) and will be installed in the alluvial sands and gravels in which the existing wells are screened. JOF-119 is located near the southeastern point of the impoundment.

Alternate well JOF-120, will be installed, if determined necessary, based on the initial phase of investigation activities and will be located in a similar alluvial setting as JOF-119, but installed further southeast of Active Ash Disposal Area 2 and south of U.S. Highway 70 on TVA owned property. Should results from JOF-119 indicate that the well is not suitable as a background well, then alternate well JOF-120 will be installed and JOF-119 will be retained as a downgradient monitoring well. The fourth background monitoring well is proposed to be installed to the northeast of the Coal Yard (JOF-112). This will also be installed into unconsolidated materials overlying bedrock. Figure 1 shows the proposed areas for installation of the background wells. The final locations of the proposed background monitoring wells will be dependent on safe access to each area and the results of ongoing investigations.

In addition, TVA plans to install up to seven additional monitoring wells and one piezometer to augment the monitoring well networks around the CCR units and Coal Yard. These wells are proposed to be installed downgradient of their respective units and set within the alluvium or unconsolidated material above bedrock. The proposed locations can be seen on Figure 1. The proposed well construction details are provided in Table 1. Three monitoring wells (JOF-108, JOF-110 and, JOF-111) will be installed downgradient of Ash Disposal Area 1 in the unconsolidated material that overlays bedrock beneath the CCR unit. One vibrating wire piezometer (JOF-116-PZ) will also be installed near the northern boundary of Ash Disposal Area 1 between JOF-109 and JOF-110. The vibrating wire piezometer will be grouted in place in foundation soils beneath the unit and will allow water level (i.e. pore water pressure) readings in the soils and improve subsurface characterization in this vicinity.

One additional monitoring well will be installed north of the Active Ash Disposal Area 2 (JOF-118) in the underlying alluvial deposits. The final three monitoring wells will be installed to the west of the Coal Yard (JOF-113, JOF-114 and JOF-117) in the unconsolidated materials above bedrock.

Table 1. Proposed Well and Piezometer Construction Details

Well/Piezometer ID	Estimated Total Depth (Feet below Ground Surface)	Estimated Screen Interval (Feet below Ground Surface)	Target Screen Lithology
JOF-108	40	25-35	Unconsolidated Materials
JOF-109	60	20-30	Unconsolidated Materials
JOF-110	40	25-35	Unconsolidated Materials
JOF-111	40	25-35	Unconsolidated Materials
JOF-112	35	18-28	Unconsolidated Materials
JOF-113	35	20-30	Unconsolidated Materials
JOF-114	40	25-35	Unconsolidated Materials
JOF-117	15	10-15	Unconsolidated Materials
JOF-118	55	40 - 50	Alluvium
JOF-119	45	30 - 40	Alluvium
JOF-120 (Alternate)	45	30 - 40	Alluvium

Results of investigations to characterize groundwater quality and flow direction will be included and described in the Environmental Assessment Report (EAR). Should the drilling not encounter the expected unconsolidated or bedrock materials at the anticipated depths, the field crews will stop work and call the Project Manager who in turn will discuss the findings with TVA. Work will only commence once a decision has been made and with the authorization from a TVA Project Manager.

TVA plans to complete the initial phase of the investigation and jointly review the results with TDEC to identify data gaps. If data gaps exist, then TVA will fill those gaps with additional investigation in collaboration with TDEC. This may include installing additional groundwater monitoring wells or piezometers to further characterize the hydrogeology.

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to prepare for field activities, install groundwater monitoring wells and a piezometer, and assist in providing scientifically defensible results.

Monitoring well and piezometer installation will adhere to applicable American Society for Testing and Materials (ASTM) and TVA Environmental Technical Instruction (TI) documents. A project field book and field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will:

- Designate a Safety Officer and a Tennessee-licensed Professional Geologist
- Review applicable reference documents, including (but not limited to), TVA TIs (Section 5.5) and Standard Operating Procedures (SOPs), QAPP (Appendix C), SAPs, and HASP.
- Complete required health and safety paperwork, field readiness checklist, and confirm field team members have completed required training.
- Coordinate activities with the drilling subcontractor.
- Clear Access – Proposed monitoring well and piezometer locations will be marked using a wooden stake or survey flag with the position surveyed using the global positioning system (GPS). Suitability of each location will be evaluated for logistical issues including access, grubbing needs, overhead and underground utility clearance, and proximity to Plant features. Access improvements, including clearing and grubbing or road building, will be completed prior to the investigation start date.
- Perform Environmental Review – As required by the National Environmental Policy Act (NEPA), an environmental review must be completed to document and mitigate any potential impact of the work described herein. The level of review required for this work is anticipated to be a categorical exclusion, which would be documented by TVA with a categorical exclusion checklist (CEC). A CEC will require a number of signatories from TVA. It is understood that the environmental review is to be completed before implementation of the field work. Additionally, plant staff will not issue an excavation permit ahead of the completed environmental review.

- Complete Utility Locate(s) / Excavation Permit(s) - Prior to initiating subsurface activities, subsurface utility clearance will be sought via the plant engineering department and/or the TN 811 service. At locations within the Plant, engineering will provide primary utility clearance assurance in addition to TN 811 being notified. At all other drilling locations where, underground obstructions or utilities are expected nearby, TVA or 3rd party underground locators will be engaged to clear boring locations. For drilling locations outside the plant (e.g., along public roads and rights-of-way), utility avoidance assurance will be supplemented by the TN 811 service and the TVA or 3rd party underground locators. An excavation permit is required prior to initiating any digging or boring at the Plant. A key component to the completion of the excavation permit is consensus on the drilling locations with pertinent TVA staff.

- Identify Water Source – During implementation of the EIP, a source of potable water will be required to complete several investigation tasks, including certain drilling methods and decontamination procedures.

- Obtain required calibrated field instruments, including health and safety equipment.

- Discuss project objectives and potential hazards with project personnel.

5.2 DRILLING AND SAMPLING METHODS AND PROTOCOL

Drilling activities performed at the Plant during implementation of this SAP will include advancing subsurface boreholes using auger techniques or other compatible technology based on field conditions and rig availability. If drilling methods that require the use of water are used for the installation of monitoring wells or piezometers, then only potable water will be used.

The following sections present drilling and soil sampling procedures required to complete the tasks presented. Once completed, borings will be surveyed for horizontal and vertical control by survey grade GPS.

5.2.1 Drilling, Logging, and Survey

The monitoring well and piezometer borings are proposed to be advanced utilizing hollow-stem augering techniques (ASTM D6151-08) until designed boring termination depth or auger refusal, whichever is shallower. In some situations, drilling with a casing advancer may be a suitable alternative to augering.

TVA proposes to perform continuous soil sampling during drilling to allow for visual logging of the materials encountered at each location. The soil boring logs will provide additional understanding of the subsurface profile including the saturated soils. Drilling and sampling activities will be performed under the direction of a Professional Geologist, licensed in the State of Tennessee, who has sufficient experience to execute the work.

The field geologist will prepare a written field log for each boring. In addition to describing each recovered soil sample, the log will document boring location, drilling personnel, tooling/equipment used, drilling performance, depth to water, sample number, sample recovery, Standard Penetration Test (SPT) blow counts, and other relevant observations. Soil color will be logged per the appropriate Munsell soil color chart.

Similarly, the field geologist will prepare a written installation log for each well. The log will document well location, well materials, well depth, depth interval for each backfill material, and surface completion details (protective casing, concrete pad, bollards, etc.).

In addition to the soil log, the field geologist will collect soil samples through the well screen interval of background monitoring wells as described in Section 5.2.1.2 of the Background Soil SAP (Appendix L).

Once the boring is completed and the well is installed it will be surveyed for horizontal and vertical control by survey grade GPS to the vertical datum used by the Plant. The survey data will be added to the final boring logs once available and a crosswalk will be provided to indicate what the Plant datum's equivalency is to mean sea level (MSL).

5.2.2 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Field Team Leader, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP.

5.2.3 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information systems (GIS)or global positioning systems (GPS) documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.2.3.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.3.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks. Boring log forms will be used to document lithologic conditions and field observations at each boring location. Monitoring well and piezometer diagrams will be prepared for each well.

Field documentation will also be prepared for development of each monitoring well.

5.2.3.3 Chain-of-Custody Forms

Chain-of-custody (COC) forms are not applicable to this SAP. Refer to the Groundwater Investigation SAP for groundwater sampling and monitoring procedures.

5.2.3.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.4 Collection of Samples

5.2.4.1 Standard Penetration Test Sampling

The SPT samples will provide information for developing continuous boring logs/soil profiles. The SPT sampling will be conducted in accordance with ASTM D 1586 *Standard Method for Penetration Testing and Sampling for Soils*, and consists of dropping a 140-pound hammer from a height of 30 inches to drive a standard size 2-inch diameter split-spoon sampler to a depth of 18-inches.

5.2.4.2 Monitoring and Sampling

Monitoring or sampling of wells is not addressed in this SAP. Refer to the Groundwater Investigation SAP for groundwater sampling and monitoring procedures.

5.2.5 Preservation and Handling

5.2.5.1 SPT Samples

SPT samples will be logged and placed in glass jars. Once each jar is filled, the rim and threads will be cleaned, the jar capped, and a label (Section 5.2.5.2) will be applied to the jar. Each sample container will be checked to confirm that it is sealed, labeled legibly, and externally clean before placing the sample container in a box for transport.

5.2.5.2 Sample Labels and Identification System

Each SPT jar will have a sample label affixed. Sample labels will contain the following information recorded in waterproof, non-erasable ink. Rock core boxes will have similar information written directly on the wooden core box in waterproof, non-erasable ink:

- Project number
- Sample location
- Boring ID number
- Depth of sampling interval
- Date of sample collection
- Sampler’s initials

5.2.5.3 Packaging and Shipping

At appropriate intervals, assigned personnel will transport the samples to the testing laboratory or designated storage facility. SPT and other disturbed bulk samples (if any) will be treated as Group B samples as discussed in ASTM D4220.

5.2.6 Sample Analyses

Select soil samples obtained during the investigation will be subjected to geotechnical laboratory testing. Testing will be assigned to characterize the predominant soil materials recovered in each boring. The laboratory tests will be performed in accordance with applicable ASTM standard testing procedures.

The laboratory analyses are expected to include natural moisture content determinations (D2216), sieve and hydrometer analyses (D422), specific gravity (D854), and Atterberg Limits (D4318). The results of the testing will be used to assist in subsurface characterization and correlation with existing data. If other tests are found to be necessary, they will also be performed in accordance with applicable ASTM standard testing procedures. The Plant-specific laboratory testing program will be developed based on the recovery and spatial distribution of samples from the drilling and sampling program.

5.2.7 Equipment Decontamination Procedures

Documented decontamination will be performed for drilling equipment, tooling, and instruments in contact with subsurface materials in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination. Decontamination pads will be constructed for decontamination of large downhole tooling (augers, drill rods, etc.). Decontamination will be conducted using a high-pressure washer/steam cleaner.

Decontamination pads will be constructed at locations designated by TVA personnel using poly sheeting with sufficient berms to contain decontamination fluids and prevent potential runoff to uncontrolled areas. Following decontamination, fluids will be disposed of in accordance with Section 5.2.8. Decontamination activities will be performed away from surface water bodies and areas of potential impacts. Decontamination of non-disposable sampling equipment or instruments can be performed using potable water and Liquinox® or other appropriate non-phosphatic detergent in 5-gallon buckets.

Decontamination of sampling equipment and instrument (e.g., split spoons, water level meters, pumps for well development, etc.) will be performed prior to use and between sampling locations. Decontamination activities will be documented in the logbook field notes. Additional information regarding equipment decontamination procedures is located in the QAPP.

5.2.8 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Soil cuttings
- Well development water
- Purge water
- Personal Protective Equipment

- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*, the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

5.3 MONITORING WELL AND PIEZOMETER INSTALLATION

Monitoring wells and a piezometer will be installed at the boring locations by qualified drill crews under the direction of a licensed Tennessee driller. TVA and contractor personnel will assist by providing excavation (drill) permitting, utility clearances, and access to locations along with other coordination.

Monitoring wells and the piezometer will be installed in accordance with TVA TI ENV-TI-05.80.25, *Monitoring Well and Piezometer Installation and Development*.

5.3.1 Materials and Installation

The monitoring wells and piezometer will be installed using current industry and regulatory protocols to reduce potential for introducing contaminants during the drilling and installation process. Decontamination processes will be in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*. These procedures include, in part, decontamination of the drilling equipment and tools before and after each well by washing with hot, potable water delivered under high pressure, using new well screen and riser that have been cleaned and sealed in plastic at the factory, and placing washed filter pack sand that is certified by NSF International.

Other steps employed during the installations include the workers donning clean, nitrile gloves during the handling of downhole equipment and well materials and using potable water for grouting purposes.

Monitoring wells will consist of a four-inch diameter Schedule 40 PVC pre-packed well screen (0.010-inch slots) and riser. The screen and riser will consist of flush-joint, threaded PVC pipe. The screen length will be selected based on the results of the boring and the target stratum but will not be longer than 10 feet. A four-inch diameter Schedule 40 PVC bottom well plug measuring approximately six inches in length will be threaded onto the bottom of the screen. The PVC riser will extend above (2.5 feet minimum) the ground surface and will be capped with a temporary plug or slip cap. The annular space will be backfilled with a sand filter pack (20/40 mesh) extending a minimum of two feet above and six inches below the screen. A minimum two-foot thick bentonite pellet seal will be placed on top of the sand filter pack.

After the bentonite pellet seal has sufficiently hydrated, (minimum of eight hours of hydration time when using cement grouts above the seal), the remaining annular space will be backfilled with a non-shrink, bentonite-cement grout.

It should be noted that the grout will be placed by tremie method through one-inch (minimum) diameter PVC pipe. The grout will be placed using pumps gauged to allow the installation crew to monitor pressures during the grouting process. In open (uncased) boreholes, the sand filter zones and bentonite pellets will be placed by tremie method through one-inch (minimum) diameter PVC. In cased boreholes (i.e., through hollow-stem augers or temporary casing), the sand filter zones and bentonite pellets may be placed by tremie method or may be poured slowly into the annular space of the drill tooling to prevent bridging.

For the vibrating wire piezometer, one transducer will be installed in the boring and grouted in-place. The piezometer will be attached to a sacrificial one-diameter PVC pipe. The boring will be backfilled using the bentonite-cement grout described previously, placed by the tremie method.

Subsequent wellhead construction will consist of an above-grade, steel locking protective cover anchored to a concrete surface pad. The protective cover will extend above the concrete pad and the annular space will be filled with sand or pea gravel to about six-inches below the top of casing. Steel protective bollards filled with concrete will be installed near each corner of the concrete pad. The top of each well casing will be surveyed and correlated to the vertical datum used by the Plant. A crosswalk will be provided that indicates what the Plant datum's equivalency is to MSL.

An example installation log is shown on Figure 2. A drawing of the wellhead construction is shown on Figure 3.

5.3.2 Well Development

Each new monitoring well will be developed by a combination of bailing, surging, and pumping after a minimum of 24 hours following completion. Equipment will be decontaminated per TVA TI ENV-TI-05.80.05. First, a bailer will be lowered and raised within the screened intervals to create a slight surging action to dislodge particles within the wells and sand filter packs. A baseline reading of turbidity, pH, temperature, and specific conductance will be measured using a properly calibrated Oakton® turbidity and PCSTestr 35 water testing meters (or equivalents). If the well contains heavy sediment, further bailing will be performed before continuation of development with surge blocks and submersible pumps. A surge block will be used within the screened interval to move water and particles through the screen and sand filter packs. This process may be repeated several times to decrease the water turbidity within the wells.

Lastly, a submersible pump will be employed to further develop the wells until an acceptable level of turbidity is achieved. Target turbidity value of less than or equal to ten (10) Nephelometric turbidity units (NTUs) will be utilized for the wells per TVA-ENV-TI-05.80.42. If the target turbidity value cannot practically be achieved, well development will be conducted according to the requirements listed in TVA-ENV-TI-05.80.25, *Monitoring Well and Piezometer Installation and Development*.

5.3.3 Slug Testing

After development, TVA will perform slug testing in each monitoring well to measure hydraulic conductivity. Equipment will be decontaminated per TVA TI ENV-TI-05.80.05. The slug tests will be performed in accordance with ASTM D 4044, *Standard Test Method for (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers*. A pressure transducer with a data recorder will be used to collect water level information from the wells.

As part of the slug testing, each well will be tested by taking an initial measurement of the static water level followed by the insertion of the pressure transducer into the well. After the transducer has been installed, a solid slug (e.g., PVC pipe filled with sand) will be introduced into the well to cause a nearly instantaneous change in the water level. The water levels will then be recorded at regular intervals until reaching near static levels. After reaching static levels, the test will be terminated, and a second slug test will be conducted by instantaneously removing the slug and monitoring water levels until static levels are reached again. The results will be recorded electronically and downloaded into a data collector. Raw data will be checked in the field for discrepancies prior to demobilizing from the Plant.

The field data, once collected and returned to the office, will be evaluated using a software program to estimate the hydraulic conductivity of the in-situ soils.

5.4 INSTALLATION OF DEDICATED SAMPLING PUMPS

New dedicated sampling pumps will be installed in the new groundwater monitoring wells after well development and slug testing are completed. The well depths and static groundwater levels will be measured during well development to place the pumps at the proper intake depths for future well sampling. The pump intake depth will be located at approximately the mid-point of the well screen or the mid-point of the saturated portion of the well screen. Well pump placement depths and additional pump installation calculations and details will be recorded on field forms in the field.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP (Appendix C) describes quality assurance (QA)/quality control (QC) requirements for the Investigation. The following sections provide details regarding QA/QC requirements specific to the installation of groundwater monitoring wells.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to confirm that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Project Manager considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

The accuracy of the drilling, monitoring well installation and slug testing processes must be maintained throughout the investigation. In addition, planned drilling and installation methods must be confirmed during field activities to provide confidence that groundwater samples and water level measurements collected as part of other SAPs provide representative analytical results and data.

Field personnel will be responsible for performing checks to confirm that the SAP has been followed. This consists of the completion of applicable field forms and documentation of field activities.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, site conditions, and weather conditions. For the overall EIP implementation schedule, including anticipated dates, see the schedule provided in Appendix A of the EIP.

Table 2. Preliminary Schedule for Hydrogeological Investigation SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Hydrogeological Investigation SAP Submittal		Completed
Prepare for Field Activities	30 Days	Following EIP Approval
Conduct Field Activities	30 Days	Following Field Preparation

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Plant-specific safety requirements are anticipated to include TVA specified training and attendance at a safety briefing. Only Field Team members and subcontractors performing work activities will be required to meet the above requirements.
- A dedicated Safety Officer will be present for this work.
- Assessment of suitability of areas and access to proposed monitoring well locations, including clearing and grubbing, will be provided by TVA, and will be completed prior to the Investigation start date.
- Field locations may be adjusted based on actual field conditions;
- Proposed monitoring well locations can be safely accessed; and
- Saturated alluvial materials exist at each proposed location.

9.0 REFERENCES

Tennessee Valley Authority (TVA). 2017a. “Field Record Keeping.” Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017b. “Field Sampling Equipment Cleaning and Decontamination.” Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 1948. “Geology of the New Johnsonville Steam Plant Site.” John M. Kellburg, TVA Water Control Planning Department, Geologic Division. January 14.

Tennessee Valley Authority (TVA). Tennessee Valley Authority (TVA). 2017c. “Monitoring Well and Piezometer Installation and Development.” Technical Instruction ENV-TI-05.80.25, Revision 0000. May 8.

Stantec Consulting Services Inc. (Stantec) 2010. “Report of Geotechnical Exploration and Slope Stability Evaluation, Ash Disposal Areas 2 and 3 (Active Ash Disposal Area) Johnsonville Fossil Plant, New Johnsonville, Tennessee.” Prepared for Tennessee Valley Authority. April 13.

ATTACHMENT A
FIGURES

Figure No.
1

Title
Proposed Groundwater Well Locations Johnsonville Fossil Plant

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

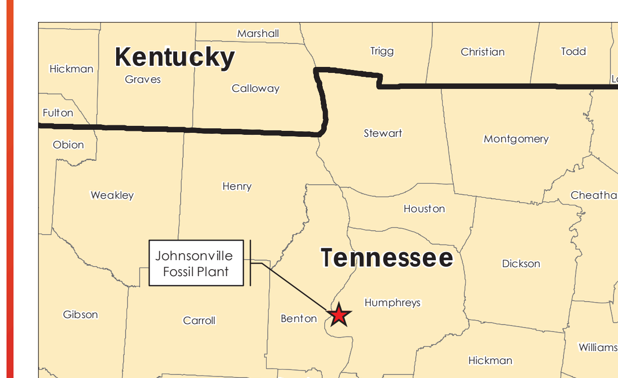
0 700 1,400 2,100 2,800 Feet
1:8,406 (At original document size of 22x34)

Legend

- Proposed Vibrating Wire Piezometer
- Proposed Groundwater Monitoring Well
- CCR Well
- CCR/State Monitoring Well
- State Compliance Monitoring Well
- Observation Well
- Surface Water Gauging Station
- TVA Property Boundary
- CCR Unit Boundary (Approximate)
- Coal Yard

Notes

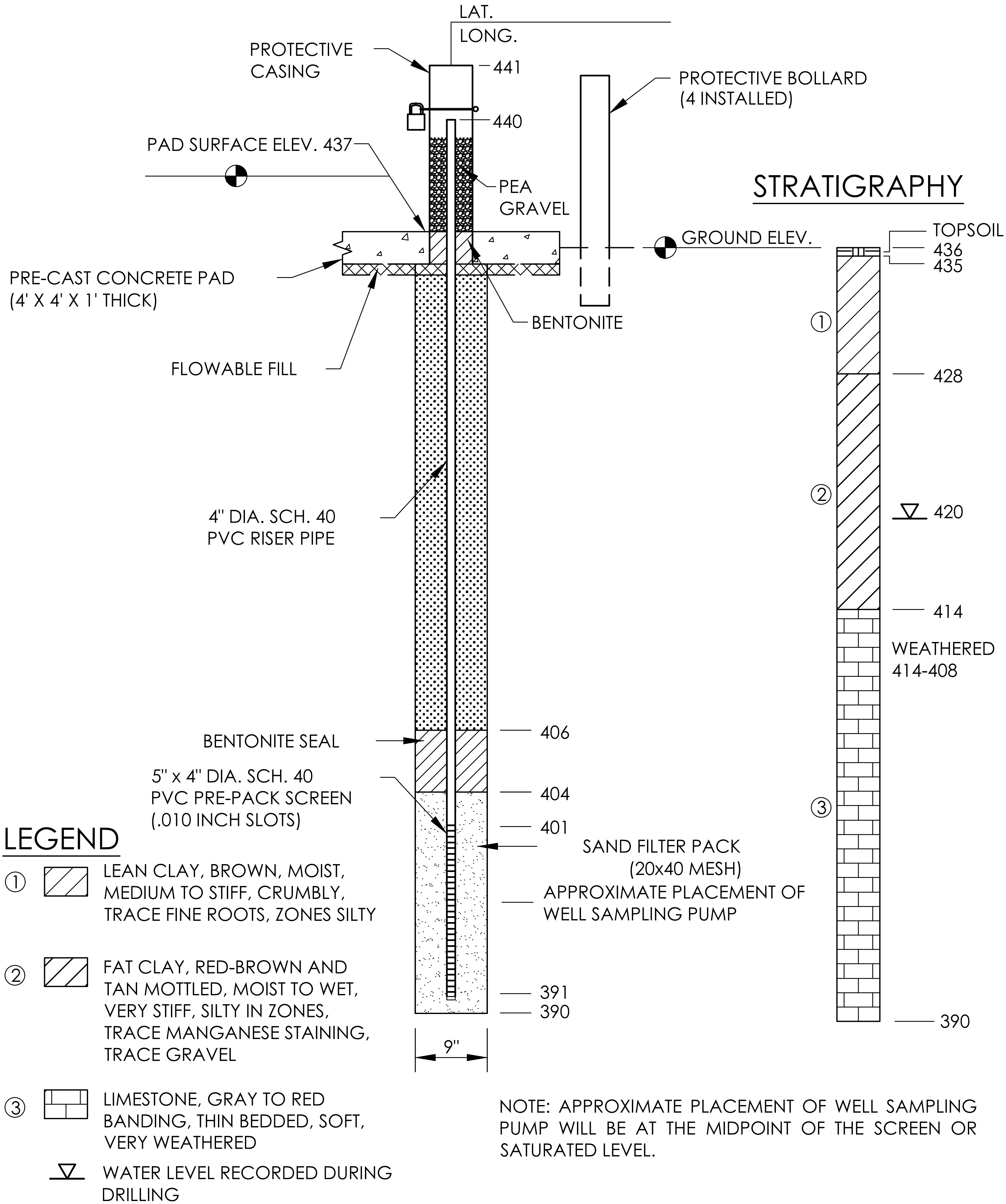
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TVA (2017) & ESRI Basemaps
3. JOF-115 is a proposed alternate background monitoring well location.



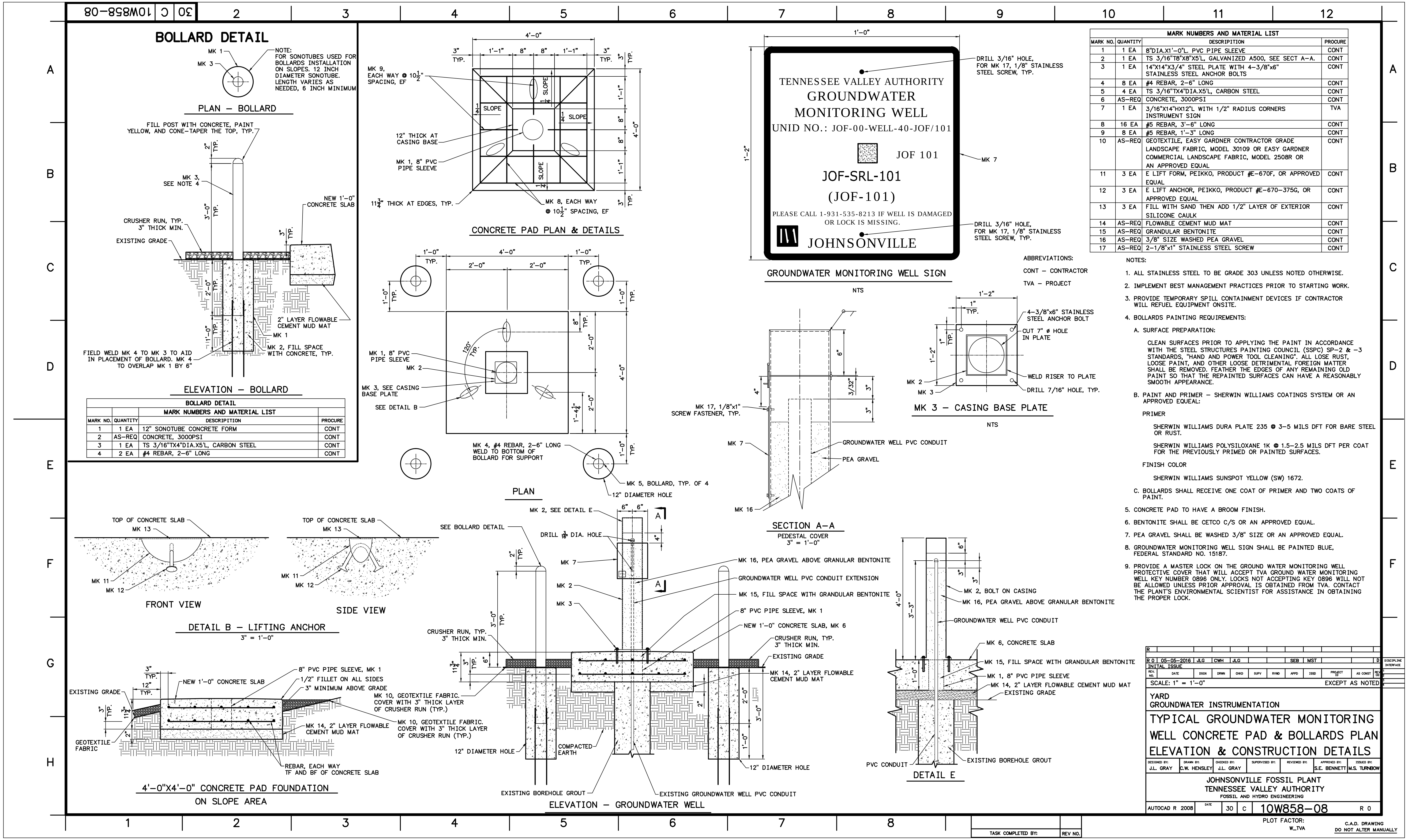
Stantec TVA

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

U:\TVA-EIP\175567296\gis\mxds\JOF_Proposed_Groundwater_Wells_PZs.mxd Revised: 2018-12-06 By: mbough



NOTE: THIS FIGURE IS AN EXAMPLE MONITORING WELL LOG PROVIDED FOR REFERENCE PURPOSES AND DOES NOT REPRESENT CURRENT SITE CONDITIONS.



BOLLARD DETAIL – MARK NUMBERS AND MATERIAL LIST

MARK NO.	QUANTITY	DESCRIPTION	PROCURE
1	1 EA	12" SONOTUBE CONCRETE FORM	CONT
2	AS-REQ	CONCRETE, 3000PSI	CONT
3	1 EA	TS 3/16"TX4"DIA.X5'L, CARBON STEEL	CONT
4	2 EA	#4 REBAR, 2'-6" LONG	CONT

MARK NUMBERS AND MATERIAL LIST

MARK NO.	QUANTITY	DESCRIPTION	PROCURE
1	1 EA	8"DIA.X1'-0"L. PVC PIPE SLEEVE	CONT
2	1 EA	TS 3/16"T8"X8"X5'L, GALVANIZED A500, SEE SECT A-A.	CONT
3	1 EA	14"X14"X3/4" STEEL PLATE WITH 4-3/8"x6" STAINLESS STEEL ANCHOR BOLTS	CONT
4	8 EA	#4 REBAR, 2'-6" LONG	CONT
5	4 EA	TS 3/16"TX4"DIA.X5'L, CARBON STEEL	CONT
6	AS-REQ	CONCRETE, 3000PSI	CONT
7	1 EA	3/16"X14"HX12"L WITH 1/2" RADIUS CORNERS INSTRUMENT SIGN	TVA
8	16 EA	#5 REBAR, 3'-6" LONG	CONT
9	8 EA	#5 REBAR, 1'-3" LONG	CONT
10	AS-REQ	GEOTEXTILE, EASY GARDNER CONTRACTOR GRADE LANDSCAPE FABRIC, MODEL 30109 OR EASY GARDNER COMMERCIAL LANDSCAPE FABRIC, MODEL 2508R OR AN APPROVED EQUAL	CONT
11	3 EA	E LIFT FORM, PEIKKO, PRODUCT #E-670F, OR APPROVED EQUAL	CONT
12	3 EA	E LIFT ANCHOR, PEIKKO, PRODUCT #E-670-375G, OR APPROVED EQUAL	CONT
13	3 EA	FILL WITH SAND THEN ADD 1/2" LAYER OF EXTERIOR SILICONE CAULK	CONT
14	AS-REQ	FLOWABLE CEMENT MUD MAT	CONT
15	AS-REQ	GRANDULAR BENTONITE	CONT
16	AS-REQ	3/8" SIZE WASHED PEA GRAVEL	CONT
17	AS-REQ	2-1/8"x1" STAINLESS STEEL SCREW	CONT

Figure 3. Typical Groundwater Monitoring Well Construction Details

ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Hydrogeological Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment[1]
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Pressure transducer and data recorder
Data collector
Dedicated well sampling pumps, fittings, and tubing
Stainless steel clamps
Pump controller and power supply
Generator (if needed)
Acoustic Televiewer
Heat Pulse Flow Meter
Multi-parameter sonde
Rubber packers
Solid Slug (e.g. PVC filled with sand)
Well pump (purging well) and tubing
***These items are detailed in associated planning documents to avoid redundancy.**
[1]Refer to the Exploratory Drilling SAP for other drilling-specific field equipment

APPENDIX F
GROUNDWATER INVESTIGATION SAP

Groundwater Investigation
Sampling and Analysis Plan
Johnsonville Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Johnsonville Fossil Plant
New Johnsonville, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 10, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	July 24, 2017
1	Addresses October 19, 2017 TDEC Review Comments and Issued for TDEC Review	January 12, 2018
2	Addresses March 9, 2018 TDEC Review Comments and Issued for TDEC Review	May 11, 2018
3	Addresses June 11, 2018 TDEC Review Comments and Issued for TDEC Review	July 20, 2018
4	Addresses comments and revisions from other EIPs and issued for TDEC review.	December 10, 2018

GROUNDWATER INVESTIGATION
SAMPLING AND ANALYSIS PLAN
JOHNSONVILLE FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Groundwater Investigation
Sampling and Analysis Plan
Johnsonville Fossil Plant
Tennessee Valley Authority
New Johnsonville, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 10, 2018 Revision 4, Final

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager — 12/6/18 Date

TVA Investigation Field Lead — 12/6/18 Date

Health, Safety, and Environmental (HSE) Manager — 12/05/2018 Date

Investigation Project Manager — 12/7/2018 Date

Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=[illegible], c=US Date: [illegible]
QA Oversight Manager — Date

Laboratory Project Manager — 12.4.18 Date

Charles L. Head
TDEC Senior Advisor — Date

Robert Wilkinson
TDEC CCR Technical Manager — Date

Stantec

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LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order), to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Johnsonville Fossil Plant (JOF) on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management at JOF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC submitted a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 24, 2017, TVA submitted JOF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

In response to TDEC's comments, TVA has developed this Groundwater Investigation Sampling and Analysis Plan (SAP) to investigate groundwater conditions at the JOF Plant (Plant). The Groundwater Investigation SAP provides the procedures necessary to conduct investigation activities associated with the sampling and analysis of groundwater.

2.0 OBJECTIVES

The objective of the Groundwater Investigation SAP is to provide the procedures necessary to characterize existing groundwater quality and evaluate groundwater flow conditions on the TVA Plant, in response to the TDEC Commissioner's Multi Site Order. The approach in characterizing the groundwater conditions is to collect groundwater samples for chemical analyses and measure groundwater and surface water elevations to evaluate the potential presence of CCR-related constituents in groundwater and direction of groundwater flow to respond to TDEC's request.

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLING LOCATIONS

TVA is currently sampling groundwater at JOF for TDEC Solid Waste Management permit requirements, the United States Environmental Protection Agency (US EPA) CCR Rule, and state compliance requirements. Monitoring wells sampled as part of other programs will not be sampled as part of this SAP. However, groundwater levels will be measured in certain wells within the existing monitoring network as part of this SAP to provide information to prepare groundwater contour maps for the Plant.

For the purposes of the SAP, observation wells are defined as wells that will be used to observe changes in groundwater levels over time, and monitoring wells are defined as wells that will be used to monitor groundwater quality and measure groundwater levels. Existing wells that are screened completely or partially in bedrock or weathered shale were designated as observation wells because groundwater quality results from these wells may not be representative of the targeted overburden zone where groundwater has been encountered. However, groundwater level measurements from these wells provide useful information related to groundwater flow conditions. The existing wells designated as monitoring wells are screened in the overburden and provide useful information related to groundwater quality and groundwater flow conditions.

Groundwater samples collected from monitoring wells from other programs will be used as applicable to the TDEC Order. However, duplicate samples will not be collected as part of the EIP Implementation (hereafter referred to as investigation) if samples have already been or will be collected as part of another program at the same time as proposed in the investigation sampling schedule. The data collected for other programs will be utilized in the Environmental Assessment Report (EAR).

Sampling Scope

TVA will measure groundwater levels at the following locations across the site:

- Existing monitoring and observation wells 10-AP1, 10-AP3, 89-B10, 94-B16, 99-B19, 99-B20A, B-6R, B-8R, B-9, B-11, B-12, B-13, JOF-101, JOF-102, JOF-103, JOF-104, JOF-105 and A-3;

- Proposed monitoring wells JOF-108 through JOF-114 and JOF-117 through JOF-120 (note that JOF-120 is proposed to be an alternate and may not be installed); and

- Proposed vibrating wire piezometer JOF-116-PZ.

The Hydrogeological Investigation SAP provides the rationale, locations, and installation methods for proposed monitoring wells and piezometer.

Surface water elevations will be measured at the existing gauging station (GS-1) in the Tennessee River/Kentucky Lake as shown in Figure 1 in Attachment A.

Groundwater samples will be collected for chemical analyses from the proposed monitoring wells JOF-108 through JOF-114 and JOF-117 through JOF-120 and submitted for laboratory analysis of parameters listed in Section 5.2.7.

Figure 1 shows the well and piezometer locations that will be sampled or from which groundwater elevation measurements will be collected as part of this SAP. This figure will be updated to show the actual locations for wells after execution of the Hydrogeological Investigation SAP. If additional wells are needed to fully characterize groundwater at JOF, then those additional wells will be monitored according to the Groundwater Investigation SAP.

Sampling Frequency

TVA plans to conduct six sampling events, at a frequency of one event every two months, for one year as part of the investigation to characterize seasonal groundwater flow direction, rates, and quality. According to the United States Environmental Protection Agency (U.S. EPA) Project Summary document "Sampling Frequency for Ground-Water Quality Monitoring" dated September 1989 (U.S.EPA 1989), quarterly and bimonthly groundwater sampling frequencies are appropriate for major, non-reactive chemical constituents. However, more frequent sampling intervals are not recommended due to potential statistical autocorrelation issues.

Data from these six sampling events will be provided in the EAR.

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to prepare for field activities, collect groundwater samples, take groundwater and surface water elevation measurements, and assist in providing scientifically defensible results.

Groundwater sampling will adhere to applicable EPA and TVA Environmental Technical Instruction (TI) documents. A project field book and field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will conduct the following:

- Designate a Safety Officer
- Review applicable reference documents, including (but not limited to), TVA Tis (Section 5.5) and Standard Operating Procedures (SOPs), Quality Assurance Project Plan (QAPP; Appendix C), SAPs, and HASP.
- Complete required health and safety documentation, field readiness checklist, and confirm field team members have completed required training
- Coordinate field activities with the Laboratory Coordinator, including ordering sample bottles and preservatives, obtaining coolers and distilled water, if needed, and notifying the laboratory of sampling dates
- Obtain required calibrated field instruments, including health and safety equipment, water level meters, and equipment needed for measuring parameters that define stability during well purging
- Discuss project objectives and potential hazards with project personnel
- Obtain a control box for dedicated pumps
- Complete sample paperwork to the extent possible, prior to deploying into the field, including chain-of-custody forms and sample labels
- Obtain ice prior to sample collection for sample preservation.

5.2 SAMPLING METHODS AND PROTOCOL

5.2.1 Groundwater and Surface Water Level Measurements

Prior to sampling, each monitoring well and staff gauge will be inspected for damage or indications that the well integrity has been compromised. If field observations indicate the need for well or staff gauge maintenance or repairs, the Field Team Leader will notify TVA.

After the monitoring well and staff gauge integrity inspection is completed, the water level in each well and at each staff gauge will be measured in relation to a surveyed reference point (e.g., top of well casing) using an electronic water level indicator. Groundwater elevation data will be measured and recorded in accordance with TVA TI ENV-TI-05.80.44, *Groundwater Level and Well Depth Measurement*. The elevation will be recorded to the nearest 0.01 foot. To the extent possible, the field team will minimize the length of time between collection of the first and last water level measurement for the monitoring well network and staff gauges. At a minimum, measurements will be made within the same day. In addition, barometric pressure readings will be recorded daily. TVA plans to use a multi-parameter sensor equipped with a National Institute of Science & Technology (NIST) certified temperature sensor.

The water level indicator will be decontaminated between each well by following the decontamination procedures provided below in Section 5.2.8.

5.2.2 Well Purging

Following the measurement of groundwater levels, monitoring wells will be purged using pumps dedicated to each well. Purging will continue until field measurements of water quality parameters stabilize during three consecutive readings at 3 to 5-minute intervals per the criteria listed in TVA TI ENV-TI-05.80.42, *Groundwater Sampling*. The stabilization criteria follow:

- pH - ±0.1
- Specific conductivity - ±5% microSiemens per centimeter (µS/cm) in accordance with ENV-TI-05.80.42 (Rev 0001, effective date 3/31/2017).
- Dissolved oxygen (DO) - ±10% for > 0.5 milligrams per Liter (mg/L) or <0.5 mg/L
- Turbidity - below 10 Nephelometric turbidity units (NTUs) or ±10% for values above 10 NTUs

Field measurements, including pH, specific conductivity, turbidity, oxidation/reduction potential, and temperature, will be collected during purging using a flow-through cell. Once the field parameters have stabilized, samples will be collected. For low yield wells, field parameters will be measured at the time of sample collection in an open sample container using a multi-parameter probe. A final turbidity measurement will be made after each sample is collected.

If after two hours of purging field parameters have not stabilized, then groundwater samples will be collected and the efforts to stabilize parameters will be recorded in the field log book and field data sheet. A final turbidity measurement will be made after each sample is collected.

Purging beginning and end times, pumping rates, water quality parameter readings, and groundwater levels will be recorded throughout the purging operation on field sampling forms. The total volume purged at each well may vary based on recharge rates and stabilization of water quality parameters.

Low-flow purging techniques will be used to collect a representative sample from the water bearing unit unless the wells do not yield sufficient water. If the well has been sampled historically using low-flow sampling methods, then the well will be purged at the rate known to induce minimal drawdown. If pump settings are unknown, purging will begin at a minimum pumping rate of 0.1 liter per minute (L/min) and will be slowly increased to a setting that induces little or no drawdown, if possible. Pumping rates will not exceed 0.5 L/min. If drawdown exceeds 0.3 feet, but reaches stability, purging of the well will continue and the current flow rate, drawdown, and time will be recorded on the field data sheet by the sampler.

Low yield wells will be purged until standing water is removed. Groundwater samples will be collected with a low-flow pump, as soon as water levels return to 80% within the well bore to obtain the necessary sample volume, but no later than 24 hours after the well purge.

5.2.3 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Field Team Leader, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP (Appendix C).

5.2.4 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS or global positioning system (GPS) documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.2.4.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.4.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks. TVA groundwater sampling forms will be used to document groundwater level measurements, stabilization parameters and field observations at each monitoring well location.

5.2.4.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COC forms will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality control (QC) check of samples in each cooler compared to sample IDs on the corresponding COC form. The Investigation Project Manager will staff the project with a field sample manager during sample collection activities. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.2.4.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.5 Collection of Samples

5.2.5.1 Groundwater Sampling

A final reading of water quality parameters will be conducted and documented on field sampling forms at the time of sample collection, but these measurements will not be from the sample itself. Unfiltered groundwater samples will be collected in appropriate, laboratory provided, pre-preserved sample containers. Samples will be collected directly from the pump discharge line.

The sampler will wear clean latex (or equivalent) gloves when handling sample containers and will not touch the interior of containers or container caps. New gloves will be used when handling each sample. When filling sample bottles, care will be taken to minimize sample aeration (i.e., water will be directed down the inner walls of the sample bottle) and avoid overfilling and diluting preservatives. Each sample bottle will be capped before filling the next bottle.

It will be necessary to collect filtered (dissolved) inorganic constituent samples, in addition to unfiltered (total) inorganic constituent samples, if the final turbidity value prior to sampling exceeds 10 NTUs. Dissolved sample collection will be accomplished in accordance with TVA TI ENV-TI-05.80.42.

Issues that could affect the quality of samples will be recorded on the field data sheet or in the log book along with the action(s) taken to resolve the issue. These could include observations such as clogged sampling tubes, highly turbid samples or defective materials or equipment.

5.2.6 Preservation and Handling

Sample containers will be labeled in accordance with TVA TI ENV-TI-05.80.02, *Sample Labeling and Custody.* Once each sample container is filled, the rim and threads will be cleaned by wiping with a clean paper towel and capped, and a signed and dated custody seal will be applied. Each sample container will be checked to confirm that it is sealed, labeled legibly, and externally clean. Sample containers will be packaged in a manner to prevent breakage during shipment.

Coolers will be prepared for shipment in accordance with TVA TI ENV-TI-05.80.06, *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright position. Small uniformly sized containers will be stacked in an upright configuration and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory. Loose ice will be placed around and among the sample containers to cool the samples to less than 6 degrees Celsius (°C) during shipment. The cooler will be filled with additional packing material to secure the containers.

The original COC form will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC form will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC form and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC form. If multiple coolers are required to ship samples contained on a single COC form, then the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e., strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC form. If there are discrepancies the Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Project Manager.

5.2.7 Sample Analyses

Groundwater samples will be submitted to the TVA-approved laboratory for analysis. Samples will be analyzed for the CCR related constituents listed in Title 40 of the Code of Federal Regulations Part 257 (40 CFR 257), Appendices III and IV. In addition, five inorganic constituents listed in Appendix I of TN Rule 0400-11-01-.04 (i.e., TDEC regulations), and not included in the 40 CFR 257 Appendices III and IV, will be analyzed to maintain continuity with TDEC environmental programs. The additional constituents listed in TDEC Appendix 1 include the following metals: copper, nickel, silver, vanadium, and zinc. The combined federal CCR Appendices III and IV constituents, and TDEC Appendix I inorganic constituents, will hereafter be referred to collectively as "CCR Parameters."

For geochemical evaluation, major cations/anions not included in the CCR Parameters are included in the analyses for this SAP. The additional geochemical parameters include bicarbonate, carbonate, magnesium, potassium and sodium.

Tables 1 through 4 summarize the constituents requiring analysis. Analytical methods, preservation requirements, container size, and holding times for each chemical analysis are presented in Table 5. Additional sampling and laboratory-specific information is covered in more detail in the QAPP.

Table 1. 40 CFR Part 257 Appendix III Constituents

Appendix III Constituents
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids

Table 2. 40 CFR Part 257 Appendix IV Constituents

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 Combined

Table 3. TN Rule 0400-11-01-.04, Appendix I Inorganic Constituents

TDEC Appendix I Constituents*
Copper
Nickel
Silver
Vanadium
Zinc

* Constituents not listed in CCR Appendices III and IV

Table 4. Additional Geochemical Parameters

Major Cations/Anions
Bicarbonate
Carbonate
Magnesium
Potassium
Sodium

Table 5. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Metals, dissolved	SW-846 6020A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Metals, total	SW-846 6020A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Mercury, dissolved	SW-846 7470A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Mercury, total	SW-846 7470A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Radium 226	SW-846 903.0	HNO3 to pH < 2 Cool to <6°C	1 L glass or Plastic	180 days
Radium 228	SW-846 904.0	HNO3 to pH < 2 Cool to <6°C	2 L glass or plastic	180 days
Chloride	SW-846 9056A	Cool to <6°C	250-mL HDPE	28 days
Fluoride	SW-846 9056A	Cool to <6°C	250-mL HDPE	28 days
Sulfate	SW-846 9056A	Cool to <6°C	125-mL HDPE	28 days
pH	SW-846 9040C (field measurement)	NA	NA	15 minutes
Total Dissolved Solids	SM2540C	Cool to <6°C	250-mL HDPE	7 days
Alkalinity (Total, Carbonate, and Bicarbonate)	SM2320B	Cool to <6°C	250-mL HDPE	14 days

The pH of groundwater samples will be measured in the field.

5.2.8 Equipment Decontamination Procedures

Documented decontamination will be performed for non-dedicated groundwater sampling equipment in contact with groundwater or surface water in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination. Pumps are dedicated to each well and do not need to be decontaminated. Decontamination activities will be performed away from surface water bodies and areas of potential impacts. Decontamination of non-disposable sampling equipment or instruments can be performed using water and Liquinox ® or other appropriate non-phosphatic detergent in 5-gallon buckets. Following decontamination, fluids will be disposed in accordance with Section 5.2.9.

Decontamination of sampling equipment and instruments (i.e., water level meters, etc.) will be performed prior to use and between sampling locations. Decontamination activities will be documented in the logbook field notes. Additional information regarding equipment decontamination procedures is located in the QAPP.

5.2.9 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Purge water
- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*, the plant's site-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to groundwater sampling and analysis.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to confirm that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Project Manager considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Five types of field QA/QC samples will be collected during sampling activities: field duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, equipment blanks, field blanks, and filter blanks. QA/QC samples will be collected in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control* and the QAPP. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below.

Field Duplicate Samples – One duplicate sample will be collected for every 20 samples or once per sampling event. Duplicate samples will be prepared as blind duplicates and will be collected in two sets of identical, laboratory-prepared sample bottles. The primary and duplicate samples will be labeled according to procedure in Section 6.2.1. Sample identifier information will not be used to identify the duplicated samples. Actual sample identifiers for duplicate samples will be noted in the field logbook. The duplicate sample will be analyzed for the same parameters as the primary sample.

MS/MSD Samples – A sufficient volume of sample will be collected for use as the MS/MSD. MS/MSD samples will be collected to allow matrix spike samples to be run to assess the effects of matrix on the accuracy and precision of the analyses. One MS/MSD sample will be analyzed for every 20 groundwater samples collected or once per sampling event. Additional sample volume intended for use as the MS/MSD must be identified in the comments field on the COC records and sample labels. The location of sample collection will be noted in the log book. The MS/MSD sample will be analyzed for the same analytes as the primary sample, with the exception of parameters that are not amenable to MS/MSD.

For parameters such as Total Suspended Solids and radium that are not amenable to the MS/MSD procedure, additional sample volume will be collected for laboratory duplicate analysis per the QAPP.

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected for each sampling event. The equipment blank will be collected at a groundwater sampling location by pouring laboratory-provided deionized water into or over the decontaminated sampling equipment (e.g., a decontaminated water level meter), then into the appropriate sample containers. The time and location of collecting the equipment blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the monitoring well location where the equipment blank is prepared. If the tubing used to collect the equipment blank is not certified clean tubing, then a tubing blank will be collected at a frequency of one blank per lot.

Field Blanks: One field blank sample will be prepared per day using laboratory-supplied deionized water. The sample will be analyzed for the same analytes, with the exception of pH.

Filter Blanks – One filter blank will be collected during each day of the sampling activities when dissolved parameters are collected for analysis. The filter blank will be collected at a groundwater sampling location by passing laboratory-supplied deionized water through in-line filters used in the collection of dissolved metals (or other analytes), then into the appropriate sample containers. The time and location of collecting the filter blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the filter blank is prepared. The filter lot check is to be performed one per lot of filters used and scheduled in a manner to allow for the laboratory to report data prior to investigative sample collection.

6.2.1 Sample Labels and Identification System

Sample identification (IDs) will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, Sample Labeling and Custody and ENV-TI-05.80.03, Field Record Keeping. Each sample container will have a sample label affixed and secured with clear package tape as necessary to prevent removal of the label. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP

Table 6. Preliminary Schedule for Groundwater Investigation SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Groundwater Investigation SAP Submittal		Completed
Prepare for Field Activities for the first bimonthly sampling event	10 Days	Following Completion of Monitoring Well Development
Conduct Field Activities	5 Days	Following Field Preparation
Laboratory Analysis	50 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

Note: Monitoring well installation and development schedules are provided in the Hydrogeological Investigation SAP.

Six bimonthly groundwater sampling events for one year are proposed for this EI. The first bimonthly sampling event will occur 10 days after completion of development of the proposed monitoring wells. The next five sampling events will occur on a bimonthly basis.

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Plant-specific safety requirements are anticipated to include TVA specified training and attendance at a safety briefing. Only Field Team members and subcontractors performing work activities will be required to meet the above requirements.
- A dedicated Safety Officer will be present for this work.
- Access to well locations will be provided by TVA prior to the field preparation start date for each round of sampling.

9.0 REFERENCES

Tennessee Valley Authority (TVA). 2017a. "Sample Labeling and Custody." Technical Instruction ENV-TI-05.80.02, Revision 0001 March 31.

Tennessee Valley Authority (TVA). 2017b. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017c. "Field Sampling Quality Control." Technical Instruction ENV-TI-05.80.04, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017d. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017e. Handling and Shipping of Samples. Technical Instruction ENV-TI-05.80.06, Revision 0000 March 31.

Tennessee Valley Authority (TVA). 2017f. "Groundwater Sampling." Technical Instruction ENV-TI-05.80.42, Revision 0001. March 31.

Tennessee Valley Authority (TVA). 2017g. "Groundwater Level and Well Depth Measurement." Technical Instruction ENV-TI-05.80.44, Revision 0000. March 31

Tennessee Valley Authority (TVA). 2017h. "Field Measurement Using a Multi-Parameter Sonde." Technical Instruction ENV-TI-05.80.46, Revision 0000. March 31.

United States Environmental Protection Agency (U.S. EPA). 1989. "Sampling Frequency for Ground-Water Quality Monitoring Project Summary Document." September.

ATTACHMENT A
FIGURE

Figure No.
1

Title

Proposed Groundwater Well Locations
Johnsonville Fossil Plant

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

0 | 700 | 1,400 | 2,100 | 2,800 Feet

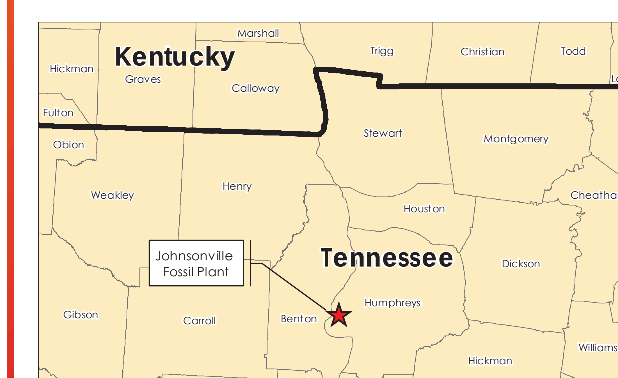
1:8,406 (At original document size of 22x34)

Legend

- Proposed Vibrating Wire Piezometer
- Proposed Groundwater Monitoring Well
- CCR Well
- CCR/State Monitoring Well
- State Compliance Monitoring Well
- Observation Well
- Surface Water Gauging Station
- TVA Property Boundary
- CCR Unit Boundary (Approximate)
- Coal Yard

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TVA (2017) & ESRI Basemaps
3. JOF-115 is a proposed alternate background monitoring well location.



Stantec
TVA

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ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Groundwater Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Flow measurement supplies (e.g. graduated cylinder, stop watch)
Water level indicator meter
Oil/water interface meter
Photoionization detector (PID)
Sample filtration device and filters
Dedicated well sampling pumps, fittings, and tubing
Stainless steel clamps
Pump controller and power supply
Air compressor, air line heads, and end fittings
Generator (if needed)
Multi-parameter Sonde with flow-through cell
Multi-parameter sensor equipped with a National Institute of Science & Technology (NIST) certified temperature sensor
Turbidity meter
***These items are detailed in associated planning documents to avoid redundancy.**

APPENDIX G
DYE TRACE STUDY SAP

Dye Trace Study
Sampling and Analysis Plan
Johnsonville Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Johnsonville Fossil Plant
New Johnsonville, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 10, 2018

REVISION LOG

Revision	Description	Date
2	Issued for TDEC Review	May 11, 2018
3	Addressed TDEC Comments and Issued for TDEC Review	July 20, 2018
4	Issued for TDEC Review	December 10, 2018

DYE TRACE STUDY
SAMPLING AND ANALYSIS PLAN
JOHNSONVILLE FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Dye Trace Study
Sampling and Analysis Plan
Johnsonville Fossil Plant
Tennessee Valley Authority
New Johnsonville, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 10, 2018 Revision 4, Final

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager	12/6/18 Date
TVA Investigation Field Lead	12/6/18 Date
Health, Safety, and Environmental (HSE) Manager	12/05/2018 Date
Investigation Project Manager	12/7/2018 Date
Rock J. Vitale (Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.12.03 11:51:20 -05'00') QA Oversight Manager	Date
Ralph O. Ewers Ph.D. Laboratory Project Manager	12/05/18 Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

Stantec

Table of Contents

LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order), to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Johnsonville Fossil Plant (JOF) on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management at JOF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC submitted a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 24, 2017, TVA submitted JOF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

According to recent discussions between TVA and TDEC personnel, TDEC is requesting that a dye trace study be conducted to determine if the Tennessee River/Kentucky Lake is influencing groundwater flow beneath Active Ash Pond 2. In response to TDEC's comments, TVA developed this Dye Trace Study Sampling and Analysis Plan (SAP). The dye trace study activities will be performed in various tasks, which will consist of a bench study, background study, dye injections, and monitoring and analysis.

2.0 OBJECTIVES

The objective of this Dye Trace Study SAP is to determine if preferential hydrogeologic transport pathways are present between CCR units and surface water bodies using dye detection. This SAP provides the procedures necessary to conduct the dye trace study activities.

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 DYE TRACE STUDY AREA

The activities described in this SAP will only be conducted within and around the periphery of Active Ash Pond 2 and adjacent surface water bodies. The general study area is shown in the Figure 1 (Attachment A).

The installation of borings will be overseen by a Tennessee licensed Professional Geologist. Results of the site activities will be included and described in the Environmental Assessment Report (EAR).

4.1 BENCH STUDY

Prior to the dye injections, samples of the surface impoundment CCR material will be collected from the bottom five-feet of material in both the northern and southern portions of Active Ash Pond 2 using either a direct-push technology (DPT) or truck-mounted drill rig. The samples of the material will be used in bench tests to determine how various dyes interact with, and are affected by, the CCR material. The results of the bench tests will assist in selecting the appropriate dyes for the injections.

Locations of the borings from which surface impoundment material will be collected for the bench study analyses are depicted in Figure 1 (Attachment A) and are shown in profile on Figure 2 (Attachment A).

The bench study will be used to identify which of the commercially-available organic dyes adsorbs the least to the CCR substrate, including pore water retained within the CCR samples, (i.e., it is the most "conservative" or "non-reactive") for use in the field-scale study. A conservative dye tracer will readily disperse through saturated media without significant mass loss and better reflect an unattenuated transport velocity.

The following dyes are proposed for the bench study:

- Sodium fluorescein Acid Yellow 73
- Eosine Acid Red 87
- Rhodamine-WT Acid Red 388
- Sulpho-rhodamine B Acid Red 52

The dyes listed are fluorescing compounds that are known as xanthene dyes. Xanthene dyes are water soluble, stable (i.e., not easily affected by geochemical changes), readily disperse (i.e., not adsorbed by formation materials), are not known to cause toxicological impacts, and have low detection limits. They are strongly fluorescent, making detection possible even under highly dispersive conditions that may exist within the CCR unit. For these reasons, xanthene dyes are generally considered to be conservative tracers (Flury 2003).

4.2 BACKGROUND STUDY

To determine if residual dyes are present within the hydrogeologic system and adjacent surface water, a background study will be conducted prior to dye injection activities. Dye detectors, which are comprised of approximately 10 grams of granular activated carbon housed in a vinyl coated fiberglass screen cloth, will be placed in the groundwater monitoring wells and open standpipe piezometers around the periphery of Active Ash Pond 2 that are deemed suitable. The monitoring wells will include wells JOF-103, JOF-104, 10-AP1, 10-AP3, JOF-118, and JOF-119. Background of the surface water will be monitored at surface water detection points prior to dye injection and will continue at five points to the south of the island throughout the duration of the injection study. The five background monitoring points are depicted on Figure 1 (Attachment A).

Dye detectors will be inserted into each monitoring well and piezometer by attaching the dye detector packets to a weighted monofilament line. After the dye detectors have remained in the monitoring wells and piezometers for a background period of approximately one week, the dye detectors will be retrieved. The detectors will be analyzed for the dyes listed in Section 4.1. Depending on what dyes, if any, are present, dyes for the injections will then be selected.

4.3 DYE INJECTION ACTIVITIES

Prior to conducting dye injection activities, new dye detectors will be placed in the groundwater monitoring wells and piezometers around the periphery of Active Ash Pond 2. Dye detectors will also be placed in the surface water around the periphery of Active Ash Pond 2 to monitor the adjacent Kentucky Lake as well as the boat harbor and inlet channel. The dye detector packets around the periphery will be suspended no less than 5-feet deep in the surface water by securing each detector to a wire embedded in a weighted concrete base and attached to a buoy. The proposed monitoring points around the periphery of Active Ash Pond 2 are also shown in Figure 1 (Attachment A).

A DPT drill rig will then be utilized to advance the proposed injection points to a depth immediately above the surface impoundment CCR/clay bottom interface at five locations in Active Ash Pond 2. One unique dye will be injected into the injection point locations (IP-3, IP-4, and IP-5 in Figure 1) advanced within the northern portion of the surface impoundment and another unique dye will be injected into the injection point locations (IP-1 and IP-2 in Figure 1) advanced within the southern portion of the surface impoundment. The selected dyes will be injected into the points in an effort to disperse the dyes at the surface impoundment CCR/clay bottom interface. Upon completion of the dye injection activities, each injection point will be filled to grade with bentonite-slurry mixture as the DPT drill rods are extracted. The locations of the injection borings are depicted in Figure 1 (Attachment A).

After approximately one week, the dye detectors will be retrieved, labeled, packaged and transported to the analytical laboratory for analysis. New dye detectors will be placed into each monitoring well and piezometer and at each surface water monitoring location after retrieval of the initial dye detectors. The process of dye detector retrieval and replacement will continue every week for two months. Beginning with the third month, dye detectors will be deployed and retrieved approximately twice per month for four months; however, sampling a detection point (well/piezometer) will cease upon two positive confirmations that recovery of dye has occurred via laboratory analysis.

To monitor potential dyes from an off-site source upstream that could impact the Active Ash Pond 2 dye trace study area, a dye detector will be placed along the upstream portion of the surface impoundment, which is the southwestern tip of the unit. Another dye detector will be placed at the southeastern tip of the unit. Two additional dye detectors will be placed upstream, positioned adjacent to the eastern and western banks of the Kentucky Lake/Tennessee River, near the Broadway Avenue/US 70-East Bridge. A dye detector will also be located in the spillway of Active Ash Pond 2. If dye is detected coming out of the pond through the NPDES outfall, then the study will be terminated for that dye.

The proposed background surface water monitoring locations can also be seen in Figure 1 (Attachment A).

5.0 DATA COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to prepare for and execute the planned dye trace study. The SAP was developed to include methodologies that are consistent with accepted field and data management practices and support the generation of scientifically defensible results.

Dye tracing activities will adhere to applicable TVA Environmental Technical Instruction (TI) documents. A project field book and field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, Field Record Keeping.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will:

- Designate a Safety Officer and a Tennessee-licensed Professional Geologist.
- Review applicable reference documents, including (but not limited to), TVA TIs (Section 5.5) and Standard Operating Procedures (SOPs), Quality Assurance Project Plan (QAPP; Appendix C), SAPs, and HASP.
- Complete required health and safety paperwork, field readiness checklist, and confirm field team members have completed the required training.
- Coordinate activities with the Laboratory Coordinator, including ordering dye detectors (charcoal packets), stainless steel clips, monofilament line, stainless well weights, the various tracer dyes, sample containers, coolers, and notifying the laboratory of sampling and sample arrival dates.
- Obtain required calibrated field instruments, including health and safety equipment.
- Discuss project objectives and potential hazards with project personnel.
- Complete and submit the required "Tennessee Department of Environment and Conservation Dye Trace Registration Form" (form CN-112) at least two (2) weeks prior to the planned dye trace study. The completed form will be submitted to the Division of Water Resources, Groundwater Management Section, located in Nashville, Tennessee.
- Coordinate activities with the drilling subcontractor.
- Clear Access – Proposed injection point locations will be marked using a wooden stake or survey flag with the position surveyed using the global positioning system (GPS). Suitability of each location will be evaluated for logistical issues including

access, grubbing needs, overhead and underground utility clearance, and proximity to Plant features. Access improvements, including clearing and grubbing or road building, will be completed prior to the investigation start date.

- Perform Environmental Review – As required by the National Environmental Policy Act (NEPA), an environmental review must be completed to document and mitigate any potential impact of the work described herein. The level of review required for this work is anticipated to be a categorical exclusion, which would be documented by TVA with a categorical exclusion checklist (CEC). A CEC will require a number of signatories from TVA. It is understood that the environmental review is to be completed before implementation of the field work. Additionally, plant staff will not issue an excavation permit ahead of the completed environmental review.

- Complete Utility Locate(s) / Excavation Permit(s) – Prior to initiating subsurface activities, subsurface utility clearance will be sought via the plant engineering department and/or the TN 811 service. At locations within the Plant, engineering will provide primary utility clearance assurance in addition to TN 811 being notified. At all other drilling locations where, underground obstructions or utilities are expected nearby, TVA or 3rd party underground locators will be engaged to clear boring locations. For drilling locations outside the plant (e.g., along public roads and rights-of-way), utility avoidance assurance will be supplemented by the TN 811 service and the TVA or 3rd party underground locators. An excavation permit is required prior to initiating any digging or boring at the Plant. A key component to the completion of the excavation permit is consensus on the drilling locations with pertinent TVA staff.

- Identify Water Source – During implementation of the EIP, a source of potable water will be required to complete several investigation tasks, including certain drilling methods and decontamination procedures.

- Complete sample paperwork to the extent possible, including chain-of-custody forms and sample labels in accordance with TVA TIs ENV-TI-05.80.02, Sample Labeling and Custody and ENV-TI-05.80.03, Field Record Keeping.

- Obtain decontamination materials, including scrub brushes, soap, solvents, buckets, and deionized (DI) water, as indicated in TVA TI ENV-TI-05.80.05, Field Sampling Equipment Cleaning and Decontamination.

- Obtain ice prior to sample collection for sample preservation.

5.2 SAMPLING METHODS AND PROTOCOLS

Drilling activities performed at the Plant during implementation of this SAP will include advancing subsurface boreholes using DPT or auger techniques or other compatible technology based on field conditions and rig availability. If drilling methods that require the use of water are used for the installation of monitoring wells, then only potable water will be used.

The following sections present drilling and sampling procedures required to complete the tasks presented. Once completed, borings and sampling locations will be surveyed for horizontal and vertical control by survey grade GPS.

5.2.1 Drilling, Logging, and Surveying

5.2.1.1 Bench Scale Testing Sample Borings

Probe advancement will be initiated using the static weight of the rig until encountering refusal or the proposed depth is reached. Percussion will be used to advance the probe rods further following maximum penetration under the static load. A new two-inch inside diameter, one-time use clear, polyvinyl chloride (PVC) sample liner will be placed inside the sample barrel before each push to collect continuous soil samples. After the sample rod is pushed to the appropriate depth, it will be retracted, and the liner and sample removed and placed on clean plastic sheeting. A new PVC liner will then be placed in the sampler and another rod will be added to the drill string. DPT samples will be collected as a continuous run until the desired soil boring depth is achieved.

A dedicated sample liner cutter will be used to open the liner for sample retrieval. Soils that are not considered part of the representative sample (e.g., slough as determined by visual inspection of the sample) will be managed in accordance with Section 5.2.8. The core length will be measured to calculate sample recovery. Soils obtained from each sample liner will be logged by a Tennessee-licensed professional geologist. Sampling activities will be conducted according to TVA TI ENV-TI-08.80.50, *Soil and Sediment Sampling.*

Once sample collection is complete at each boring, the boreholes will generally be filled with a bentonite-cement grout mixture using a tremie pipe to within approximately six inches of the surface. The top six inches will be restored to match the existing conditions.

5.2.1.2 Borehole Logging

During boring advancement, each borehole will be logged by a Tennessee-licensed professional geologist. At a minimum, the following information will be recorded in accordance with TVA TI ENV-TI-05.80.03, *Field Record Keeping* and *American Society of Testing and Materials (ASTM) Standard D2488* and entered on boring logs for each borehole and each distinct stratum described:

- Name of person completing boring log.
- Boring identification and boring date.
- Soil color and classification, using Munsell soil color charts and Modified Unified Soil Classification System (USCS) for unconsolidated materials.
- Visual identification of CCR in soil cores, if present.
- Moisture content (e.g. dry, moist, or wet).
- Soil consistency or density, size, shape, and angularity of particles (for fine to coarse grained soils).
- Soil pH as determined in the field using field pH test kits.
- Depth interval represented by stratum observations.
- Additional observations deemed relevant (e.g. presence of groundwater, fractures, GPS survey data, etc.).
- Field boring logs will be collected on field forms and then input to gINT for final production.

5.2.1.3 Surveying

Once completed, borings will be surveyed for horizontal and vertical control using a survey-grade GPS unit. The final survey of each location will be conducted following completion and abandonment of each individual sampling location. The survey data will be added to the final boring logs once available.

5.2.2 Field Equipment Description, Testing/Inspection, Calibration and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Field Team Leader, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP (Appendix C).

5.2.3 Field Documentation

Field documentation will be maintained in accordance with TVA TI *ENV-05.80.03, Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.2.3.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or their designees will approve deviations before they occur.

5.2.3.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks.

5.2.3.3 Chain-of-Custody Forms

For the environmental samples and dye detectors to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COC forms will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality assurance (QA) check of samples in each cooler compared to sample IDs on the corresponding COC form. The Investigation Project Manager will staff the project with a field sample manager during sample collection activities. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.2.3.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be compiled, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.4 Collection of Samples

The dye detectors will be retrieved and placed into individual resealable plastic bags. Each resealable plastic bag will be labeled with the appropriate monitoring well, piezometer, or surface water location designation on the exterior of the baggie using black waterproof, non-erasable ink. Different colored markers will not be used because black waterproof, non-erasable ink does not contain fluorescent compounds. New, disposable latex or nitrile gloves will be used each time a different dye detector packet is handled. The dye detectors will be transported to the laboratory under COC procedures.

5.2.5 Preservation and Handling

Dyes adsorbed onto charcoal are extremely stable. Under normal circumstances, each dye detector packet is placed in separate resealable plastic bag and transported in crush resistant containers at ambient temperature. If more than 48 hours will elapse before the dye detector packets are sent to the laboratory, they will be placed in an iced cooler.

Sample containers will be labeled in accordance with TVA TI ENV-05.80.02, *Sample Labeling and Custody.* The dye detectors will be retrieved and placed into individual resealable plastic bags. Each resealable plastic bag will be securely sealed and cleaned by wiping with a clean paper towel. A signed and dated custody seal will be applied. New, disposable latex or nitrile gloves will be used each time a different dye detector packet is handled. For other samples, such as CCR material, once each sample container is filled, the rim and threads will be cleaned by wiping with a clean paper towel and capped, and a signed and dated custody seal will be applied. Each sample container will be checked to confirm that it is sealed, labeled legibly, and externally clean. Sample containers will be packaged in a manner to prevent breakage during shipment.

Coolers will be prepared for shipment in accordance with TVA TI ENV-TI-05.80.06, *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright position. Small uniformly sized containers will be stacked in an upright configuration, and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory. Loose ice will be placed around and among the sample containers to cool the samples to less than 6 degrees Celsius (°C) during shipment. The cooler will be filled with additional packing material to secure the containers.

The original COC form will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC form will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC form and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC form. If multiple coolers are required to ship samples contained on a single COC form, then the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e., strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC form. If there are discrepancies the Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Project Manager.

5.2.6 Sample Analyses

Samples will be submitted to the TVA-approved laboratory for analysis, as follows:

- Each dye detector will be removed from the resealable plastic bag and rinsed with dechlorinated, activated carbon filtered potable water.
- Each dye detector will then be dried in a temperature controlled, filter forced air, dye free drying cabinet.
- Approximately 3 grams of the activated charcoal will be removed from the zip-lock baggie and placed into a disposable, pre-labeled plastic container.
- The dye (if present) will be eluted with 6 milliliters of Smart Solution for 1 hour, covered (Note: Smart Solution is a 5:2:3 ratio mixture of 1-propanol: 30% ammonium hydroxide: DI Water, respectively).
- Decant the elutent into a clean cuvet.
- Analyze the elutent using a spectrofluorometer.

5.2.7 Equipment Decontamination Procedures

Documented decontamination will be performed for sampling equipment and instruments in contact with water or subsurface materials in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination.

Following decontamination, fluids will be placed into a drum for storage, transportation, and ultimately disposal in accordance with Section 5.2.8. Decontamination activities will be performed away from surface water bodies and areas of potential impacts. Decontamination of non-disposable sampling equipment or instruments can be performed using water and Liquinox® or other appropriate non-phosphatic detergent in 5-gallon buckets.

Decontamination of sampling equipment and instruments (e.g., water level meters, etc.) will be performed prior to use and between sampling locations. Decontamination activities will be documented in the logbook field notes. Additional information regarding equipment decontamination procedures is in the QAPP.

5.2.8 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Soil Cuttings
- Sampling Equipment
- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, ***Field Sampling Equipment Cleaning and Decontamination***, the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to pore water sampling and analysis.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to confirm that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Project Manager considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Field duplicate samples will be added to the dye detector collection activities. QA/QC samples will be collected in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control*. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below. A complete description of the QA requirements is provided in the QAPP.

Field Duplicate Samples – One duplicate sample will be collected for every 10 samples or once per sampling event. Duplicates samples will be prepared as blind duplicates and will be deployed and collected in the same manner. The primary and duplicate samples will be labeled according to procedure in Section 6.2.1. Sample identifier information will not be used to identify the duplicated samples. Actual sample identifiers for duplicate samples will be noted in the field logbook.

Trip Blanks – During retrieval and replacement of each dye detector, a new, unused dye detector will be placed in a resealable plastic bag and labeled as "clean". The "clean" packet will be maintained, transported, and analyzed in the same manner as the primary dye detectors.

Equipment Blanks (Rinsate Blanks) – Where non-disposable sampling equipment is used to collect the sample, one equipment (rinsate) blank will be collected for each sampling event. The equipment blank will be collected at a sampling location by pouring laboratory-provided deionized water into or over the decontaminated sampling equipment, then into the appropriate sample containers. The time and location of collecting the equipment blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the equipment blank is prepared.

6.2.1 Sample Labels and Identification System

Sample identifications (IDs) will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*. Each sample container will have a sample label affixed and secured with clear package tape as necessary to prevent removal of the label. Information on sample labels will be recorded in waterproof, non-erasable ink.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. The study will begin after the installation of the two additional proposed groundwater monitoring wells, JOF-118 and JOF-119, for additional monitoring points. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 1. Preliminary Schedule for Dye Trace Study SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Dye Trace SAP Submittal		Completed
Prepare for Field Activities	25 Days	Following NTP
Conduct Field Activities	270 Days	Following Field Preparation and installation of wells JOF-118 & JOF-119
Laboratory Analysis (if required)	30 Days	Following Field Activities
Data Validation (if required)	15 Days	Following Lab Analysis

8.0 ASSUMPTION AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Plant-specific safety requirements are anticipated to include TVA specified training and attendance at a safety briefing. Only Field Team members and subcontractors performing work activities will be required to meet the above requirements.
- A dedicated Safety Officer will be present for this work.
- Approved sampling methods and protocols may have to be substituted in the EIP based on changing field conditions.

9.0 REFERENCES

Flury, M. and N. N. Wai. 2003. Dyes as Tracers for Vadose Zone Hydrology. Rev. Geophys. 41(1), 1002, doi: 10.1029/2001RG000109.

ATTACHMENT A
FIGURE

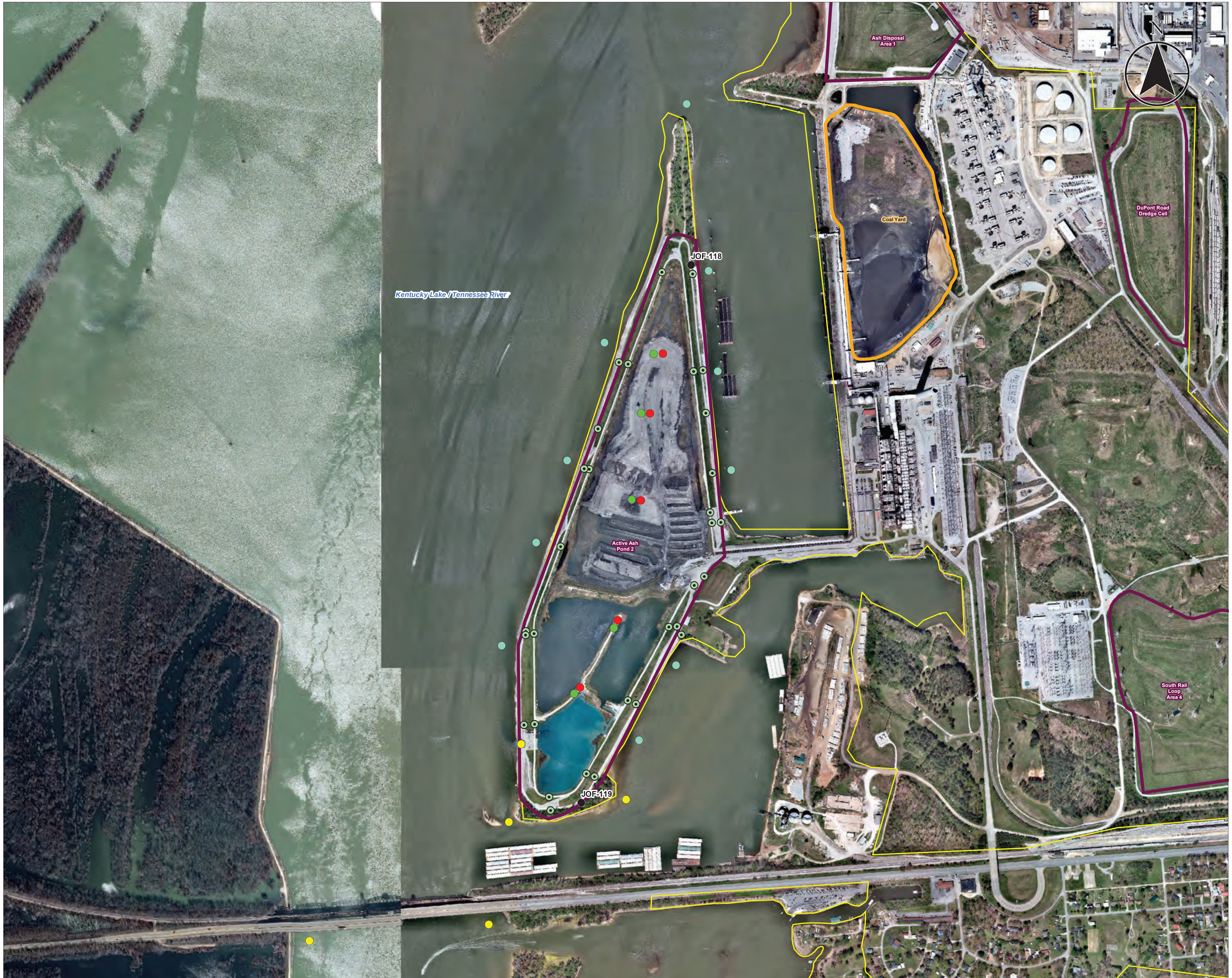


Figure No.
1

Title

Proposed Dye Trace Injection Points Active Ash Pond 2

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

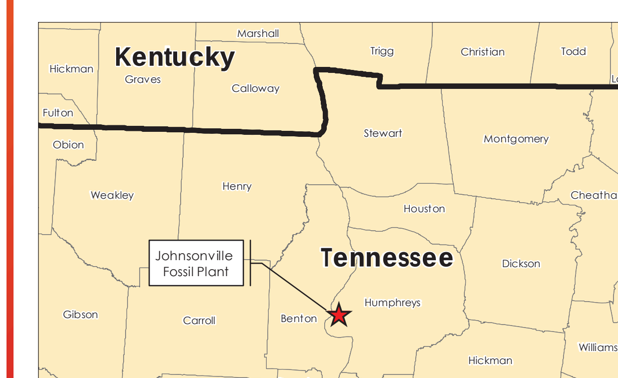
0 400 800 1,200 1,600 Feet
1:4,800 (At original document size of 22x34)

Legend

- Proposed Groundwater Monitoring Well
- Proposed Dye Trace Injection Points
- Proposed Boring Locations to Collect Samples for Bench Study
- Proposed Monitoring Points (In addition to monitoring wells and piezometers)
- Proposed Surface Water Background Monitoring Location
- Existing Piezometer Open Standpipe
- TVA Property Boundary

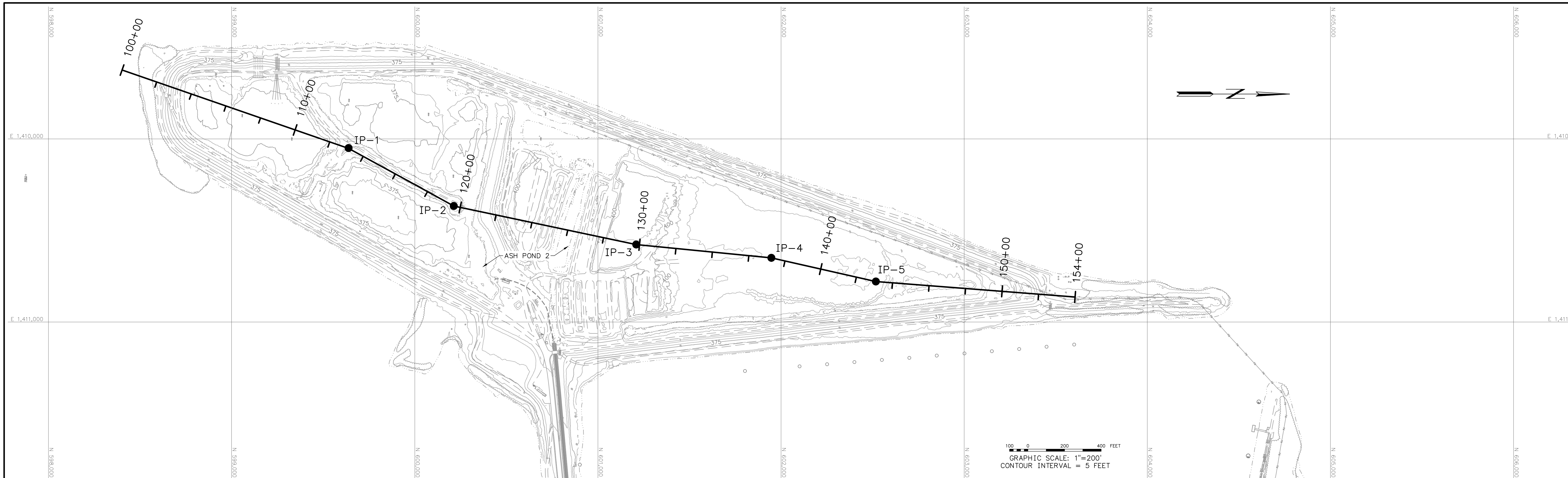
Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)

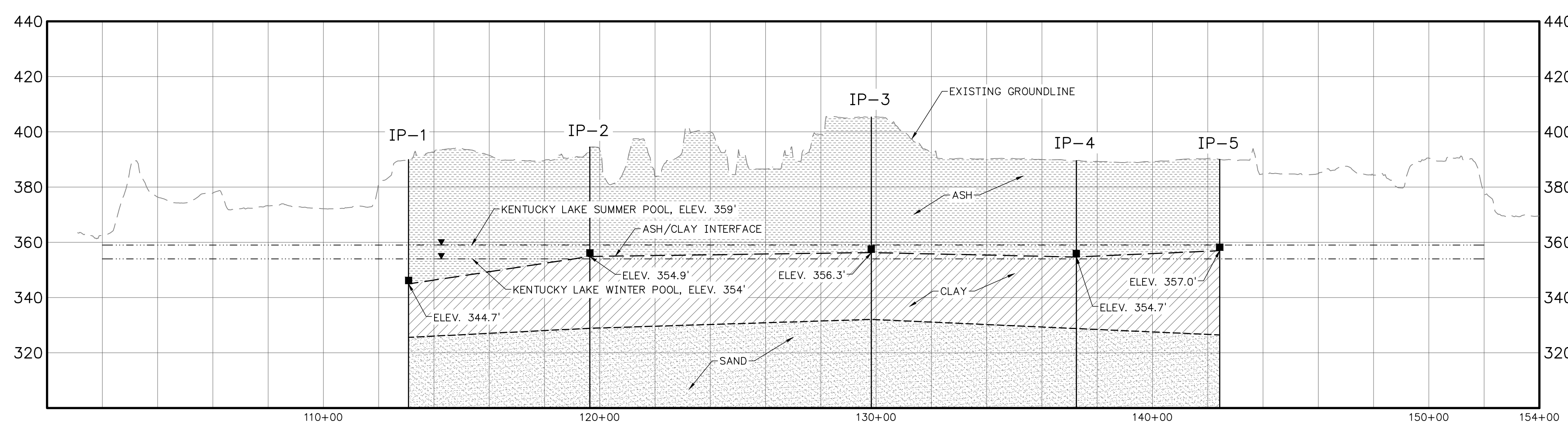


Disclaimer: Stantec assumes no responsibility for data supplied in electronic format. The recipient accepts full responsibility for verifying the accuracy and completeness of the data. The recipient releases Stantec, its officers, employees, consultants and agents, from any and all claims arising in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

U:\TVA-EIP\175567296\gis\mxds\JOF_Trace_Injection_Points_AshPond2.mxd Revised: 2018-12-06 By: mbough



PLAN – DYE INJECTION POINTS
SCALE: 1"=200'



PROFILE – INJECTION POINTS
SCALE: 1"=200' (HORIZONTAL)
1"=20' (VERTICAL)

LEGEND

IP INJECTION POINT

ASH

CLAY

SAND

■ DYE INJECTION ZONE

JOHNSONVILLE FOSSIL PLANT

ACTIVE ASH POND 2
DYE INJECTION POINTS PROFILE
FIGURE 2 - ATTACHMENT A

Stantec
3052 Beaumont Centre Circle
Lexington, Kentucky 40513
www.stantec.com

JOHNSONVILLE FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

JUNE 29, 2018

ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Dye Trace Study

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Resealable plastic bags
Replacement monofilament line and weights
Replacement charcoal packets
***These items are detailed in associated planning documents to avoid redundancy.**

APPENDIX H
EVALUATION OF EXISTING GEOTECHNICAL DATA

Evaluation of Existing Geotechnical Data Johnsonville Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Johnsonville Fossil Plant
New Johnsonville, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 10, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	July 24, 2017
1	Addresses October 19, 2017 TDEC Review Comments and Issued for TDEC Review	January 12, 2018
2	Addresses March 9, 2018 TDEC Review Comments and Issued for TDEC Review	May 11, 2018
3	Addresses June 11, 2018 TDEC Review Comments and Issued for TDEC Review	July 20, 2018
4	Addresses comments and revisions from other EIPs and issued for TDEC review.	December 10, 2018

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LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order), to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Johnsonville Fossil Plant (JOF) on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management at JOF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC submitted a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 24, 2017, TVA submitted JOF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

2.0 OBJECTIVES AND EVALUATION CRITERIA

Through the various information requests, as well as TDEC comments on the EIP, a need has been identified for an evaluation of existing geotechnical data. This document has been prepared to review the existing data and evaluate its adequacy with respect to responding to the various information requests.

Characterization of geotechnical parameters may differ from one evaluation to the next and can be due to multiple factors, such as:

1. Different loading cases (long-term static, short-term static, seismic, etc.) necessitate different strengths,
2. Spatial variation in subsurface conditions and analyses that consider different locations,
3. New information (field data, laboratory data, etc.) that allows updates to the characterization,
4. Changes in subsurface conditions due to the passage of time and/or geometric/operational changes at the site,
5. Evolution of the standard of practice and differences in professional engineering judgement with respect to geotechnical characterization and/or stability analyses,

Such differences are common within geotechnical engineering practice, particularly over a long period of time, with multiple studies performed by various professionals, and as additional data becomes available through various field and laboratory testing efforts. The relevancy of the above factors, with respect to the existing and upcoming analyses will be included as part of the response in the Environmental Assessment Report (EAR).

Evaluating the adequacy of existing data depends on both the type of data and its use. Existing geotechnical data will be used to support the following subjects addressed within the information requests:

1. Three-dimensional model (including CCR saturation) and volumetric estimates,
2. Stability of bedrock below fill areas,
3. Stability of the waste fill and side-slope berms,
4. CCR and soil shear strengths,
5. Potential for solution channeling, karst features, etc. in the shallow rock formations beneath the CCR units.

2.1 THREE-DIMENSIONAL MODEL (INCLUDING CCR SATURATION) AND VOLUMETRIC ESTIMATES

For evaluating the three-dimensional model and volumetric estimates, existing data to be considered (if available) includes:

1. Ground survey, aerial, and hydrographic surveys which including existing ground surface, upper CCR surface, and dike geometry data,

2. Instrumentation data and/or seepage models that include piezometric levels of saturation in CCR,

3. Borings that included the lower CCR surface, thickness of the clay foundation (or other materials) overlying bedrock, and top of bedrock elevations.

4. Electrical Resistivity Imaging (ERI) data that includes interpreted top of bedrock data.

For this subject, the basis for evaluating the adequacy of each type of data listed above are similar:

- Suitability of methods used to perform topographic surveys, geotechnical borings, and geophysical surveys, as well as the associated documentation. Suitability is evaluated qualitatively, based on how well the methods obtain the necessary data and how the methods compare to the current standard of practice.

- Spatial coverage of borings and geophysical surveys.

- Potential for relevant changes in subsurface conditions since borings or surveys were performed.

2.2 STABILITY OF BEDROCK BELOW FILL AREAS

For evaluating the stability of bedrock below fill areas, existing data to be considered (if available) includes:

1. Geotechnical data from borings that included rock coring,

2. Geophysical surveys that included data below the top of bedrock,

3. Routine visual observations of CCR units, with respect to indicators of structural distress.

4. Geologic mapping and characterization of the site, including descriptions of the shallow rock formations.

For this subject, the basis for evaluating the adequacy of each type of data listed above are similar:

1. Spatial coverage of borings, geophysical surveys, and visual observations,
2. Suitability of methods used to perform rock coring, geophysical surveys, and visual observations, and of the associated documentation. Suitability is evaluated qualitatively, based on how well the methods obtain the necessary data and how the methods compare to the current standard of practice.
3. Potential for relevant changes in subsurface conditions since borings, surveys, or observations were performed.

2.3 STABILITY OF WASTE FILL AND SIDE-SLOPE BERMS

For evaluating stability of the waste fill and side-slope berms, existing data to be considered includes:

1. Slope stability analyses of existing conditions,
2. Slope stability analyses of future (i.e., permitted, "build-out", or closed) conditions.
3. Structural stability assessments performed for CCR Rule compliance.

For this subject, the basis for evaluating the adequacy of each type of data listed above are similar:

1. Representative coverage with stability analysis cross sections,
2. Representative cross section geometry and subsurface characterization,
3. Representative material parameters and phreatic conditions,
4. Representative loads (static loads, seismic loads, etc.),
5. Appropriate stability analysis methods,
6. Potential for relevant changes in conditions since analyses were performed.

2.4 CCR AND SOIL SHEAR STRENGTHS

For evaluating CCR and soil shear strengths, existing data to be considered includes:

1. Shear strengths based on in-situ testing,
2. Shear strengths based on laboratory testing,
3. Shear strengths based on published values for similar materials.

For this subject, the basis for evaluating the adequacy of each type of data listed above are similar:

1. Locations of in-situ tests and/or samples for each material,
2. Suitability of methods used to perform in-situ testing, to collect samples, and to perform laboratory testing. Suitability is evaluated qualitatively, based on how well the methods obtain the necessary data and how the methods compare to the current standard of practice.
3. Potential for relevant changes in subsurface conditions since in-situ testing and/or sampling were performed.

2.5 POTENTIAL FOR SOLUTION CHANNELING AND KARST FEATURES

For evaluating the potential for solution channeling in the shallow rock formations beneath the CCR units, existing data to be considered (if available) includes:

1. Geotechnical data from borings that included rock coring,
2. Geophysical surveys that included data at/below the top of bedrock,
3. Geologic mapping/characterization of the site, including descriptions of the shallow rock formations.

For this subject, the basis for evaluating the adequacy of each type of data listed above are similar:

1. Spatial coverage of borings, geophysical surveys, and geologic mapping,
2. Suitability of methods used to perform rock coring, geophysical surveys, and geologic mapping, and of the associated documentation,
3. Potential for relevant changes in subsurface conditions since borings, surveys, or mapping was performed.

3.0 EXISTING GEOTECHNICAL REPORTS

The following sections review and evaluate existing geotechnical reports with respect to the data necessary to support EIP information request responses. Each evaluation begins with a summary table of the key items, followed by additional details of each report.

3.1 TVA (1948)

Table 1. Summary of Evaluation for TVA (1948)

Reference:	Tennessee Valley Authority (TVA). 1948. "Geology of the New Johnsonville Steam Plant Site." Report by John M. Kellberg for TVA Water Control Planning Dept: Geologic Division. January 14.	
Purpose:	Site investigation for proposed steam plant to characterize subsurface conditions to aid in designing foundations	
CCR Unit(s):	General area of JOF site	
Spatial coverage:	Area extending 2,000 feet along the eastern shore of Kentucky Reservoir and 2,000 feet east from the edge of the lake	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	33 borings spaced on either 250- or 500-foot centers
Rock coring:	Yes	33 borings
Other subsurface data:	No	Isometric projection of geologic sections and isopach maps from top of ground to top of weathered rock, and top of ground to proposed foundation grade.
Boring locations surveyed:	No	No indication of survey.
Data adequate to support three-dimensional model:	No	Written descriptions and laboratory test summaries provide comparative data for foundation soils and bedrock. No boring logs provided.
Geometry at time of document representative of 2017 conditions:	No	Foundation soils likely similar, but CCR units had not yet been constructed.
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	Yes	Strength testing of rock. Testing standards were not documented.
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	

Reference:	Tennessee Valley Authority (TVA). 1948. "Geology of the New Johnsonville Steam Plant Site." Report by John M. Kellberg for TVA Water Control Planning Dept: Geologic Division. January 14.	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.1.1 Field Activities

In 1947, 33 soil borings were advanced along the eastern shore of Kentucky Reservoir (i.e., Kentucky Lake). The area of exploration extended 2,000 feet along the eastern shore of Kentucky Reservoir and 2,000 feet east from the edge of the lake (approximate locations are provided in Figure 1 of Attachment A).

It was not documented whether the boring locations were surveyed upon the completion of drilling. Boring diagrams were provided that denoted the approximate location of each boring in relation to site contours that existed prior to construction of the steam plant and the surrounding facilities. Also noted were several small faults that were encountered, and one large fault that was inferred from the boring logs. The faults are thrust faults, striking northwest to southeast and dipping about 60 degrees southwest.

3.1.2 Laboratory Testing

Unconfined compressive strength testing was performed on five selected rock core samples.

3.1.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Top of rock surface
    a. Geologic mapping can be correlated to rock cores and top of rock elevations.
    b. Geologic mapping methods meet current standard of practice.

3.2 TVA (1949)

Table 2. Summary of Evaluation for TVA (1949)

Reference:	Tennessee Valley Authority (TVA). 1949. "Supplemental Report, Geology of the Johnsonville Steam Plant Site." Report by John M. Kellberg for TVA Water Control Planning Dept: Geologic Division. January 5.	
Purpose:	Supplemental site investigation for proposed steam plant to characterize subsurface conditions to aid in designing foundations	
CCR Unit(s):	General area of JOF site	
Spatial coverage:	Area extending approximately 900 feet along the eastern shore of Kentucky Reservoir and 500 feet east from the edge of the lake	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	7 borings total across 4 cross-sections
Rock coring:	Yes	7 borings
Other subsurface data:	Yes	1 test pit with geologic log. Isometric projection of geologic sections.
Boring locations surveyed:	No	No indication of survey.
Data adequate to support three-dimensional model:	No	Written descriptions provide comparative data for foundation soils and bedrock. No boring logs provided.
Geometry at time of document representative of 2017 conditions:	No	Foundation soils likely similar, but CCR units had not yet been constructed.
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.2.1 Field Activities

In December 1948, seven soil borings and one test pit were advanced along the eastern shore of Kentucky Reservoir (i.e., Kentucky Lake). The area of exploration extended approximately 900 feet along the eastern shore of Kentucky Reservoir and 500 feet east from the edge of the lake. The supplemental exploration was within the footprint of the previous geotechnical exploration reported in 1948.

It was not documented whether the boring locations were surveyed upon the completion of drilling. Boring diagrams were provided that denoted the approximate location of each boring in relation to site contours that existed prior to construction of the steam plant and the surrounding facilities. Also noted were several small faults that were encountered, and one large fault that was inferred from the boring logs. The faults are thrust faults, striking northwest to southeast and dipping about 60 degrees southwest.

3.2.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Top of rock surface
    a. Geologic mapping can be correlated to rock cores and top of rock elevations.
    b. Geologic mapping methods meet current standard of practice.

3.3 TVA (1969)

Table 3. Summary of Evaluation for TVA (1969)

Reference:	Tennessee Valley Authority (TVA). 1969. "Memorandum for Johnsonville Steam Plant - Ash Pond - Soil and Foundation Exploration." Prepared for Tennessee Valley Authority. September 17.	
Purpose:	To determine general subsurface conditions and obtain data to evaluate the engineering characteristics of CCR and underlying soils	
CCR Unit(s):	Active Ash Pond 2	
Spatial coverage:	Perimeter dike and interior of impoundment	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	20 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	Yes	Data support dike geometry for hydraulic fill and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Hydraulic fill dike and perimeter foundation soils only
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	Yes	Testing standards are not documented.
Shear strength parameters:	Yes	Static undrained strengths of hydraulic fill and alluvium foundation soil
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	May be used for qualitative comparison to more recent results
Other relevant analyses:	No	

3.3.1 Field Activities

A subsurface exploration program consisted of a total of 20 borings within the area of Active Ash Pond 2, 14 auger borings and 6 undisturbed (Shelby tube) sample borings, with an additional 6 auger borings in Borrow Area "B". The approximate locations for each boring within the impoundment are shown on the boring layout in Figure 2. The undisturbed sample borings were drilled along the centerline of the hydraulic fill perimeter dike on approximately 900-foot centers. The auger borings were drilled within the impoundment interior to ascertain the amount of borrow soils above the elevation of the existing hydraulic fill dike.

The borrow soils were for construction of the Lower Clay Dike. The borings within Borrow Area "B" were spaced to provide general coverage. All borings were drilled using hollow stem augers. Boring depths ranged from 5 to 16.5 feet in Active Ash Pond 2 and from 11.5 to 16.5 feet in Borrow Area "B".

3.3.2 Laboratory Testing

The undisturbed (Shelby) tube samples of the hydraulic fill and foundation soils obtained during conventional drilling were subjected to the following laboratory tests: 21 natural moisture content, 20 Atterberg limits, 21 gradation, 20 unit weight, 20 specific gravity, 21 USCS soil classifications, 6 UU triaxial compression, and 8 CU triaxial compression tests.

Additionally, the borrow area soils were tested for use in future dike construction. The borrow area soils were subjected to the following tests: Atterberg limits, gradation, USCS soil classification, specific gravity, standard Proctor, moisture-penetration, and CU triaxial compression.

3.3.3 Analysis

The scope of this exploration was to characterize foundation soils and potential borrow soils, in preparation for constructing the Lower Clay Dike around the unit perimeter. Potential borrow sources included Borrow Area "A" (within the interior of the unit), as well as nearby Borrow Area "B". The testing program indicated that the borrow and foundation soils are of adequate and relatively equal strengths, with the foundation being slightly weaker. It is noted that isolated pockets of weak foundation soils had been excavated prior to this exploration.

3.3.4 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were provided; however, it is unclear if these were surveyed or estimated based on other means.
    b. Boring logs document material descriptions and thicknesses.
2. Soil properties (including shear strengths)
    a. Sampling and testing did not document ASTM standards. However, based on the lab reports, both appeared to follow standard procedures. Thus, results may be used comparatively to more recent testing.
    b. Subsurface conditions beneath the perimeter dike are substantially the same as current, except that static loads have increased due to construction of Lower and Upper Clay Dikes.

3.4 TVA (1977)

Table 4. Summary of Evaluation for TVA (1977)

Reference:	Tennessee Valley Authority (TVA). 1977. "Memorandum for Johnsonville Steam Plant - Ash Disposal Area No. 2 Dike Raising - Soil Exploration and Testing." Prepared for Tennessee Valley Authority. November 22.	
Purpose:	Geotechnical exploration and evaluation of in-situ and borrow soils associated with construction of Upper Clay Dike of Active Ash Pond 2	
CCR Unit(s):	Active Ash Pond 2	
Spatial coverage:	Perimeter dike	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	14 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed after drilling.
Data adequate to support three-dimensional model:	Yes	Data support dike geometry (hydraulic fill and Lower Clay dike) and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Hydraulic Fill, Lower Clay Dike, and perimeter foundation soils only.
Piezometer installation:	No	
In-situ testing:	Yes	Standard penetration testing.
Laboratory testing:	Yes	Testing standards are not documented.
Shear strength parameters:	Yes	Static undrained strengths on hydraulic fill, lower clay dike fill, bottom ash, alluvial foundation soils, and compacted borrow soils. Static drained strengths on lower clay dike fill and bottom ash.
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	Material properties and strength parameters may be used to compare to more recent results.
Other relevant analyses:	No	

3.4.1 Field Activities

A geotechnical drilling program was developed that consisted of a total of 14 soil borings: 11 SPT borings and 3 undisturbed sample borings. The boring locations were surveyed after drilling (approximate locations are shown on the boring layout in Figure 2).

The borings were drilled using hollow-stem or solid flight augers powered by two trailer-mounted drilling rigs. In the hollow-stem auger borings, continuous SPTs were performed in accordance with ASTM D1586. If applicable, an offset boring was performed after completion of a SPT boring to obtain Shelby tube samples in targeted soils at targeted depths. Shelby tube samples were obtained in accordance with ASTM D1587.

In-place density determinations using a sand cone apparatus were made around the perimeter of the existing dike in areas of traffic-compacted bottom ash. Bulk bottom ash samples for laboratory testing were obtained from these areas.

3.4.2 Laboratory Testing

The undisturbed (Shelby) tube soil samples obtained during conventional drilling were subjected to the following laboratory tests: 18 natural moisture content, 16 Atterberg limits, 18 gradation, 17 unit weight, 17 specific gravity, 18 USCS soil classifications, 8 UU triaxial compression, and 7 CU triaxial compression tests.

The bulk bottom ash samples were subjected to the following laboratory tests: USCS soil classifications and gradation testing. Remolded bottom ash samples were subjected to UU triaxial compression, CU triaxial compression, and direct shear tests.

3.4.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed.
    b. Boring logs document material descriptions and thicknesses.
    c. Subsurface conditions beneath the perimeter dike are substantially the same as current, except that static loads have increased due to construction of the Upper Clay Dike.

2. Soil properties (including shear strengths)

    a. Sampling and testing did not document ASTM standards. However, based on the lab reports, both appear to follow standard procedures. Thus, results may be used comparatively to more recent testing.

    b. Subsurface conditions are substantially the same as current.

3.5 TVA (1988)

Table 5. Summary of Evaluation for TVA (1988)

Reference:	Tennessee Valley Authority (TVA). 1988. "Johnsonville Steam Plant, Offsite and Onsite Dredge Fly Ash Storage Areas" Prepared for Tennessee Valley Authority. February 2. Addendum April 18.	
Purpose:	Limited geotechnical exploration to establish preliminary groundwater and rock elevations, determine material properties and total volume of the potential borrow material	
CCR Unit(s):	DuPont Road Dredge Cell	
Spatial coverage:	General coverage of unit	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	6 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	No	
Geometry at time of document representative of 2017 conditions:	No	
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	Yes	Most testing followed ASTM standards. Permeability, CU triaxial, and unit weight tests followed TVA standards.
Shear strength parameters:	Yes	Static undrained strengths
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.5.1 Field Activities

A geotechnical drilling program was developed that consisted of a total of six soil borings: five auger borings and one undisturbed sample boring within an onsite storage area. The boring locations were shown on an existing contour map (approximate locations are shown on the boring layout in Figure 1).

The borings were drilled using a CME-55 drill equipped with six-inch interior diameter hollow stem augers and six-inch outer diameter solid flight augers. At one boring location, an offset boring was drilled after completion of an auger boring to obtain Shelby tube samples in targeted soils at specific depths.

3.5.2 Laboratory Testing

The two undisturbed (Shelby tube) soil samples obtained during conventional drilling were each subjected to the following laboratory tests: natural moisture content (D2216), Atterberg limits (D4318), gradation (D422), unit weight, specific gravity (D854), USCS soil classification (D2487), and permeability tests.

As part of the addendum, additional laboratory testing of the on-site storage area was requested. Two representative soil samples were subjected to the following laboratory tests: Atterberg limits (D4318), gradation (D422), specific gravity (D854), standard Proctor (D698), unit weight, CU triaxial compression, UU triaxial compression (D2850), and permeability tests.

3.5.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were approximated from existing contour map.
    b. Boring logs document material descriptions and thicknesses.
2. Soil properties
    a. Sampling and laboratory testing of permeability, CU triaxial compression, and unit weight did not follow ASTM standards. However, these results may be used comparatively to more recent testing.
    b. Soil classification, standard Proctor, and UU triaxial compression testing followed relevant ASTM standards.

3.6 LAW (1994A)

Table 6. Summary of Evaluation for Law (1994a)

Reference:	Law Engineering and Environmental Services (Law). 1994a. "Report of Geotechnical Evaluation Ash Pond Dike, New Johnsonville Fossil Plant, New Johnsonville, Tennessee." Prepared for Tennessee Valley Authority. January 17.	
Purpose:	Geotechnical exploration to obtain limited subsurface data in the area of the southwest spillway, as related to subsidence near spillway pipes	
CCR Unit(s):	Active Ash Pond 2	
Spatial coverage:	Southwest perimeter dike, in the immediate vicinity of spillway pipes	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	17 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed by TVA after drilling.
Data adequate to support three-dimensional model:	Yes	Data support dike geometry and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	No	Pipes were repaired by unknown means after this evaluation. Spillways were closed in 2011.
Piezometer installation:	Yes	14 borings, screened in CCR, dike fill or alluvium
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Testing follows ASTM standards.
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.6.1 Field Activities

The geotechnical drilling program consisted of 17 soil borings. The boring locations were chosen by Law and surveyed after drilling was completed (approximate locations are shown on the boring layout in Figure 2).

The borings were drilled using hollow-stem augers. SPTs were performed on 2.5-feet intervals in accordance with ASTM D1586. If warranted, Shelby tube samples were obtained in targeted soils at specific depths. Shelby tube samples were obtained in accordance with ASTM D1587.

Upon completion of drilling, boreholes without piezometers were backfilled. Boreholes with piezometers received a quartz sand filter pack from the bottom of the boring to approximately one to two feet above the screened interval. Auger cuttings were used to backfill from the filter pack to one to two feet below the surface. A bentonite seal was then installed to the surface. Piezometers were installed at 14 locations.

3.6.2 Laboratory Testing

Select undisturbed (Shelby) tube soil samples obtained during conventional drilling were subjected to the following laboratory tests: natural moisture content (D2216), unit weight, specific gravity (D854), and CU triaxial compression with pore pressures (D4767).

3.6.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed.
    b. Boring logs document material descriptions and thicknesses.
2. Soil properties (including shear strengths)
    a. Sampling and testing followed relevant ASTM standards.

3.7 LAW (1994B)

Table 7. Summary of Evaluation for Law (1994b)

Reference:	Law Engineering and Environmental Services (Law). 1994b. "Subsurface Exploration Data: TVA Borings at Johnsonville Fossil Plant, Johnsonville, Tennessee." Prepared for Gilbert Commonwealth. October 11.	
Purpose:	Determine general subsurface conditions along the centerline of the perimeter dike and causeway and obtain data to support soil strength parameters.	
CCR Unit(s):	Active Ash Pond 2	
Spatial coverage:	Centerline of Upper Clay Dike and causeway	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	14 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed by TVA prior to drilling.
Data adequate to support three-dimensional model:	Yes	Data support dike geometry and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry is substantially the same as current. Phreatic levels were higher than current.
Piezometer installation:	Yes	5 borings
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Testing follows ASTM standards.
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.7.1 Field Activities

A geotechnical drilling program was developed that consisted of 14 soil borings. The boring locations were proposed by TVA. TVA, Gilbert Commonwealth, and Law Engineering established the field locations and surveyed them prior to drilling (the locations are shown on the boring layout in Figure 2). Boring elevations were obtained by superimposing boring locations onto the topographic site plan and interpolating between contours.

The borings were drilled using hollow-stem augers. In the borings, continuous SPTs were performed in accordance with ASTM D1586. Targeted soils at specific depths were sampled with Shelby tubes. Shelby tube samples were obtained in accordance with ASTM D1587.

Upon completion of drilling, boreholes without piezometers were backfilled. The type of backfill is not documented for boreholes with or without piezometers. Piezometers were installed at 5 locations.

3.7.2 Laboratory Testing

The laboratory tests were performed in accordance with ASTM standard testing procedures. Natural moisture content (D2216) tests were performed on all SPT and Shelby tube samples. Soil index classification testing (D2487) was performed on selected soil samples. These tests included particle size analyses (D421 and D422), Atterberg limits (D4318), and specific gravity (D854). In addition to soil index classification testing, consolidated undrained (D4767) and unconsolidated undrained (D2850) triaxial compression tests were performed on cohesive Shelby tube samples.

3.7.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations were surveyed, and elevations are estimated based on acceptable topographic mapping.
    b. Boring logs document material descriptions and thicknesses.
    c. Perimeter dike and foundation geometry is substantially the same as current.
2. Piezometers
    a. Locations and elevations were surveyed, and elevations are estimated based on acceptable topographic mapping.
    b. Instruments are adequate to provide current water level readings.
3. Soil properties (including shear strengths)
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current.

3.8 TVA (1995)

Table 8. Summary of Evaluation for TVA (1995)

Reference:	Tennessee Valley Authority (TVA). 1995. "Johnsonville Groundwater Assessment" Prepared for Tennessee Valley Authority. March.	
Purpose:	Assess ambient groundwater quality at JOF, investigate the potential for offsite groundwater contamination, and consolidate hydrogeologic information from previous studies for future use	
CCR Unit(s):	All units	
Spatial coverage:	All CCR impoundments plus powerhouse, hopper building, coal yard, and gas turbines	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	48 borings (7 within impoundments)
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Local Plant Coordinates translated into Tennessee State Plane
Data adequate to support three-dimensional model:	Yes	Data support dike geometry and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	No	
Piezometer installation:	Yes	68 monitoring wells (28 within impoundments)
In-situ testing:	Yes	Step testing, slug testing, multi- and single-well testing, and borehole flowmeter testing
Laboratory testing:	Yes	Not documented if testing followed ASTM standards
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	Groundwater flow modeling, contaminant transport modeling, water quality tests

3.8.1 Field Activities

The report summarized soil borings drilled and monitoring wells installed for a variety of purposes across the TVA JOF site between 1980 and 1993. A total of 48 soil borings and 68 monitoring wells were reviewed and considered as part of the groundwater assessment. The boring and monitoring well locations were presented in terms of the local plant coordinate system (approximate locations are shown on the boring layouts in Figures 1, 2, and 3). Most of the monitoring wells were installed within the area of the powerhouse and hopper building. However, 28 monitoring wells were installed within the areas of Ash Disposal Area 1, Active Ash Pond 2, DuPont Road Dredge Cell, and South Rail Loop Area 4.

The borings were predominantly drilled using hollow-stem augers. Upon completion of drilling, boreholes without piezometers were backfilled. Boreholes with piezometers received filter sand from the bottom of the boring to approximately one to two feet above the screened interval. At the top of the filter sand, an approximately 2-foot bentonite seal was used before grouting the piezometer to the surface.

As a part of these explorations, single well pumping and injection, slug, and step tests were performed in 18 wells. Drawdown of each well was measured with a pressure transducer and electronic data logger. Step tests were conducted in 14 monitoring wells to assist in selecting pump rates for the pumping and injection tests. Slug tests were conducted in 12 monitoring wells (six screened in ash, five in alluvium/terrace deposits, and one in fill) to determine hydraulic conductivity in unconfined and confined aquifer conditions.

Short-term single well pumping and injection tests were conducted in 13 monitoring wells (two screened in ash, seven screened in alluvium/terrace deposits, two screened in structural fill, and two screened in bedrock). This test was performed by either injecting potable water into or pumping water out of the well at a constant rate and observing the drawdown. The choice to use injection or pumping for the test was dependent upon the height of the water column in the well.

Finally, a multi-well pumping test and electronic borehole flowmeter tests were performed within the bedrock. The multi-well pumping test utilized monitoring wells screened in the Camden Formation for a duration of 29 hours. The average pumping rate during this test was 280 liters/minute. The water level drawdown was monitored in the pumping well and four adjacent well locations. The borehole flowmeter tests were performed in wells screened in the Chattanooga Shale and Camden formation to evaluate the vertical variability of hydraulic conductivity.

3.8.2 Laboratory Testing

As part of the multiple prior efforts that were summarized, a total of 31 soil samples and 4 fly ash samples have been tested. Soil index testing (i.e., natural moisture content, grain size analysis, Atterberg limits, and specific gravity testing) and bulk density testing was performed on select soil samples. In addition to this testing, 11 soil samples were analyzed for porosity and 16 were tested for permeability. Laboratory testing documentation did not indicate if soil testing followed ASTM standards.

3.8.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed.
    b. Boring logs document material descriptions and thicknesses.
2. Piezometers
    a. Installation methods meet current standard of practice.
    b. Locations and elevations were surveyed.
    c. Existing instruments are adequate to provide current water level readings.

3.9 LAW (1997)

Table 9. Summary of Evaluation for Law (1997)

Reference:	Law Engineering and Environmental Services Inc. (Law). 1997. "Report of Subsurface Exploration and Stability Analysis, Johnsonville Fossil Plant Ash Disposal Area, New Johnsonville, Tennessee" Prepared for Tennessee Valley Authority. September 19.	
Purpose:	Determine general subsurface conditions and perform a stability analysis for the proposed disposal area configuration	
CCR Unit(s):	South Rail Loop Area 4	
Spatial coverage:	General coverage across the unit	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	9 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Boring locations were not surveyed, but elevations were surveyed.
Data adequate to support three-dimensional model:	Yes	Data support dike geometry, CCR thickness, and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions likely similar or more conservative than current.
Piezometer installation:	No	
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Testing follows ASTM standards.
Shear strength parameters:	Yes	Static drained strengths (CCR, foundation soil)
Static slope stability:	Yes	2 cross-sections
Seismic slope stability:	Yes	1 cross-section
Information adequate to support stability evaluation:	Yes	Analyses are representative of long term, static and short-term, pseudostatic stability of perimeter.
Other relevant analyses:	Yes	Veneer Stability

3.9.1 Field Activities

A geotechnical drilling program was developed that consisted of nine widely spaced borings. The boring locations were chosen by TVA and located in the field by Law Engineering by means of taping distances and estimating right angles relative to on-site landmarks (approximate locations are shown on the boring layout in Figure 3). Boring elevations were obtained by survey, using an existing observation well as a temporary benchmark.

The borings were drilled using hollow-stem augers. SPTs were performed on five foot intervals in accordance with ASTM D1586. Shelby tube samples were taken within the same boring in targeted soils at specific depths. Shelby tube samples were obtained in accordance with ASTM D1587. Groundwater measurements were obtained at the time of drilling. Upon completion of drilling, borings were backfilled.

3.9.2 Laboratory Testing

The laboratory tests were performed in accordance with ASTM standard testing procedures. Natural moisture content (D2216), particle size analyses (D421 or D2217 and D422), and Atterberg limits (D4318) were performed on select soil samples. Additionally, three CU triaxial compression tests with pore pressures (D4767) and one UU triaxial compression (D2850) test were performed on select Shelby tube samples. Falling head permeability tests (D5084) were performed on two undisturbed samples. Unit weight (D7263) testing was performed on all triaxial compression and permeability tests.

3.9.3 Analysis

Two cross-sections were developed for slope stability analyses of the proposed South Rail Loop Area 4 ash stack closure configuration for long-term, static loading and during a design earthquake event. The cross-sections were selected because section A-A' represented the highest slope and section B-B' represented the steepest slope. These analyses incorporated available historic information, parameter correlations in published literature, results of the geotechnical field exploration, and the results of the laboratory testing.

The proposed landfill cover was evaluated for veneer stability based on the proposed ash stack configuration. This analysis was performed assuming a maximum slope of 2.2:1 (horizontal:vertical) and the shear strength of the ash.

3.9.4 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring elevations were surveyed (locations were not).
    b. Boring logs document material descriptions and thicknesses.
    c. Foundation geometry is substantially the same as current.

2. CCR and soil properties (including shear strengths)

    a. Sampling and testing followed relevant ASTM standards.

3. Static slope stability analyses

    a. Material parameters are representative of current.

3.10 MACTEC (2003)

Table 10. Summary of Evaluation for MACTEC (2003)

Reference:	MACTEC Engineering and Consulting, Inc. (MACTEC). 2003. "Report of Ash Pond Investigation, Johnsonville Fossil Plant, New Johnsonville, Tennessee." Prepared for Tennessee Valley Authority. December 4.	
Purpose:	Measuring densities and moisture contents of in-situ and excavated ash. Collect in-situ ash samples using a Geoprobe	
CCR Unit(s):	Active Ash Pond 2	
Spatial coverage:	Interior of northern portion (Cell 2) of the unit	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	9 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed by TVA.
Data adequate to support three-dimensional model:	Yes	Data support CCR thickness.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry is substantially the same as current. Phreatic conditions were higher than current.
Piezometer installation:	No	
In-situ testing:	Yes	Nuclear density testing of in-situ CCR
Laboratory testing:	Yes	Testing follows ASTM standards.
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.10.1 Field Activities

A subsurface exploration program consisted of 9 Geoprobe borings in Cell 2 of the Active Ash Pond 2. The approximate locations are shown on the boring layout in Figure 2. The probe hole locations were surveyed by TVA.

The borings were made utilizing a Geoprobe sampling system with either a Macro-core soil sampler or a DT21 dual tube soil sampling system. The holes were generally extended to refusal or through the CCR deposits to foundation soils. The refusal or termination depth at each location varied from 24 to 36 feet. The Geoprobe samples were sealed upon recovery in their acetate liners.

In addition to Geoprobe sampling, nuclear density (and moisture) testing was conducted on the surface of the in-situ CCR. Testing was performed at 20 locations on the ash surface prior to any excavation. Another ten locations were tested after approximately three feet of ash had been excavated. Finally, nuclear density testing was performed on the surface of disturbed ash which had been excavated and loaded into 31 dump trucks.

3.10.2 Laboratory Testing

The Geoprobe samples were transported to a MACTEC laboratory where they were subjected to moisture content, dry unit weight, and specific gravity testing.

3.10.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed.
    b. Boring logs document material descriptions and thicknesses.
    c. Perimeter dike and foundation geometry is substantially the same as current.

3.11 TVA (2005)

Table 11. Summary of Evaluation for TVA (2005)

Reference:	Tennessee Valley Authority (TVA). 2005. "DuPont Road Dredge Cell Piezometer Installation Logs". August.	
Purpose:	Installation of piezometers for DuPont Road Dredge Cell(boring and installation logs only)	
CCR Unit(s):	DuPont Road Dredge Cell	
Spatial coverage:	Spaced across the unit	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	7 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed by TVA.
Data adequate to support three-dimensional model:	Yes	Data supports top surface modeling of CCR
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry is substantially the same as current. Phreatic conditions were higher than current.
Piezometer installation:	Yes	7 piezometers, screened in CCR
In-situ testing:	No	
Laboratory testing:		
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.11.1 Field Activities

A subsurface exploration program consisted of 7 Geoprobe borings in the DuPont Road Dredge Cell. The approximate locations are shown on the boring layout in Figure 1. The top of casing and ground surface at each boring were surveyed by TVA.

The borings were made utilizing a Geoprobe sampling system. The holes were extended to the installation depth for the piezometers. The refusal or termination depth at each location varied from 10 to 36 feet. Piezometers were installed at each of the boring locations. However, the annular backfill of each piezometer was not indicated on the piezometer construction diagram.

3.11.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed.
    b. Boring logs document material descriptions and thicknesses.
    c. Perimeter dike and foundation geometry is substantially the same as current.
2. Piezometers
    a. Locations and elevations were surveyed.

3.12 STANTEC (2010A)

Table 12. Summary of Evaluation for Stantec (2010a)

Reference:	Stantec Consulting Services, Inc. 2010a. "Report of Geotechnical and Slope Stability Evaluation, Ash Disposal Areas 2 and 3 (Active Ash Disposal Area), Johnsonville Fossil Plant, New Johnsonville, Tennessee." Prepared for Tennessee Valley Authority. April 13.	
Purpose:	Evaluation of the existing subsurface conditions to determine long-term static stability of the perimeter dike, evaluation of temporary ash stacking west of the sluice channel, evaluation of stability for multiple phases of proposed closure	
CCR Unit(s):	Active Ash Pond 2	
Spatial coverage:	Borings at 14 cross-sections (labeled A through M) around the perimeter dike and three borings on the interior of the unit	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	54 borings
Rock coring:	No	
Other subsurface data:	Yes	5 Slope Inclinometers, 4 test pits
Boring locations surveyed:	Yes	Surveyed by TVA after drilling.
Data adequate to support three-dimensional model:	Yes	Data support dike geometry, CCR thickness, foundation stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry is substantially the same as current, except for more recent outslope repairs. Phreatic conditions were higher than current.
Piezometer installation:	Yes	32 piezometers
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Testing follows ASTM standards.
Shear strength parameters:	Yes	Static drained and undrained strengths for CCR, dike fill (upper, lower, and hydraulic), and alluvium foundation
Static slope stability:	Yes	9 cross-sections
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses are representative of long-term, static slope stability of the perimeter dike.
Other relevant analyses:	Yes	Seepage modeling and calculation of critical exit gradients.

3.12.1 Field Activities

A subsurface exploration program was designed that consisted of 49 borings with five offset borings and four inspection pits. The cross-sections and boring locations were selected and staked by Stantec. Upon completion of drilling, TVA surveyed the boring locations and inspection pits along with providing topographic mapping for each of the slope stability sections. The approximate locations are shown in Figure 2.

The borings were drilled using either a truck-mounted or ATV-mounted drilling rig with hollow stem augers. In the soil borings, SPTs were performed in accordance with ASTM D1586 at 2.5-foot intervals. Shelby tube samples were obtained in accordance with ASTM D1587 at depths determined by Stantec personnel within cohesive soil layers. Bulk samples of the dike material were collected at the discretion of Stantec personnel.

Upon completion of drilling, piezometers were installed at select locations in separate auger borings directly adjacent to stability section borings. The annular backfill for the piezometer consisted of a sand filter pack to some distance above the screened zone followed by at least a two-foot bentonite seal. The remaining backfill was cement-bentonite grout tremied into place. All other borings were tremie backfilled using cement-bentonite grout for the full depth. At a later date, Stantec installed five slope inclinometers at four cross-sections (C, C1, E, and K).

3.12.2 Laboratory Testing

SPT samples were subjected to natural moisture content (D2216) testing. Select SPT samples representing the dominant soil layers were subjected to soil classification tests that included Atterberg limits (D4318), specific gravity (D854), and sieve and hydrometer analyses (D422) tests. Select bulk samples were subjected to standard Proctor (D698) tests. Undisturbed samples were extruded and subjected to unit weight determination, unconfined compression (D2166), and CU triaxial compression testing with pore pressure measurements (D4767).

3.12.3 Analysis

Historical boring information along with the new data gathered from this geotechnical exploration were used to establish subsurface geometry and material parameters of the different soils and CCR at each cross-section. Once the geometry of the sections was approximated, each section was reviewed and evaluated to determine the critical cross-sections for analyses. The selection of critical cross-sections was dependent upon the steepness of the slopes, heights of dikes, geometry of the sections, phreatic surface, seepage conditions, and subsurface conditions. Based on these criteria, nine representative cross-sections were chosen for further analyses.

The perimeter dike stabilities were evaluated using two-dimensional limit equilibrium methods. Analyses were completed for static loading and long-term, steady-state seepage conditions. The drained shear strength parameters were derived using laboratory triaxial tests along with consideration given to SPT, laboratory classification of soils, and historical triaxial data. For non-cohesive alluvial granular soils, shear strength parameters were estimated from literature review and correlations to SPT N-values. The stability analyses focused on the potential for an outward failure of the perimeter dike system.

For the existing conditions, several cross-sections had static, long-term factors of safety below the acceptance criteria. Proposed conditions based on phased closure geometry were analyzed and shown that they would meet the acceptance criteria.

3.12.4 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed.
    b. Boring logs document material descriptions and thicknesses.
    c. Perimeter dike (excluding more recent outslope repairs) and foundation geometry is substantially the same as current.
2. Piezometers
    a. Installation methods meet current standard of practice.
    b. Locations and elevations were surveyed.
    c. Instruments are adequate to provide current water level readings.
3. Soil properties (including shear strengths)
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current.

4. Static slope stability analyses

    a. Material parameters are representative of current.

    b. Surface and subsurface geometry is substantially the same as present.

    c. Pool elevations and phreatic conditions are similar or more conservative than current.

    d. Analysis methods meet current standard of practice.

3.13 STANTEC (2010B)

Table 13. Summary of Evaluation for Stantec (2010b)

Reference:	Stantec Consulting Services, Inc. 2010b. "Report of Geotechnical and Evaluation of Slope Stability, DuPont Road Dredge Cell, Johnsonville Fossil Plant, Humphreys County, Tennessee." Prepared for Tennessee Valley Authority. April 19.	
Purpose:	Evaluate the stability of the dredge cell and provide information and recommendations to support the design and construction of a cap and leachate collection system	
CCR Unit(s):	DuPont Road Dredge Cell	
Spatial coverage:	Spaced across the impoundment	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	16 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Piezometer locations were surveyed.
Data adequate to support three-dimensional model:	Yes	Data support dike geometry, CCR thickness, foundation stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry is substantially the same as current, except for more recent cap installation. Phreatic conditions are similar to, or more conservative than, current.
Piezometer installation:	Yes	5 borings
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Testing followed relevant ASTM standards.
Shear strength parameters:	Yes	Static, drained strengths for CCR, compacted fill (soil and CCR), and foundation soils
Static slope stability:	Yes	2 cross-sections
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses are representative of long-term, static slope stability of the perimeter dike.
Other relevant analyses:	No	

3.13.1 Field Activities

A subsurface exploration program was designed that consisted of 16 borings. The cross-sections and boring locations were selected and staked by Stantec. Upon completion of drilling, TVA surveyed the boring locations where piezometers were installed. Borings without instrumentation were field-staked but not surveyed; locations and elevations from interpolating from existing contour maps. The approximate locations are shown in Figure 1.

The borings were drilled using a track-mounted rotary drill rig. In the soil borings, SPTs were performed in accordance with ASTM D1586 at 2.5-foot intervals. Shelby tube samples were obtained in accordance with ASTM D1587 at depths determined by Stantec personnel within cohesive soil layers. Representative bulk samples of the dike materials were collected by Stantec personnel.

Piezometers were installed at five boring locations. The annular backfill of each piezometer consisted of a sand filter pack to some distance above the screened zone followed by at least a two-foot bentonite seal. The remaining backfill was cement-bentonite grout, which was tremied into place. All other borings were backfilled with sand and cement-bentonite grout.

3.13.2 Laboratory Testing

Shelby tube and SPT samples were subjected to natural moisture content (D2216) tests. Select SPT soil samples were combined and subjected to soil classification tests that included Atterberg limits (D4318), specific gravity (D854), and sieve and hydrometer analyses (D422) tests. Undisturbed samples were subjected to CU triaxial compression testing with pore pressure measurements (D4767).

3.13.3 Analysis

Historical boring information and the new data gathered from this geotechnical exploration were used to establish subsurface geometry and material parameters of the different soils and CCR at each cross-section. Once the geometry of the sections was approximated, each section was reviewed and evaluated to determine the critical cross-sections for analyses. The selection of critical cross-sections was dependent upon the steepness of the slopes, heights of dikes, geometry of the sections, phreatic surface, seepage conditions, and subsurface conditions. Based on these criteria, two representative cross-sections were chosen for further analyses.

The perimeter dike stabilities were evaluated using static limit equilibrium methods. Analyses were completed for high water level during wet season, lower water level during dry season, and anticipated lower water level after cap installation. The drained shear strength parameters were derived using laboratory triaxial tests along with consideration given to SPT, laboratory classification of soils, and historical triaxial data. For non-cohesive alluvial granular soils, shear strength parameters were estimated from literature review and correlations to SPT N-values, relative density, and effective friction angle.

The parameters for compacted and hydraulic ash are based on historical test results by AECOM and Law Engineering at other TVA fossil plants. The stability analyses considered both deep seated global failures and shallow maintenance failures.

The critical slip surfaces are associated with failures in the upper ash dike during wet times of the year. Low factors of safety were also computed for surficial maintenance failures.

3.13.4 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Some boring locations and elevations were surveyed, although others were estimated based on topographic mapping.
    b. Boring logs document material descriptions and thicknesses.
    c. Perimeter dike geometry is more conservative than the existing, closed condition.
    d. Foundation geometry is substantially the same as current.
2. Piezometers
    a. Installation methods meet current standard of practice.
    b. Locations and elevations were surveyed.
    c. Instruments are adequate to provide current water level readings.
3. Soil properties (including shear strengths)
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current.
4. Static slope stability analyses
    a. Material parameters are representative of current.
    b. Surface and subsurface geometry is substantially the same as present.
    c. Pool elevations and phreatic conditions are similar or more conservative than current.
    d. Analysis methods meet current standard of practice.

3.14 STANTEC (2010C)

Table 14. Summary of Evaluation for Stantec (2010c)

Reference:	Stantec Consulting Services Inc. (Stantec). 2010c. "Southeast Dike Stability Improvements Project, Johnsonville Fossil Plant Active Ash Disposal Facility." Prepared for Tennessee Valley Authority. September 9.	
Purpose:	Characterize the subsurface conditions of the lower bench of the southeast perimeter dike relative to ground support of construction equipment and channel bank stability	
CCR Unit(s):	Active Ash Pond 2	
Spatial coverage:	Southeast perimeter dike, from the Chemical Treatment Pond dike to the southern end of Active Ash Pond 2	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	16 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed by TVA personnel.
Data adequate to support three-dimensional model:	Yes	Data supports dike geometry and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry (after the proposed improvements) is substantially the same as current. Phreatic conditions were higher than current.
Piezometer installation:	No	
In-situ testing:	Yes	SPT
Laboratory testing:	No	
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.14.1 Field Activities

A geotechnical drilling program was developed that consisted of 16 soil borings. Borings were located along the lower bench (adjacent to the Condenser Water Inlet Channel) and between the Chemical Treatment Pond dike and the southern end of the eastern perimeter dike of Active Ash Pond 2. The boring locations were chosen by Stantec and surveyed by TVA personnel (approximate locations are shown on the boring layout in Figure 2).

All 16 of the borings were drilled using hollow-stem augers powered by a truck-mounted drilling rig. In the soil borings, continuous SPTs were performed in the upper 6 feet and on 2.5-foot centers to the bottom of the boring. SPTs were performed in accordance with ASTM D1586. Upon completion of drilling, borings were backfilled with bentonite grout.

3.14.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring and sounding locations and elevations were surveyed.
    b. Boring logs document material descriptions and thicknesses.
    c. Perimeter dike (after the proposed improvements) and foundation geometry is substantially the same as current.

3.15 STANTEC (2010D)

Table 15. Summary of Evaluation for Stantec (2010d)

Reference:	Stantec Consulting Services Inc. (Stantec). 2010d. "DuPont Dredge Cell, Overburden Logging Record." Prepared for Tennessee Valley Authority. November.	
Purpose:	Installation of piezometers for DuPont Road Dredge Cell(boring and installation logs only)	
CCR Unit(s):	DuPont Road Dredge Cell	
Spatial coverage:	Along the perimeter of the unit	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	6 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed by TVA personnel.
Data adequate to support three-dimensional model:	Yes	Data supports top surface modeling of CCR
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry (after the proposed improvements) is substantially the same as current. Phreatic conditions were higher than current.
Piezometer installation:	Yes	6 piezometers, screened in CCR
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.15.1 Field Activities

A subsurface exploration program consisted of 6 borings in the DuPont Road Dredge Cell. The approximate locations are shown on the boring layout in Figure 1. The top of instrument casing and ground surface at each boring were surveyed by TVA. All six of the borings were drilled using hollow-stem augers powered by a CME-55 drilling rig. In the soil borings, SPTs were not performed.

Piezometers were installed at all six boring locations. The annular backfill of each piezometer consisted of a sand filter pack to some distance above the screened zone followed by at least a one-foot bentonite seal and then cement-bentonite grout to one foot below grade. The remaining backfill was a one-foot clay soil cover.

3.15.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed.
    b. Boring logs document material descriptions and thicknesses.
    c. Perimeter dike and foundation geometry is substantially the same as current.
2. Piezometers
    a. Installation methods meet current standard of practice.
    b. Locations and elevations were surveyed.
    c. Instruments are adequate to provide current water level readings.

3.16 STANTEC (2011A)

Table 16. Summary of Evaluation for Stantec (2011a)

Reference:	Stantec Consulting Services Inc. (Stantec). 2011a. "Report of Piezometer Installation, DuPont Dredge Cell, Johnsonville Fossil Plant, New Johnsonville, Humphreys County, Tennessee." Prepared for Tennessee Valley Authority. October 18.	
Purpose:	Installation of piezometers for DuPont Road Dredge Cell to evaluate effectiveness of the Phase 1 Cap installation	
CCR Unit(s):	DuPont Road Dredge Cell	
Spatial coverage:	Three borings along the top and seven borings along the perimeter of the unit	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	10 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed by TVA personnel.
Data adequate to support three-dimensional model:	Yes	Data supports CCR thickness and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry is substantially the same as current. Phreatic conditions were higher than current.
Piezometer installation:	Yes	10 piezometers, screened in CCR
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.16.1 Field Activities

A subsurface exploration program consisted of 10 borings in the DuPont Road Dredge Cell. All ten of the borings were drilled using hollow-stem augers. In the soil borings, SPTs were performed in accordance with ASTM D1586 and on approximately 5-foot intervals. The boring locations were selected by Stantec. Then, TVA personnel staked the locations and provided ground surface elevations. The approximate locations are shown on the boring layout in Figure 1.

Vibrating wire piezometers were installed at all ten boring locations. Each piezometer was secured to a sacrificial 1.5-inch diameter PVC pipe and lowered into place in the borehole. The annular backfill of each piezometer consisted of cement-bentonite grout to the surface.

3.16.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed.
    b. Boring logs document material descriptions and thicknesses.
    c. Perimeter dike and foundation geometry are substantially the same as current.
2. Vibrating Wire Piezometers
    a. Installation methods meet current standard of practice.
    b. Locations and elevations were surveyed.

3.17 STANTEC (2011B)

Table 17. Summary of Evaluation for Stantec (2011b)

Reference:	Stantec Consulting Services Inc. (Stantec). 2011b. "Report of Monitoring Well Abandonment, Tennessee Valley Authority, Johnsonville Fossil Plant, New Johnsonville, Tennessee." Prepared for Tennessee Valley Authority. December 15.	
Purpose:	Abandonment of six monitoring wells at Johnsonville Fossil Plant	
CCR Unit(s):	Ash Disposal Area 1	
Spatial coverage:	Interior of CCR unit	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	6 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed by Stantec personnel.
Data adequate to support three-dimensional model:	Yes	Data supports CCR thickness and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry is substantially the same as current. Phreatic conditions were higher than current.
Piezometer installation:	No	6 monitoring wells, screened in CCR and Alluvial Clay and Silt, were abandoned
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.17.1 Field Activities

Field work consisted of the abandonment of six existing monitoring wells in Ash Disposal Area 1. The monitoring wells were installed in August 1989 and the logs for these wells were provided in this abandonment report. All six of the borings were drilled using hollow-stem augers. The approximate locations are shown on the boring layout in Figure 1.

Monitoring wells were installed at all six boring locations. The annular backfill of each piezometer consisted of a sand filter pack to some distance above the screened zone followed by at least a one-foot bentonite seal and then grouted to the surface.

3.17.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed.
    b. Boring logs document material descriptions and thicknesses.
    c. Perimeter dike and foundation geometry are substantially the same as current.
2. Monitoring Wells
    a. Installation methods meet current standard of practice.
    b. Locations and elevations were surveyed.

3.18 STANTEC (2012)

Table 18. Summary of Evaluation for Stantec (2012)

Reference:	Stantec. 2012. "Basis of Design Report, Johnsonville Fossil Plant, Metal Cleaning Waste Pond Closure, Humphreys County, Tennessee." Prepared for Tennessee Valley Authority. November 30.	
Purpose:	Geotechnical exploration to support closure design of the Metal Cleaning Waste Pond	
CCR Unit(s):	Active Ash Pond 2	
Spatial coverage:		
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	7 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed by TVA after drilling.
Data adequate to support three-dimensional model:	Yes	Data support dike geometry and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Closed conditions of the Metal Cleaning Waste Pond geometry and phreatic conditions are similar to current.
Piezometer installation:	Yes	3 borings
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Testing follows ASTM standards.
Shear strength parameters:	Yes	Static drained and static undrained strengths for soils and CCR
Static slope stability:	Yes	1 cross-section. Long-term and rapid drawdown analyses of existing conditions, long-term analyses of proposed closed conditions.
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses are representative of current, closed conditions.
Other relevant analyses:	Yes	Seepage modeling, closure cap design

3.18.1 Field Activities

The geotechnical exploration program included five SPT borings and two offset, undisturbed sample borings (approximate locations are shown on the boring layout in Figure 2). The borings were performed using a truck-mounted drill rig with hollow-stem augers. SPT sampling was performed at approximately 2.5 feet to 5 feet intervals in accordance with ASTM D1586. Undisturbed samples were obtained in accordance with ASTM D1587. Bulk samples from auger cuttings were also obtained.

Upon completion of drilling, piezometers were installed in three borings. The annular backfill for the piezometers consisted of a sand filter pack to some distance above the screened zone followed by at least a two-foot bentonite seal. The remaining backfill was cement-bentonite grout tremied into place. Borings without piezometers were backfilled with bentonite grout.

3.18.2 Laboratory Testing

Select disturbed (SPT), undisturbed (Shelby tube), and bulk soil samples obtained during conventional drilling were subjected to the following laboratory tests: Atterberg limits (D4318), specific gravity (D854), USCS classification (D2487), and gradation (D422). A bulk sample was subjected to a standard Proctor (D698) test. Eight falling head permeability (D5084) tests were performed on remolded samples to develop a permeability window (for use during cap construction). Additionally, a Shelby tube sample was subjected to a unit weight (D7263) and CU triaxial compression (D4767) test.

3.18.3 Analysis

Historical boring information along with the new data gathered from this geotechnical exploration were used to establish existing subsurface geometry and material parameters of the different soils at the section location. The selection of the design cross-section was dependent upon the steepness of the slopes, heights of dikes, geometry of the sections, phreatic surface, seepage conditions, and subsurface conditions. Based on these criteria, one representative cross-section was chosen for further analyses. The design cross-section was evaluated for both existing conditions and proposed closure conditions.

The interior slope stability of the Metal Cleaning Waste Pond was evaluated using two-dimensional limit equilibrium methods. Analyses were completed for static loading for both long-term, steady-state seepage conditions and short-term, rapid drawdown conditions. The drained shear strength parameters were derived using laboratory triaxial tests along with consideration given to SPT, laboratory classification of soils, and historical triaxial data. For non-cohesive alluvial granular soils, shear strength parameters were estimated from literature review and correlations to SPT N-values. The stability analyses focused on the potential for failure along the interior slopes of the pond, which includes the exterior slope of the Active Ash Pond 2 perimeter dike.

The critical slip surfaces for each analysis extend into the Upper Clay Dike to affect the crest and represent a global surface failure.

3.18.4 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed.
    b. Boring logs document material descriptions and thicknesses.
    c. Perimeter dike (closed condition) and foundation geometry is substantially the same as current.
2. Piezometers
    a. Installation methods meet current standard of practice.
    b. Locations and elevations were surveyed.
3. Soil properties (including shear strengths)
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions (closed condition) are substantially the same as current.
4. Static slope stability analyses
    a. Material parameters are representative of current.
    b. Surface and subsurface geometry (closed condition) is substantially the same at present.
    c. Pool elevations and phreatic conditions are similar to or more conservative than current.
    d. Analysis methods meet current standard of practice.

3.19 GEOCOMP (2016A)

Table 19. Summary of Evaluation for Geocomp (2016a)

Reference:	Geocomp Consulting Inc. (Geocomp). 2016a. "Tennessee Valley Authority, EPA Seismic Assessment, Supplemental Site Exploration, Johnsonville Fossil Plant, Active Ash Pond 2, Final Report." Volume 1-4. Prepared for Tennessee Valley Authority. October.	
Purpose:	Geotechnical exploration and evaluation of seismic performance of the perimeter dike	
CCR Unit(s):	Active Ash Pond 2	
Spatial coverage:	Geotechnical exploration of 5 cross-sections through the perimeter dike of the Active Ash Pond 2. Analysis of 2 cross-sections	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	8 borings
Rock coring:	No	
Other subsurface data:	Yes	14 CPT soundings with shear wave velocity and pore pressure dissipation testing
Boring locations surveyed:	Yes	Surveyed by TVA after drilling.
Data adequate to support three-dimensional model:	Yes	Data support dike geometry, CCR thickness, and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar.
Piezometer installation:	Yes	7 borings instrumented with strings of vibrating wire piezometers; up to 5 sensors per boring (31 sensors total); sensing zones in alluvium, CCR, lower clay dike and hydraulic fill.
In-situ testing:	Yes	SPT, CPT with shear wave velocity and pore pressure dissipation
Laboratory testing:	Yes	All testing follows ASTM standards, except laboratory measurement of shear wave velocity using bender elements, which does not have an ASTM standard.
Shear strength parameters:	Yes	Static drained, static undrained, seismic, and post-earthquake strengths (CCR and soils)
Static slope stability:	Yes	5 cross-sections (B-B', C-C', E-E', H-H', and K-K')
Seismic slope stability:	Yes	2 cross-sections (C-C', E-E')
Information adequate to support stability evaluation:	Yes	Analyses are representative of static, post-earthquake and pseudostatic stability of existing perimeter dike.
Other relevant analyses:	Yes	Liquefaction triggering analyses; seismic displacement analysis (without liquefaction)

3.19.1 Field Activities

Based on previous work at the site, a supplemental evaluation of Active Ash Pond 2 was requested by TVA. A subsurface exploration program was designed that consisted of a total of 8 borings and 14 seismic CPT (SCPTu) soundings across five cross-sections. The approximate locations are shown in Figure 2.

The borings were drilled using a truck-mounted drilling rig with mud rotary equipment using a 4-inch rotary bit. In the soil borings, SPTs were performed in accordance with ASTM D1586 at 2.5-foot intervals. SPT hammer energy verification was performed on one borehole in accordance with ASTM D4633. At depths determined by the engineer, undisturbed tube samples were obtained with an Osterberg sampler in accordance with ASTM D6519. In material too stiff for Osterberg sampling, Shelby tube samples were obtained in accordance with ASTM D1587.

SCPTu soundings were advanced at 14 locations using a 15-ton CPT track rig. Tip resistance, sleeve friction, and dynamic pore pressure was recorded approximately every two inches as the cone was advanced into the ground. Shear wave velocity measurements were taken at approximately five foot intervals.

Upon completion of drilling, a multi-level vibrating wire piezometer (VWPZ) string was installed into selected boreholes. Each VWPZ string was lowered into the open boring and then fully grouted into place with a cement/bentonite grout that simulates the compressive strength of a very stiff to hard clay.

3.19.2 Laboratory Testing

The disturbed (SPT) and undisturbed (Osterberg or Shelby tube) soil samples obtained during conventional drilling were subjected to the following laboratory tests: natural moisture content (D2216), Atterberg limits (D4318), specific gravity (D854), USCS classification (D2487), gradation (D422), unit weight (D7263), CU triaxial with pore pressure measurements (D4767), direct shear (D3080), direct simple shear (D6528), cyclic direct simple shear (D6528), resonant column (D4015), and one-dimensional consolidation using controlled-strain loading (D4186). Select direct simple shear samples were subjected to shear wave velocity measurement using bender element sensors. Prior to tube extrusion, tubes were x-rayed (D4452) to evaluate sample disturbance and to select intervals for testing. Additionally, undisturbed samples were subjected to laboratory shear wave velocity using Bender element sensors tests to compare shear wave velocity of laboratory testing to in-situ testing.

3.19.3 Analysis

Historical boring information along with the new data gathered from this geotechnical exploration were used to establish subsurface geometry and material parameters of the different soils and CCR at each cross-section. The phreatic conditions were modeled based on the measurements from field piezometers.

Five representative critical cross-sections were subjected to a preliminary evaluation for short-term static, seismic, and post-earthquake stability. Preliminary seismic and post-earthquake stability were based on simplified two-dimensional, equivalent-linear dynamic analyses and approximate soil parameters. From this preliminary evaluation, two cross-sections were chosen for further evaluation.

A site-specific seismic study was conducted on the design response spectra developed by USGS. The site-specific seismic amplification analyses (i.e., ground response analyses) used seven spectrally-matched ground motion time histories. Spectral matching was performed relative to the uniform hazard response spectrum. Site-specific two-dimensional amplification analyses were performed to model the seismic response of each analysis cross-section.

The results of the analyses were used to determine displacement-compatible accelerations used in the seismic slope stability analyses to calculate the seismic factor of safety. The results of these analyses were also used to determine cyclic shear stresses for laboratory testing to measure post-shaking residual strengths in evaluating the liquefaction factor of safety.

Liquefaction triggering was assessed using the stress-based methodology of Idriss and Boulanger. The cyclic resistance ratio (CRR) is based on in-situ penetration resistance (SPT and/or CPT) or cyclic laboratory testing. The results of the site-specific two-dimensional analysis were used to obtain the Cyclic Stress Ratio (CSR) imposed by the design earthquake on the soil. Liquefaction triggering was based on a comparison of the CRR to the CSR. If a layer was deemed potentially liquefiable, then its residual undrained shear strength was assigned in the post-earthquake slope stability analysis.

Limit equilibrium slope stability analyses were performed for each cross-section for static undrained, pseudostatic, and post-earthquake conditions. The design earthquake had a return period of 2,500 years. Pseudostatic strengths were a reduced version of the static undrained strengths. Liquefaction triggering was assessed, and residual shear strengths were applied to the liquefied materials in the post-earthquake slope stability analyses.

3.19.4 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed.
    b. Boring logs document material descriptions and thicknesses.
    c. Perimeter dike and foundation geometry is substantially the same as current.
2. Piezometers
    a. Installation methods meet current standard of practice.
    b. Locations and elevations were surveyed.
    c. Instruments are adequate to provide current water level readings.
3. Soil properties (including shear strengths)
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current.
4. Static and seismic slope stability analyses
    a. Material parameters are representative of current.
    b. Surface and subsurface geometry is substantially the same as present.
    c. Pool elevations and phreatic conditions are similar to current.
    d. Analysis methods meet current standard of practice.

3.20 GEOCOMP (2016B)

Table 20. Summary of Evaluation for Geocomp (2016b)

Reference:	Geocomp Consulting Inc. (Geocomp). 2016b. "Initial Seismic Safety Factor Assessment, EPA Final CCR Rule, TVA Johnsonville Fossil Plant Active Ash Pond 2, New Johnsonville, Tennessee." Prepared for Tennessee Valley Authority. October 15.	
Purpose:	Demonstrate adequate seismic performance (pseudostatic stability, post-liquefaction stability considering liquefaction) of Active Ash Pond 2	
CCR Unit(s):	Active Ash Pond 2	
Spatial coverage:	One cross-section through the northeastern perimeter dike	
Item	**Yes/No**	**Remarks**
Soil borings:	No	This report leverages prior field and lab work (Geocomp 2016a) instead of performing new work.
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	No	
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar.
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	Yes	Static undrained strengths, seismic strengths for soils/CCR that do not liquefy, residual strengths for soils/CCR that do liquefy
Static slope stability:	No	
Seismic slope stability:	Yes	1 cross-section through the perimeter dike
Information adequate to support stability evaluation:	Yes	Analyses are representative of pseudostatic stability and post-earthquake stability of the perimeter dike.
Other relevant analyses:	Yes	Liquefaction triggering assessment potential analyses in support of post-earthquake slope stability evaluation.

3.20.1 Analysis

As required by §257.73 of the EPA Final CCR Rule, an initial structural integrity evaluation for seismic loading was required by October 17, 2016 and must include initial assessments of the seismic factor of safety (i.e., pseudostatic slope stability) and liquefaction factor of safety (i.e., post-earthquake slope stability, considering liquefaction) for each existing CCR surface impoundment that meets the conditions of paragraph (b) as follows:

1. Has a height of five feet or more and a storage volume of 20 acre-feet or more, or
2. Has a height of 20 feet or more.

The seismic and liquefaction factor of safety assessments must document whether the calculated factors of safety for the critical cross-sections of each existing CCR surface impoundment achieve the minimum factors of safety specified in paragraphs (e)(1)(iii) and (e)(1)(iv) of §257.73 in the EPA Final CCR Rule.

As part of the EPA Final CCR Rule requirements, a site-specific seismic study was conducted on the design response spectra developed by USGS. The site-specific seismic amplification analyses (i.e., ground response analyses) used seven spectrally-matched ground motion time histories. Spectral matching was performed relative to the uniform hazard response spectrum. Site-specific two-dimensional amplification analyses were performed to model the seismic response of cross-section C-C'. This cross-section had been developed previously based on a subsurface exploration and laboratory testing by Geocomp (2016a).

The results of the analyses were used to determine displacement-compatible accelerations used in the seismic slope stability analyses to calculate the seismic factor of safety. The results of these analyses were also used to determine cyclic shear stresses for laboratory testing to measure post-shaking residual strengths in evaluating the liquefaction factor of safety.

The seismic factor of safety was evaluated under seismic loading using a phreatic surface developed from existing pond levels and piezometric data. The pseudostatic loading conditions were determined from applied displacement-compatible accelerations derived from the sliding block analyses from Geocomp (2016a).

Liquefaction triggering was assessed using the stress-based methodology of Idriss and Boulanger. The cyclic resistance ratio (CRR) is based on in-situ penetration resistance (SPT and/or CPT) or cyclic laboratory testing. The results of the site-specific two-dimensional analysis were used to obtain the Cyclic Stress Ratio (CSR) imposed by the design earthquake on the soil. Liquefaction triggering was based on a comparison of the CRR to the CSR. If a layer was deemed potentially liquefiable, then its residual undrained shear strength was assigned in the post-earthquake slope stability analysis.

The slope stability results were obtained with a two-dimensional limit equilibrium program. The minimum factors of safety correspond to slip surfaces that could potentially result in the release of water and CCR materials from within the impoundment. Based upon the analysis performed for the Active Ash Pond 2, the impoundment meets or exceeds the minimum factor of safety for both seismic factor of safety and liquefaction factor of safety.

3.20.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Pseudostatic and post-earthquake slope stability analyses
    a. Material parameters are representative of current.
    b. Surface and subsurface geometry is substantially the same at present.
    c. Pool elevations and phreatic conditions are similar to (or more conservative than) current.
    d. Analysis methods meet current standard of practice.

3.21 STANTEC (2016A)

Table 21. Summary of Evaluation for Stantec (2016a)

Reference:	Stantec Consulting Services Inc. (Stantec). 2016a. "2012 Geotechnical Exploration - TVA Johnsonville Fossil Plant, Active Ash Pond 2." Prepared for Tennessee Valley Authority. October 5.	
Purpose:	Geotechnical exploration to provide subsurface data to support future closure design	
CCR Unit(s):	Active Ash Pond 2	
Spatial coverage:	General coverage of the interior and along the perimeter dike of the unit	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	43 borings
Rock coring:	No	
Other subsurface data:	Yes	30 cone penetration tests (CPT) borings, 4 test pits
Boring locations surveyed:	Yes	Surveyed by TVA after drilling.
Data adequate to support three-dimensional model:	Yes	Data to support dike geometry, CCR thickness, and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry, unit interior geometry, and phreatic conditions similar to current.
Piezometer installation:	Yes	8 temporary monitoring wells
In-situ testing:	Yes	SPTs, CPT with Pore Pressure Dissipation, Full Flow Penetrometer testing
Laboratory testing:	Yes	Testing follows relevant ASTM standards.
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.21.1 Field Activities

The subsurface exploration program consisted of 43 soil borings, 30 cone penetration test soundings, 3 full flow penetration tests, and 4 test pits along the crest and interior slope of the Upper Clay Dike and well as within the unit interior. The soil boring locations were surveyed (approximate locations are shown on the boring layout in Figure 2).

The encountered soils and CCR were sampled by continuous SPT tests per ASTM D1586. Undisturbed soil samples (Shelby tubes) were also retrieved for laboratory testing. Thirty CPT soundings with pore pressure measurements, 13 pore pressure dissipation tests, and three full flow penetration tests were completed by ConeTec near companion SPT borings. Four test pits were excavated along the interior slope of the perimeter dike.

Upon completion of drilling, borings were backfilled with cement bentonite grout. Eight temporary monitoring wells were installed to monitor water levels in the CCR.

3.21.2 Laboratory Testing

The laboratory testing program included natural moisture content (D2216), Atterberg limits (D4318), specific gravity (D854) and hydraulic conductivity (D5084) tests. Thirteen falling head permeability tests were performed on select Shelby tube specimens.

3.21.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed.
    b. Boring logs document material descriptions and thicknesses.
    c. Perimeter dike and foundation geometry is substantially the same as current.
2. Piezometers
    a. Installation methods meet current standard of practice.
    b. Locations and elevations were surveyed.
3. Soil properties
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current.

3.22 STANTEC (2016B)

Table 22. Summary of Evaluation for Stantec (2016b)

Reference:	Stantec Consulting Services Inc. (Stantec). 2016b. "Initial Static Safety Factor Assessment, Active Ash Pond 2, EPA Final Coal Combustion Residuals (CCR) Rule, TVA Johnsonville Fossil Plant, Humphreys County, Tennessee" Prepared for Tennessee Valley Authority. October 6.	
Purpose:	Demonstrate adequate static slope stability (long-term pool and short-term surcharge) for EPA Final CCR Rule initial safety factor assessment for the Active Ash Pond 2.	
CCR Unit(s):	Active Ash Pond 2	
Spatial coverage:	One cross-section through the northwestern perimeter dike	
Item	**Yes/No**	**Remarks**
Soil borings:	No	This report leverages prior field and lab work (Stantec 2010a) instead of performing new work.
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	No	
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar.
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	Yes	Static drained and static undrained strengths for soils/CCR
Static slope stability:	Yes	1 cross-section
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses are representative of both long-term, drained, and short-term, undrained static stability of existing Active Ash Pond 2 perimeter dike.
Other relevant analyses:	No	

3.22.1 Analysis

Stantec used historical data gathered from Stantec 2010a. This data was used to determine the material properties and subsurface geometry used to model cross-sections within the Active Ash Pond 2. This subsurface data, along with recently updated topographic and bathymetric mapping, one critical cross-section was developed for slope stability analysis.

Static slope stability was analyzed for both long-term, drained conditions (normal pool) and short-term, undrained conditions (surcharge pool). The slope stability assessments were focused on the potential for slope failures of significant mass, which could directly influence potential release of water and CCR materials from the Active Ash Pond 2. The search for a critical slip surface in the slope stability assessments is thus restricted to consider only potential surfaces where the depth (measured at the base of at least one slice) is more than 10 feet vertically below the ground surface and causes a release of CCR materials. Based upon these criteria, the Active Ash Pond 2 meets or exceeds the minimum factor of safety required by the EPA Final CCR Rule for static slope stability.

3.22.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Static slope stability analyses
    a. Material parameters are representative of current.
    b. Surface and subsurface geometry is substantially the same at present.
    c. Pool elevations and phreatic conditions are similar to current.
    d. Analysis methods meet current standard of practice.

3.23 STANTEC (2016C)

Table 23. Summary of Evaluation for Stantec (2016c)

Reference:	Stantec Consulting Services, Inc. 2016c. "Project Planning Document Rev. 0, Johnsonville Fossil Plant Coal Yard Closure (608486), Coal Yard Runoff Pond Closure (608485), Process Water Pond (611489), New Johnsonville, Humphreys County, Tennessee" Prepared for Tennessee Valley Authority. December 6.	
Purpose:	Develop a subsurface profile of the elevations and thicknesses of coal, ash fill, groundwater, and native soil to support closure design.	
CCR Unit(s):	Coal Yard and Coal Yard Runoff Pond	
Spatial coverage:	Grid pattern across the majority of the coal yard, except for existing coal pile	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	37 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Surveyed by TVA after drilling.
Data adequate to support three-dimensional model:	Yes	Data to support CCR thickness and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Unit interior geometry and phreatic conditions similar to current.
Piezometer installation:	Yes	15 temporary observation wells
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Testing followed relevant ASTM standards.
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.23.1 Field Activities

A subsurface exploration program was designed that originally proposed 37 borings. However, field conditions involving underground utilities required the elimination of four proposed boring locations. Thus, the exploration consisted of a total of 33 borings and 4 offset borings: 21 borings and 4 offset borings in the coal yard, 2 around the coal yard runoff pond, and 10 borings in the proposed process water pond. The boring locations were selected in agreement between TVA and Stantec. Upon completion of drilling, TVA surveyed the boring locations. The approximate locations are shown in Figure 1.

The borings were drilled using a track-mounted drilling rig with hollow stem augers. In the soil borings, SPTs were performed in accordance with ASTM D1586 at 2.5-foot intervals. Shelby tube samples were obtained in accordance with ASTM D1587 at depths determined by Stantec personnel within cohesive soil layers. Bulk samples were obtained of the Coal Yard Runoff Pond sediments in several locations.

Photo-ionization detector (PID) testing was performed on recovered soil samples in 2.5 feet intervals during the exploration in accordance with TDEC Division of Underground Storage Tanks, Technical Guidance Document - 005. Upon completion of drilling, temporary wells (i.e., piezometers) were installed at select boring locations. The annular backfill for the piezometer consisted of sand and bentonite. All other borings were backfilled using auger cuttings for the full depth. Temporary well readings were taken at 24 hours and 7 days after boring was completed.

3.23.2 Laboratory Testing

Select SPT samples were subjected to natural moisture content (D2216) tests, along with soil classification tests that included Atterberg limits (D4318), specific gravity (D854), and sieve and hydrometer analyses (D422) tests. One bulk sample of the Coal Yard Runoff Pond sediment was subjected to soil classification tests that included Atterberg limits (D4318), specific gravity (D854), and sieve and hydrometer analyses (D422) tests.

Select SPT samples from borings B-13, B-15, B-20, B-22, and B-25 were sent to the University of Kentucky Center for Applied Energy Research (CAER) for verification of fly ash material utilizing an electron microscope.

A representative sample from each boring with the greatest PID result was collected for laboratory analysis to determine concentrations of extractable petroleum hydrocarbons (EPH) above 500 milligrams/kilogram by the Tennessee EPH Method. Additionally, EPH testing was utilized to analyze BTEX (benzene, toluene, ethylbenzene, and xylene), naphthalene, and MTBE (methyl-tert-butyl-ether) concentrations.

3.23.3 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed.
    b. Boring logs document material descriptions and thicknesses.
    c. Foundation geometry is substantially the same as current.
2. Temporary Wells
    a. Installation methods meet current standard of practice.
    b. Locations and elevations were surveyed.
3. Soil properties
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current.

3.24 STANTEC (2017)

Table 24. Summary of Evaluation for Stantec (2017)

Reference:	Stantec Consulting Services Inc. (Stantec). 2017. "Geotechnical Field Services for Well Installations and Closures, Groundwater Monitoring Optimization - Phase 3, Johnsonville Fossil Plant, New Johnsonville, Humphreys County, Tennessee." Prepared for Tennessee Valley Authority. February 23.	
Purpose:	Updating groundwater monitoring network for TVA Johnsonville Fossil Plant	
CCR Unit(s):	TVA JOF Property (all units)	
Spatial coverage:	Widely spaced	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	5 borings
Rock coring:	No	
Other subsurface data:	Yes	Downhole video logging of existing wells
Boring locations surveyed:	Yes	Surveyed by Stantec after field work.
Data adequate to support three-dimensional model:	Yes	Data support dike perimeter geometry and foundation soil stratigraphy
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar.
Piezometer installation:	Yes	Five monitoring wells
In-situ testing:	Yes	SPT
Laboratory testing:	No	Analytical testing of soil only.
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	
Other relevant analyses:	No	

3.24.1 Field Activities

The field work included 6 new monitoring wells, 38 well closures and the redevelopment of 13 existing wells. One planned monitoring well, JOF-106, was not installed because a suitable location could not be determined. The work was performed by qualified Stantec drill crews using rotary drill units. The monitoring wells were installed using current industry and regulatory protocols to prevent introducing contaminants during the drilling and installation process. These procedures include the decontamination of the drilling equipment and tools before and after each well by washing with hot, potable water delivered under high pressure, using new well screen and riser that have been cleaned and sealed in plastic at the factory, and placing washed filter pack sand.

The well borings were advanced using 4.25-inch inside diameter (ID) hollow stem augers (HSAs). Standard penetration tests (SPT) were conducted at 2.5-foot intervals through the soil overburden. The subsurface materials were logged by a Tennessee licensed professional geologist or engineer for material type, color, consistency, and other notable composition characteristics. The split-spoon samples were placed into glass jars with lids and transported to Stantec's Lexington, Kentucky laboratory.

New wells were installed through 8.25-inch ID HSAs (offset from the 4.25-inch boring). The new wells consist of a 4-inch diameter by 10-foot long Schedule 40 PVC pre-packed well screen with 0.01-inch slots and associated PVC risers. The PVC risers extended to approximately forty-five inches above the ground surface. The annular space was backfilled with a sand filter pack to approximately two to three feet above the screened interval. Then a minimum of a two feet layer of bentonite was used as a seal. The annular space from the bentonite seal to the ground surface was backfilled with a bentonite grout.

Upon completion of the field work, the soil borings and well locations were surveyed referencing the Tennessee state plane coordinate system (approximate locations are shown in Figures 1, 2, and 3).

3.24.2 Evaluation of Existing Data

Based on a review of the referenced document and its data, and comparing against the evaluation criteria in Section 2.0, the following data is considered suitable for use in responding to the EIP information requests:

1. Material descriptions, thicknesses, and elevations from boring logs
    a. Boring locations and elevations were surveyed.
    b. Boring logs document material descriptions and thicknesses.
    c. Perimeter dike and foundation geometry is substantially the same as current.

2. Monitoring Wells

    a. Installation methods meet current standard of practice.

    b. Locations and elevations were surveyed.

    c. Instruments are adequate to provide current water level readings.

4.0 ASSUMPTIONS AND LIMITATIONS

In preparing this document, assumptions are as follows:

- The summaries presented herein cannot fully communicate the information contained in each document. Refer to the individual reference documents for additional context and detail.

5.0 REFERENCES

References are provided in the summary table for each document discussed herein.

ATTACHMENT A
FIGURES

Figure No.
1

Title
Existing Borings
Ash Disposal Area 1, Coal Yard, & DuPont Road Dredge Cell

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-11
Technical Review by ZW on 2018-01-11

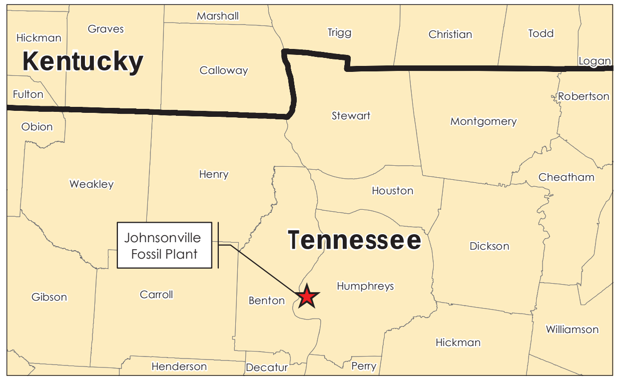
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Existing Boring
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec

TVA

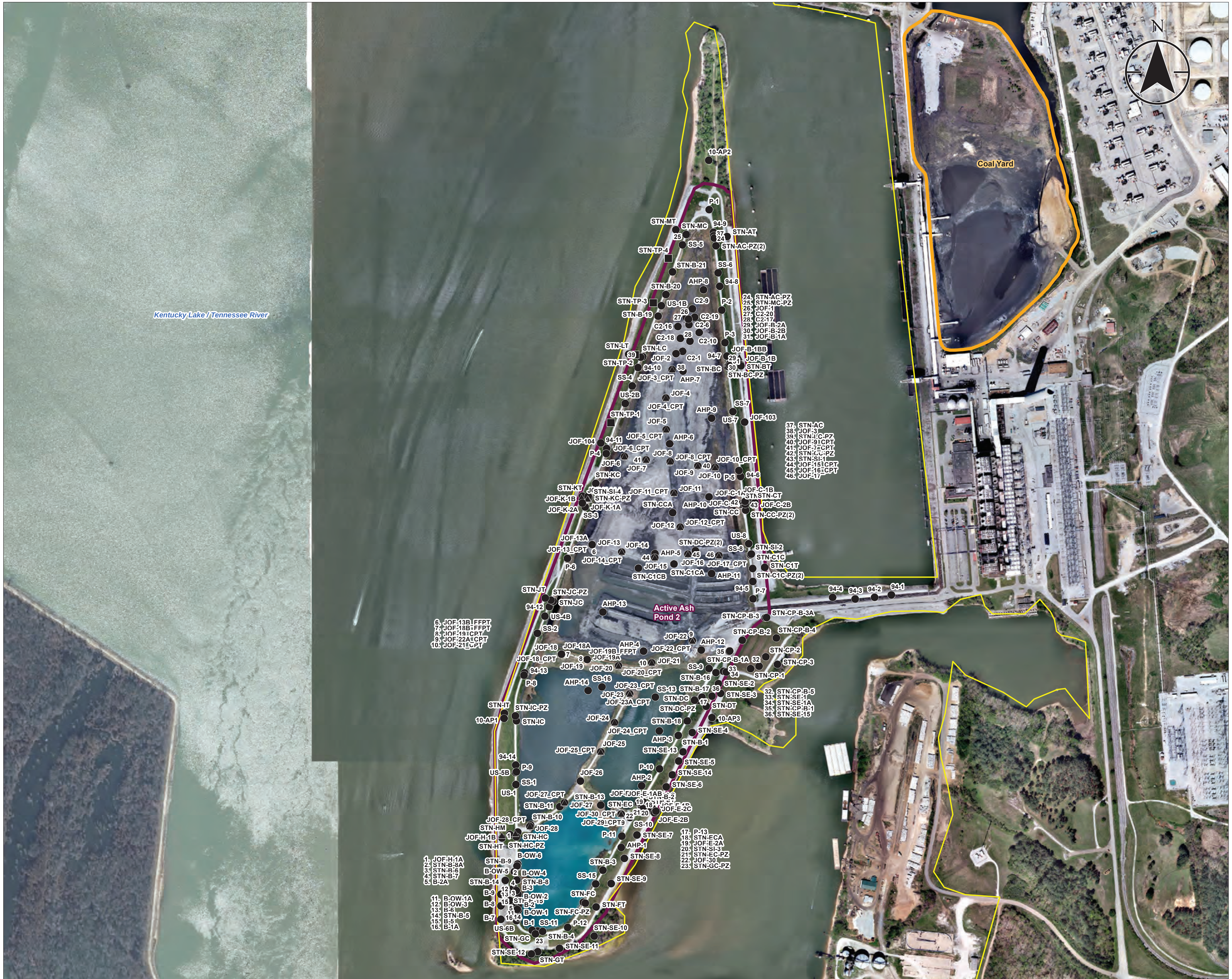


Figure No.
2

Title
Existing Borings
Active Ash Pond 2

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2017-12-19
Technical Review by ZW on 2017-12-19

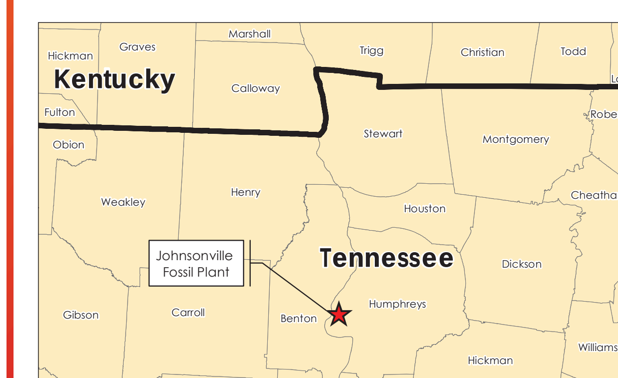
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- ● Existing Boring
- ▲ Existing CPT
- ■ Existing Test Pit
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

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Figure No.
3

Title
Existing Borings
South Rail Loop Area 4

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2017-12-19
Technical Review by ZW on 2017-12-19

0 300 600 900 1,200 Feet

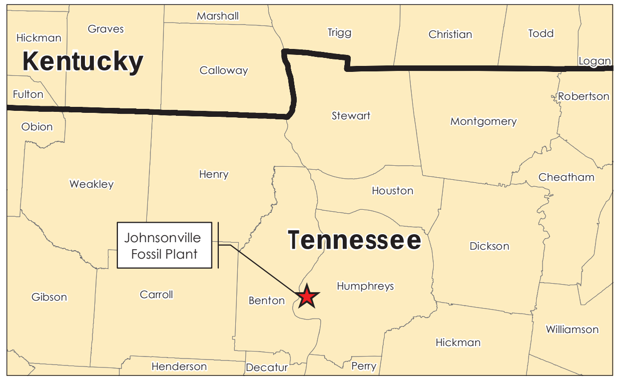
1:3,600 (At original document size of 22x34)

Legend

- Existing Boring
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

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APPENDIX I
MATERIAL QUANTITY SAP

Material Quantity
Sampling and Analysis Plan
Johnsonville Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Johnsonville Fossil Plant
New Johnsonville, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 10, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	July 24, 2017
1	Addresses October 19, 2017 TDEC Review Comments and Issued for TDEC Review	January 12, 2018
2	Addresses March 9, 2018 TDEC Review Comments and Issued for TDEC Review	May 11, 2018
3	Addresses June 11, 2018 TDEC Review Comments and Issued for TDEC Review	July 20, 2018
4	Addresses comments and revisions from other EIPs and issued for TDEC review.	December 10, 2018

Material Quantity
Sampling and Analysis Plan
Johnsonville Fossil Plant

TITLE AND REVIEW PAGE

Title of Plan: Material Quantity
Sampling and Analysis Plan
Johnsonville Fossil Plant
Tennessee Valley Authority
New Johnsonville, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 10, 2018 Revision 4, Final

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager	12/6/18 Date
TVA Investigation Field Lead	12/6/18 Date
Health, Safety, and Environmental (HSE) Manager	12/05/2018 Date
Investigation Project Manager	12/7/2018 Date
Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.12.03 11:51:37 -05'00' QA Oversight Manager	Date
N/A Laboratory Project Manager	Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

Stantec

Table of Contents

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order), to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Johnsonville Fossil Plant (JOF) on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management at JOF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC submitted a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 24, 2017, TVA submitted JOF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

In response to TDEC's comments, TVA has developed this Material Quantity Sampling and Analysis Plan (SAP) to answer TDEC's information requests regarding three-dimensional models, CCR material quantity, groundwater elevations, saturation levels, and subsurface conditions with respect to the Coal Yard, Active Ash Pond 2, South Rail Loop Area 4, DuPont Dredge Cell, and Ash Disposal Area 1 (Study Area Units) at the JOF Plant (Plant).

2.0 OBJECTIVES

The purpose of this Material Quantity SAP is to describe the methods TVA will use to answer TDEC's information requests regarding CCR unit geometry, CCR material quantity, groundwater elevations, saturation levels, and subsurface conditions with respect to the Study Area. Activities described in this SAP will be completed to:

- Estimate the volume of CCR below and above groundwater
- Estimate the volume of CCR below and above the piezometric level of saturation
- Develop three-dimensional models of the subsurface from ground surface to bedrock and CCR volume estimates for each CCR unit
- Produce drawings specified in TDEC's information requests from the three-dimensional model

3.0 APPROACH

3.1 EXPLORATORY BORINGS AND TEMPORARY WELLS

3.1.1 Proposed TDEC Order Borings and Temporary Wells

In order to address TDEC's information requests regarding CCR material quantity, water levels, CCR material characteristics, and subsurface materials, subsurface characterization will be supplemented by drilling multi-purpose borings and installing temporary wells at locations shown on Figures 1 through 3 (Attachment A). These additional borings, some of which will be converted into temporary wells, will provide supplemental data relative to CCR thickness, water levels, foundation soil type and thickness, and top of bedrock elevations for the interior of the CCR units. A total of 25 borings are proposed. Details regarding proposed drilling, sampling, temporary well, and piezometric activities are provided in the Exploratory Drilling SAP. Table 1 provides a summary of borings, piezometers, and temporary wells proposed in each CCR unit.

Table 1. Exploratory Drilling Proposed in each CCR Unit

CCR Unit	Total No. of Proposed Borings	No. of Borings with Temporary Wells	No. of Borings with Vibrating Wire Piezometers	No. of Borings with Rock Coring
Active Ash Pond 2	5	5	0	0
Ash Disposal Area 1	5	2	3	3
Coal Yard*	3	3	0	0
DuPont Road Dredge Cell	3	3	0	0
South Rail Loop Area 4	9	3	6	6
Total	**25**	**16**	**9**	**9**

*The Coal Yard is not a CCR unit, but drilling is planned to fulfill a specific TDEC information request for temporary wells in CCR material that was beneficially reused as structural fill.

3.1.2 Data Analysis

Data from the proposed borings will be compared to the existing boring data and pre-construction topographic information available for each CCR unit. If this evaluation indicates different results between information sources for the lower CCR surface elevations, additional borings may be warranted. TVA will communicate with TDEC and discuss / determine if additional data collection is needed to meet the objectives listed in Section 2.0.

3.1.3 Water Level Monitoring

Monthly water level monitoring will be conducted for six months to establish and monitor levels in each CCR unit. TVA proposes using manual readings from temporary wells and open standpipe piezometers and automated readings from existing automated vibrating wire transducer piezometers shown on Figures 4, 5, and 6 to estimate saturation levels in CCR. Details regarding water level monitoring field activities are provided in the CCR Material Characteristics SAP. Following characterization of the Plant and in communication with TDEC, TVA may elect to remove the temporary wells following the 6-month monitoring period.

3.2 THREE-DIMENSIONAL MODELS

Three-dimensional models of the Study Area Units will be developed to depict subsurface conditions from the ground surface to bedrock using the data summarized below which includes data from the proposed exploratory borings and temporary wells discussed in Section 4.1.

1. Ground and aerial survey data will be used with record drawings to model features such as a soil cap and riprap.

2. Contour data from the most recent aerial and hydrographic surveys, recent as-built closure surveys (Stantec 2010b, 2015) and borings shown on Figures 1, 2, 3, 7, 8, and 9 will be used to model the upper CCR surface.

3. Pre-construction topographic information from TVA drawings 10N502 and 10N527 (Active Ash Pond No. 2), 10W530-1(South Rail Loop 4), 10N503 (Ash Disposal Area 1) and data from borings that penetrated the lower boundary of the CCR surface shown on Figures 1, 2, 3, 7, 8, and 9 will be used to model the lower CCR surface.

4. TVA surveyed slopes, embankments, and benches to develop stability sections of Active Ash Pond 2 (Stantec 2010a). TVA will use this topographic data with the most recent aerial survey data to model the geometry of the dikes and benches

5. Data from borings shown on Figures 1, 2, 3, 10, 11, and 12 will be used to model the foundation soils underlying each site.

6. Data from borings that encountered top of bedrock shown on Figures 1, 2, 3, 13, 14, and 15 will be used to model the top of bedrock surface.

7. Estimated piezometric levels of saturation discussed in Section 4.1.3 will be incorporated into the models.

8. Groundwater levels estimated as part of the Investigation will be incorporated into the models.

The three-dimensional model will be generated using software capable of rendering three-dimensional surfaces and calculating volumes such as Autodesk's AutoCAD Civil 3D or ArcGIS. Environmental Visualization Software (EVS) may also be used to visualize the three-dimensional model of the facilities.

3.3 DRAWINGS

After the three-dimensional models are finalized, they will be used to produce drawings of the Study Area Units showing the following:

- Subsurface material types, properties, elevations, and thickness from the ground surface to top of bedrock
- Upper and lower CCR surfaces and CCR thickness for each facility
- Top of bedrock contours
- Estimated piezometric saturation levels, contours, and river stage
- Estimated groundwater elevations, contours, and river stage
- Plan view showing areas where CCR is saturated
- Normal/minimum pool elevation (lowest spillway rim elevation) and minimum embankment crest elevation (maximum pool elevation) in Active Ash Pond 2
- Estimated extent of foundation soils between CCR and bedrock and estimated groundwater elevation

3.4 VOLUMETRIC ESTIMATES

The following volumetric estimates will be calculated for each Study Area Unit using three-dimensional modeling software such as Autodesk's AutoCAD Civil 3D or ArcGIS:

- Total volume of CCR
- Volume of CCR below estimated piezometric saturation levels
- Volume of CCR below estimated groundwater elevations
- Volume of CCR above estimated piezometric saturation levels
- Volume of CCR above estimated groundwater elevations

The combined total volume of CCR for all Study Area Units at JOF will also be estimated. These volumetric estimates will be calculated using two methods to validate the model and results.

4.0 REPORTING AND DELIVERABLES

The Environmental Assessment Report (EAR) will document the field activities from the Investigation. This will include deviations from those procedures, results, and geological and hydrogeological interpretations. The results of the CCR material quantity assessment, including three-dimensional models of the facilities, drawings, and volumetric estimates, will also be incorporated into the EAR.

5.0 QUALITY ASSURANCE/QUALITY CONTROL

The Plant-specific Quality Assurance Project Plan (QAPP) describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to this Material Quantity SAP.

5.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to confirm that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Project Manager considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

5.2 QUALITY CONTROL CHECKS

The accuracy of the material quantity analysis procedures must be maintained throughout the investigation. Field and office personnel will be responsible for performing checks to confirm that the quality control checks in this SAP and the Exploratory Drilling SAP are followed. This consists of the completion of applicable field forms, collection of appropriate quality control samples, and documentation of field and office activities.

5.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP.

6.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 2. Preliminary Schedule for Material Quantity SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Material Quantity SAP Submittal	-	Completed
Develop models	60 Days	Following EIP Approval
Supplement models with data from proposed TDEC Order multi-purpose borings and temporary wells	30 Days	Following Field Activities
Use model to develop drawings and complete volumetric estimates	90 Days	Following Modeling Activities
Reporting and deliverables	60 Days	Following Analysis Activities

7.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Inaccuracies in historical data may cause uncertainty in the material quantity analysis. Uncertainty in the material quantity analysis will be evaluated and taken into consideration when determining if sufficient data has been gathered to complete the analysis.

8.0 REFERENCES

Stantec Consulting Services Inc. (Stantec). 2010a. "Report of Geotechnical Exploration and Slope Stability Evaluation, Ash Disposal Areas 2 and 3 (Active Ash Disposal Area) Johnsonville Fossil Plant, New Johnsonville, Tennessee." Prepared for Tennessee Valley Authority. April 13.

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Tennessee Valley Authority (TVA). 1954. "Dike for Ash Disposal Area. Johnsonville Fossil Plant." TVA Record Drawing No. 10N503, Rev. 9.

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Tennessee Valley Authority (TVA). 1968. "Ash Disposal Area West of Boat Harbor, Johnsonville Fossil Plant." TVA Record Drawing No. 10N527, Rev. 3.

Tennessee Valley Authority (TVA). 1996. "Ash Disposal Area Inside Railroad Loop. Johnsonville Fossil Plant." TVA Record Drawing No. 10W530-1, Rev. 2.

ATTACHMENT A
FIGURES

Figure No.
1

Title **Proposed Temporary Wells Ash Disposal Area 1, Coal Yard, & DuPont Road Dredge Cell**

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location 175567296

New Johnsonville, Tennessee

Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Proposed Boring with Piezometer Vibrating Wire
- Proposed Temporary Well (Screened Interval)
- Existing Piezometer Open Standpipe
- Existing Piezometer Vibrating Wire
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)

Stantec TVA

U:\TVA-EIP\175567296\gis\mxds\JOF_TempWells_AshArea1_CY_Dupont.mxd Revised: 2018-12-06 By: mbough

Figure No.
2

Title
Proposed Borings
South Rail Loop Area 4

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

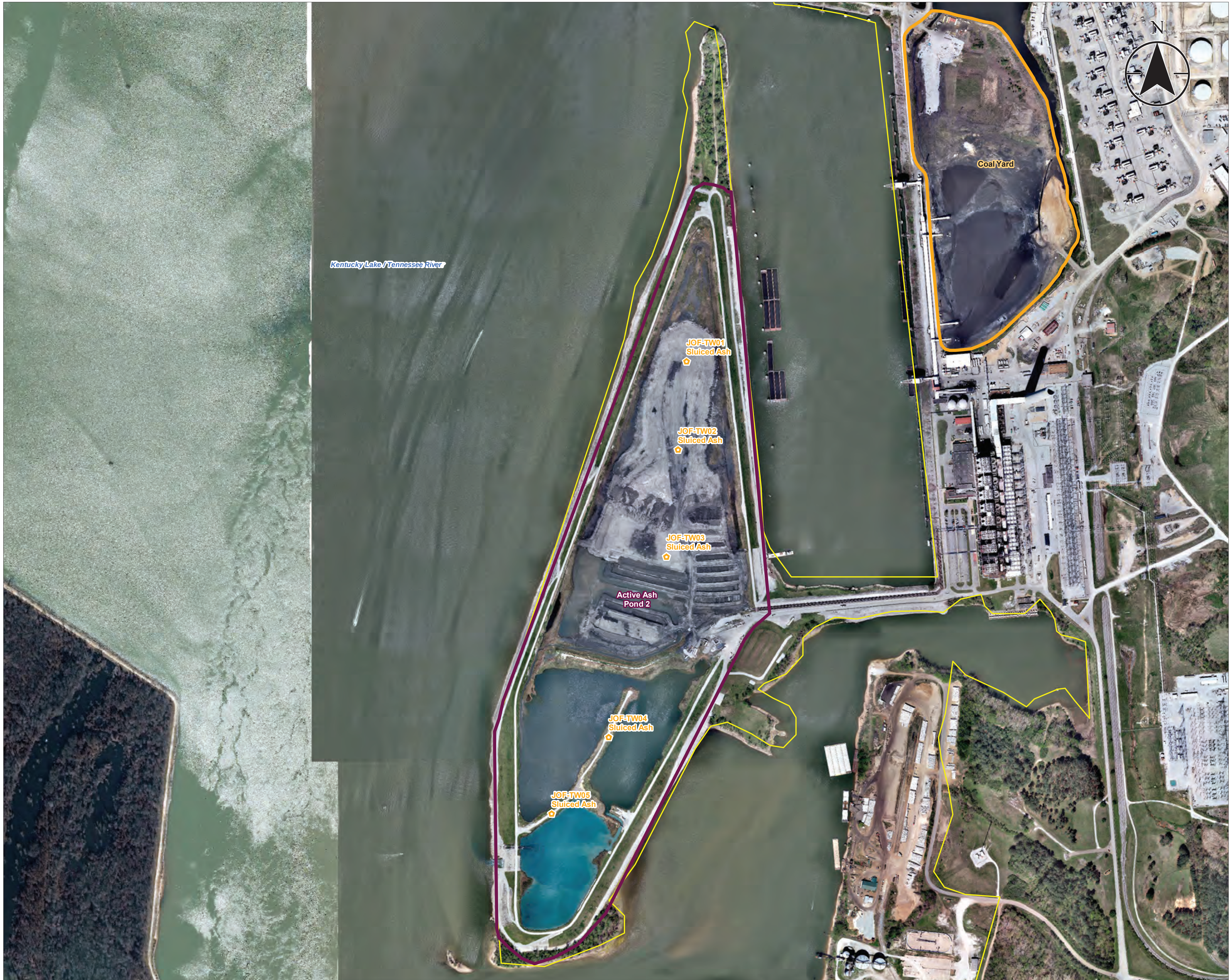
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Proposed Boring with Piezometer Vibrating Wire
- Proposed Temporary Well (Screened Interval)
- Existing Piezometer Open Standpipe
- Existing Piezometer Vibrating Wire
- Unit Boundary (Approximate)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



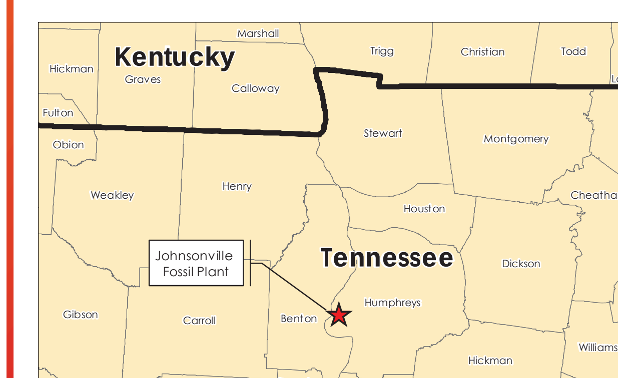


Figure No.
3

Title

Proposed Temporary Wells Active Ash Pond 2

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Proposed Temporary Well (Screened Interval)
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)

Stantec

TVA

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Figure No.
4

Title

Existing Instrumentation
South Rail Loop Area 4

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296
Prepared by LMB on 2017-12-18
Technical Review by ZW on 2017-12-18

0 300 600 900 1,200 Feet

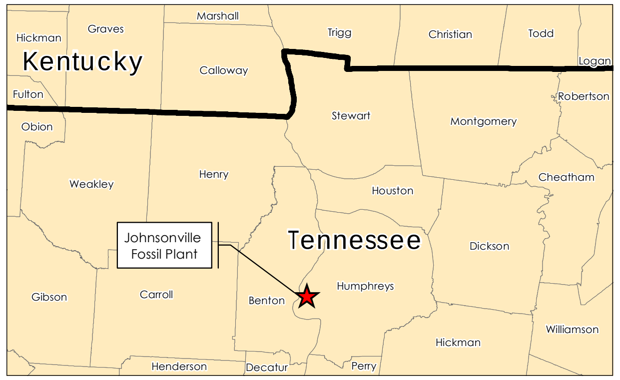
1:3,600 (At original document size of 22x34)

Legend

- Existing Piezometer Open Standpipe (Screened Interval Lithology)
- CCR Unit Boundary (Approximate)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

Figure No.
5

Title **Existing Instrumentation Ash Disposal Area 1, Coal Yard, & DuPont Road Dredge Cell**

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-05
Technical Review by ZW on 2018-01-05

0 300 600 900 1,200 Feet

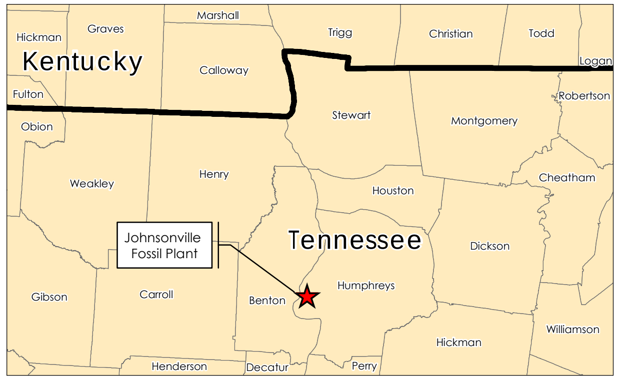
1:3,600 (At original document size of 22x34)

Legend

- Existing Piezometer Open Standpipe (Screened Interval Lithology)
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

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Figure No.
6

Title

Existing Instrumentation Active Ash Pond 2

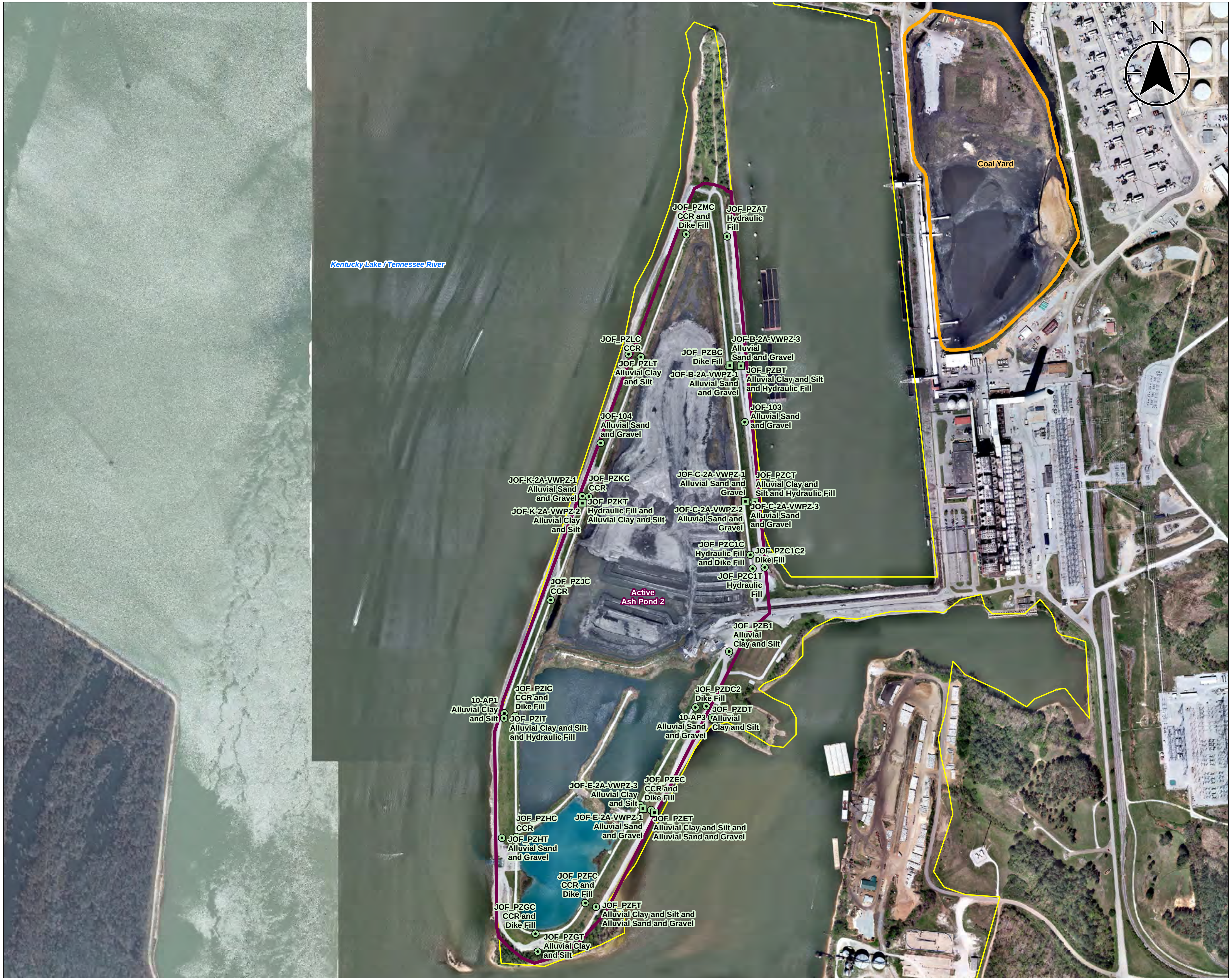
Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2017-12-19
Technical Review by ZW on 2017-12-19

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

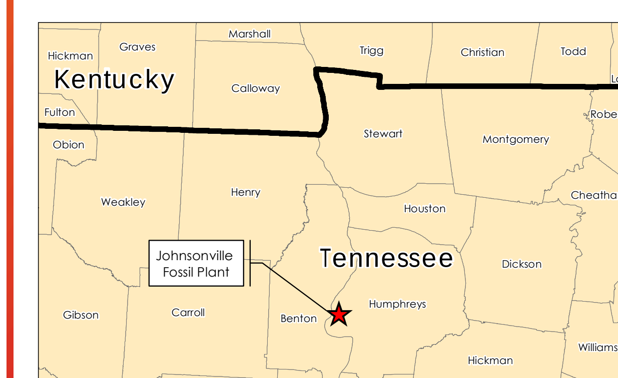


Legend

- Existing Piezometer Open Standpipe (Screened Interval Lithology)
- Existing Piezometer Vibrating Wire (Tip Interval)
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

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Exhibit No.

7

Title

Existing CCR Thickness Boring Data Ash Disposal Area 1, Coal Yard, & DuPont Road Dredge Cell

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296

Prepared by LMB on 2018-01-05
Technical Review by ZW on 2018-01-05

0 300 600 900 1,200 Feet

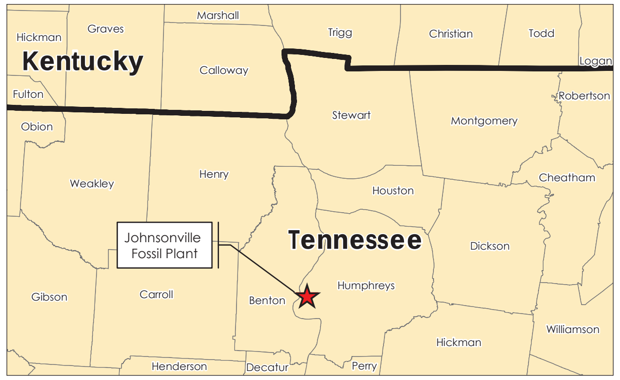
1:3,600 (At original document size of 22x34)

Legend

- Boring with CCR Thickness Data
- Boring - CCR Not Encountered (Coal Yard only)
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec

TVA

Exhibit No.
8

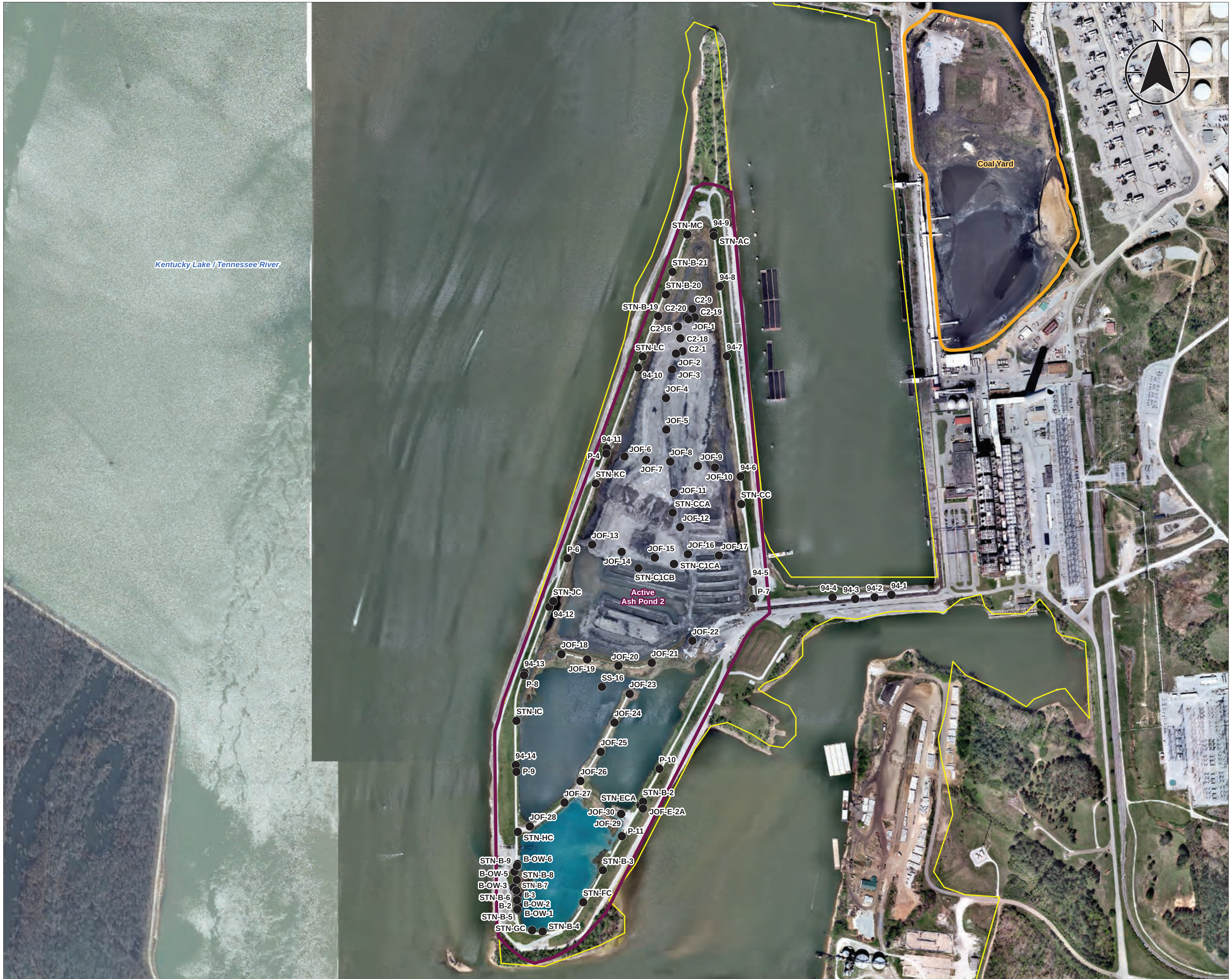
Title
Existing CCR Thickness Boring Data Active Ash Pond 2

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2017-12-19
Technical Review by ZW on 2017-12-19

0 400 800 1,200 1,600 Feet
1:3,600 (At original document size of 22x34)

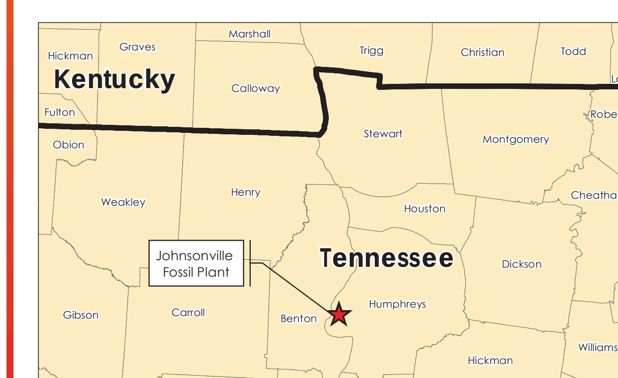


Legend

- Boring with CCR Thickness Data
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec
TVA

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Exhibit No.
9

Title
Existing CCR Thickness Boring Data South Rail Loop Area 4

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2017-12-18
Technical Review by ZW on 2017-12-18

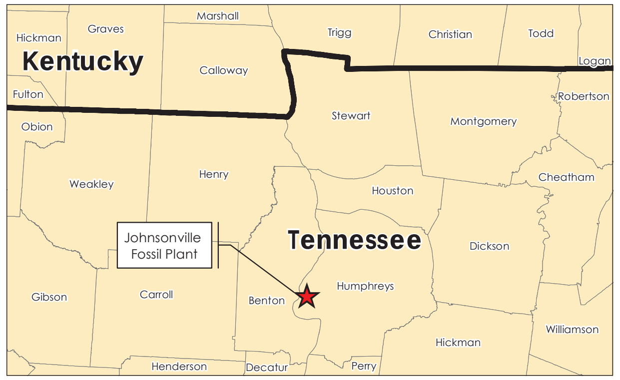
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Boring with CCR Thickness Data
- CCR Unit Boundary (Approximate)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec
TVA

Exhibit No.
10

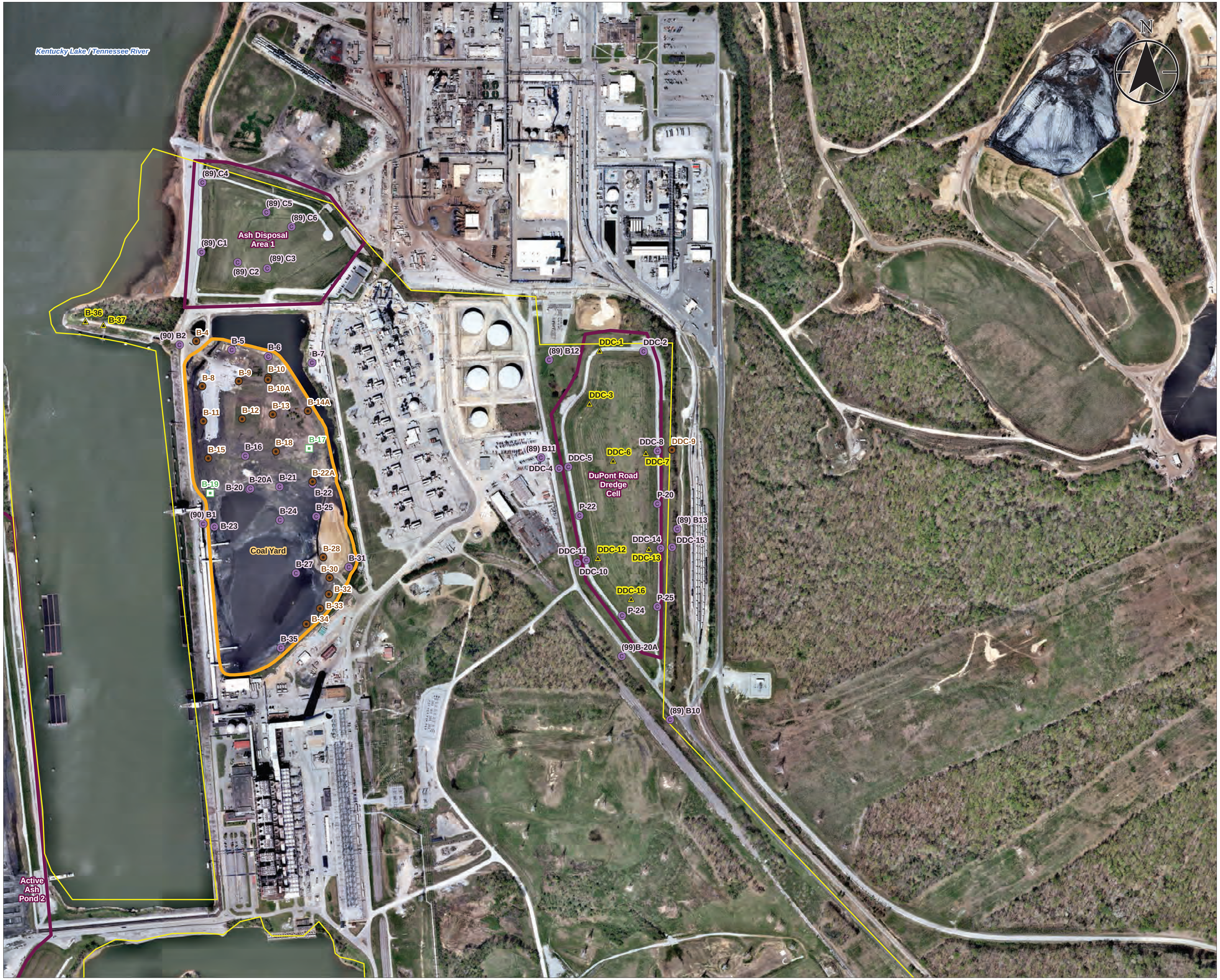
Title **Uppermost Foundation Soil Data Ash Disposal Area 1, Coal Yard, & DuPont Road Dredge Cell**

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-05
Technical Review by ZW on 2018-01-05

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



Legend

Alluvial Clay and Silt	Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]
Alluvial Sand and Gravel	Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]
Bedrock	Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]
Clayey Fill	Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]

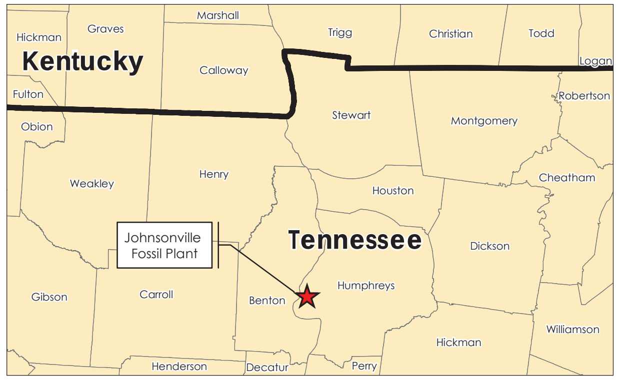
CCR Unit Boundary (Approximate)

Coal Yard

TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec

TVA

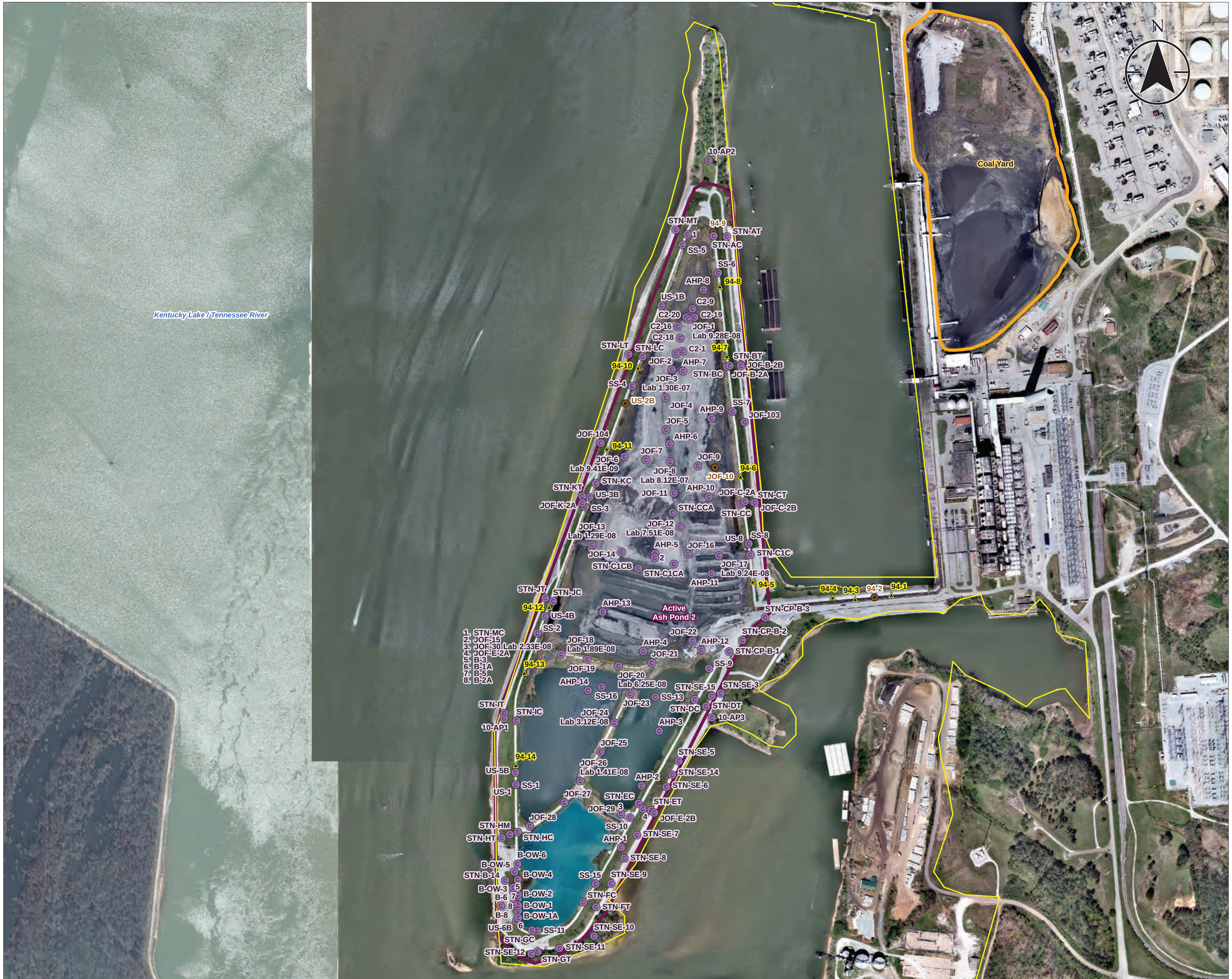


Exhibit No.

11

Title

Uppermost Foundation Soil Data
Active Ash Pond 2

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

175567296

New Johnsonville, Tennessee

Prepared by LMB on 2017-12-18
Technical Review by ZW on 2017-12-18

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

Alluvial Clay and Silt	●	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Alluvial Sand and Gravel	●	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Clayey Fill	▲	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*

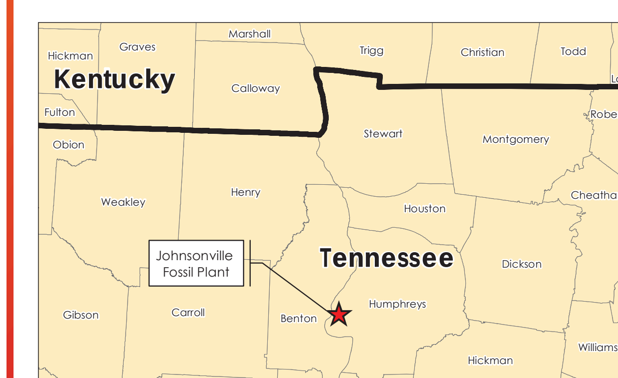
CCR Unit Boundary (Approximate)

Coal Yard

TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec

TVA

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

Exhibit No.
12

Title

Uppermost Foundation Soil Data South Rail Loop Area 4

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2017-12-18
Technical Review by ZW on 2017-12-18

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

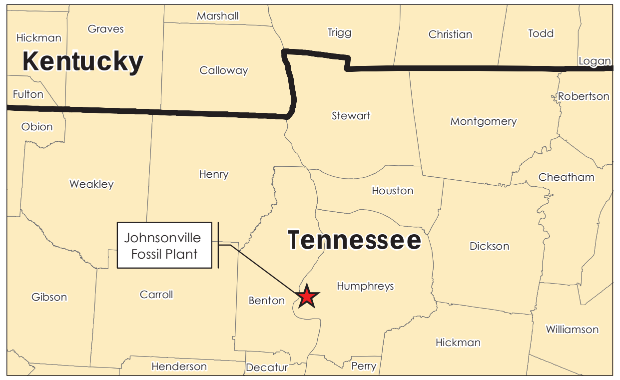
Alluvial Clay and Silt	●	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Alluvial Sand and Gravel	●	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*

CCR Unit Boundary (Approximate)

TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

Exhibit No.
13

Title
Existing Top of Rock Elevation Boring Data Ash Disposal Area 1, Coal Yard, & DuPont Road Dredge Cell

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-05
Technical Review by ZW on 2018-01-05

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

Legend

- Boring without Rock Core Data *[ID, TOR Elevation]*
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary
- D -Devonian Formations, includes Pegram Formation, Camden Formation, Harriman Formation, Flat Gap Limestone, and Ross Formation
- Mfp - Fort Payne Formation or Fort Payne Formation and Chattanooga Shale
- Msw - St. Louis Limestone and Warsaw Limestone
- Qal - Alluvial deposits

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)
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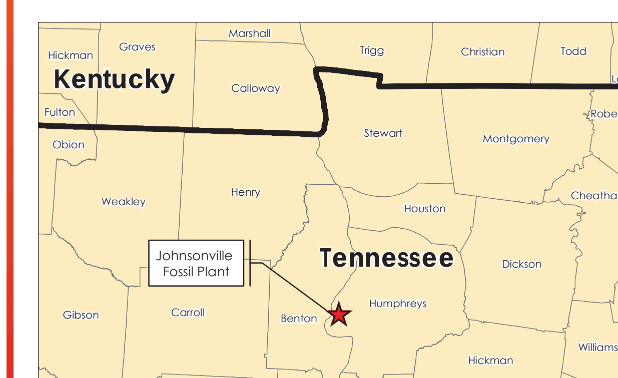


Stantec

TVA

Exhibit No.
14

Title
Existing Top of Rock Elevation Boring Data Active Ash Pond 2

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2017-12-19
Technical Review by ZW on 2017-12-19

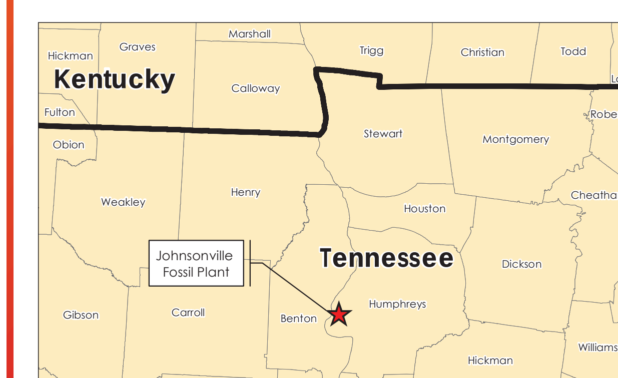
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Boring without Rock Core Data [ID, TOR Elevation]
- Boring with Rock Core Data
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary
- D -Devonian Formations, includes Pegram Formation, Camden Formation, Harriman Formation, Flat Gap Limestone, and Ross Formation
- Qal - Alluvial deposits

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)
3. Geologic Data downloaded from https://mrdata.usgs.gov/geology/state/state.php?state=TN



Stantec TVA

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Exhibit No.
15

Title

Existing Top of Rock Elevation Boring Data South Rail Loop Area 4

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
175567296

New Johnsonville, Tennessee
Prepared by LMB on 2017-12-19
Technical Review by ZW on 2017-12-19

0 300 600 900 1,200 Feet

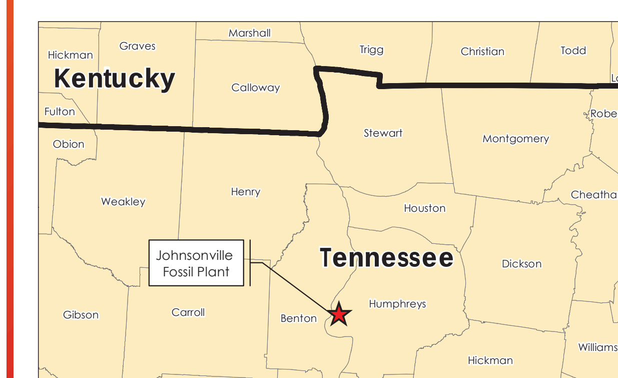
1:3,600 (At original document size of 22x34)

Legend

- Boring without Rock Core Data *[ID, TOR Elevation]*
- TVA Property Boundary
- CCR Unit Boundary (Approximate)
- D -Devonian Formations, includes Pegram Formation, Camden Formation, Harriman Formation, Flat Gap Limestone, and Ross Formation
- Mfp - Fort Payne Formation or Fort Payne Formation and Chattanooga Shale
- Msw - St. Louis Limestone and Warsaw Limestone
- Qal - Alluvial deposits

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)
3. Geologic Data downloaded from https://mrdata.usgs.gov/geology/state/state.php?state=TN



Stantec TVA

APPENDIX J
EXPLORATORY DRILLING SAP

Exploratory Drilling Sampling and Analysis Plan Johnsonville Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Johnsonville Fossil Plant
New Johnsonville, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 10, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	July 24, 2017
1	Addresses October 19, 2017 TDEC Review Comments and Issued for TDEC Review	January 12, 2018
2	Addresses March 9, 2018 TDEC Review Comments and Issued for TDEC Review	May 11, 2018
3	Addresses June 11, 2018 TDEC Review Comments and Issued for TDEC Review	July 20, 2018
4	Addresses comments and revisions from other EIPs and issued for TDEC review.	December 10, 2018

EXPLORATORY DRILLING
SAMPLING AND ANALYSIS PLAN
JOHNSONVILLE FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Exploratory Drilling
Sampling and Analysis Plan
Johnsonville Fossil Plant
Tennessee Valley Authority
New Johnsonville, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 10, 2018 Revision 4, Final

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager — Date 12/6/18

TVA Investigation Field Lead — Date 12/6/18

Health, Safety, and Environmental (HSE) Manager — Date 12/05/2018

Investigation Project Manager — Date 12/7/2018

Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envirostd.com, c=US Date: 2018.12.05 11:51:54 -05'00'

QA Oversight Manager — Date

Laboratory Project Manager — Date 12-05-18

Charles L. Head
TDEC Senior Advisor — Date

Robert Wilkinson
TDEC CCR Technical Manager — Date

Stantec

Table of Contents

LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order) to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Johnsonville Fossil Plant (JOF) on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residual (CCR) management at JOF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC submitted a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 24, 2017, TVA submitted JOF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

Through the various information requests, as well as TDEC comments, a need for exploratory borings at JOF (the Plant) has been identified. This Exploratory Drilling Sampling and Analysis Plan (SAP) has been prepared to outline the proposed borings and the methods to be employed during the Investigation.

2.0 OBJECTIVES

The objective of this Exploratory Drilling SAP is to outline the methods that will be used to execute the following activities:

- Where applicable, perform additional soil and rock borings, piezometer installation, and laboratory testing to refine subsurface characterization and CCR material quantity estimates,
- Where applicable, install temporary wells to allow for pore water sampling and measuring piezometric (i.e., water) levels within CCR units.

Pore water sampling and water level readings are not within the scope of this SAP but are addressed in other SAPs within the EIP.

Additional, future borings performed under other programs, such as EPA Final CCR Rule compliance and closure design, may be used to supplement the data necessary to respond to information requests in the EIP. However, performance of those borings is governed by other programs and is not covered herein.

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and will document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 PLANT-SPECIFIC EXPLORATION PLAN

The proposed soil and rock boring locations were selected to aid in addressing data gaps and supplementing existing data, as necessary to address information requests of the TDEC Multi-Site Order for JOF. Rationale for individual borings, piezometers, and/or well locations are discussed below. Refer to Figures 1 through 3 in Attachment A for a layout of proposed boring locations. Proposed boring locations are accessible using existing access routes without modification.

In order to address TDEC's information requests regarding CCR material quantity, water levels, CCR material characteristics, and subsurface materials, subsurface characterization will be supplemented by installing multi-purpose borings and temporary wells at locations shown on Figures 1 through 3. These additional borings, some of which will be converted into temporary wells, will provide supplemental data relative to CCR thickness, water levels, foundation soil type and thickness, and top of bedrock elevations for the interior of the CCR units. A total of 25 borings are proposed. Table 1 provides a summary of borings, piezometers, and temporary wells proposed in each CCR unit. Table 2 lists individual borings along with more detail about the purpose of each. If the boring for a temporary well demonstrates that the CCR is unsaturated and above the expected phreatic surface, the temporary well will not be installed, and the boring will be backfilled.

Table 1. Summary of Exploratory Drilling Proposed in each CCR Unit

CCR Unit	Total No. of Proposed Borings	No. of Borings with Temporary Wells	No. of Borings with Vibrating Wire Piezometers	No. of Borings with Rock Coring
Active Ash Pond 2	5	5	0	0
Ash Disposal Area 1	5	2	3	3
Coal Yard*	3	3	0	0
DuPont Road Dredge Cell	3	3	0	0
South Rail Loop Area 4	9	3	6	6
Total	**25**	**16**	**9**	**9**

*The Coal Yard is not a CCR unit, but drilling is planned to fulfill a specific TDEC information request for temporary wells in CCR material that was beneficially reused as structural fill.

Table 2. Detailed Boring Descriptions

Boring No.	CCR Unit	Deepest Material Encountered	Temporary Well Screen Location	VWPZ Tip Location(s)[1]	Boring Purpose[2]
TW01	Active Ash Pond 2	Alluvium	Sluiced Ash	--	PZ, PW, Geo
TW02	Active Ash Pond 2	Alluvium	Sluiced Ash	--	PZ, PW, Geo
TW03	Active Ash Pond 2	Alluvium	Sluiced Ash	--	PZ, PW, Geo
TW04	Active Ash Pond 2	Alluvium	Sluiced Ash	--	PZ, PW, Geo
TW05	Active Ash Pond 2	Alluvium	Sluiced Ash	--	PZ, PW, Geo
TW06	Ash Disposal Area 1	Alluvium	Sluiced Ash	--	PZ, PW, Geo
TW07	Ash Disposal Area 1	Alluvium	Sluiced Ash	--	PZ, PW, Geo
TW08	Coal Yard	Alluvium	Stacked Ash	--	PZ, PW, Geo
TW09	Coal Yard	Alluvium	Stacked Ash	--	PZ, PW, Geo
TW10	Coal Yard	Alluvium	Stacked Ash	--	PZ, PW, Geo
TW11	DuPont Road Dredge Cell	Foundation Soil	Sluiced Ash	--	PZ, PW, Geo
TW12	DuPont Road Dredge Cell	Foundation Soil	Sluiced Ash	--	PZ, PW, Geo
TW13	DuPont Road Dredge Cell	Foundation Soil	Sluiced Ash	--	PZ, PW, Geo
TW14	South Rail Loop Area 4	Alluvium	Ash	--	PZ, PW, Geo
TW15	South Rail Loop Area 4	Alluvium	Ash	--	PZ, PW, Geo
TW16	South Rail Loop Area 4	Alluvium	Ash	--	PZ, PW, Geo
B01	Ash Disposal Area 1	Bedrock	--	CCR, Foundation Soils, Bedrock	PZ, Geo
B02	Ash Disposal Area 1	Bedrock	--	CCR, Foundation Soils, Bedrock	PZ, Geo
B03	Ash Disposal Area 1	Bedrock	--	CCR, Foundation Soils, Bedrock	PZ, Geo
B04	South Rail Loop Area 4	Bedrock	--	CCR, Foundation Soils, Bedrock	PZ, Geo
B05	South Rail Loop Area 4	Bedrock	--	CCR, Foundation Soils, Bedrock	PZ, Geo

Table 2. Detailed Boring Descriptions

Boring No.	CCR Unit	Deepest Material Encountered	Temporary Well Screen Location	VWPZ Tip Location(s)[1]	Boring Purpose[2]
B06	South Rail Loop Area 4	Bedrock	--	CCR, Foundation Soils, Bedrock	PZ, Geo
B07	South Rail Loop Area 4	Bedrock	--	CCR, Foundation Soils, Bedrock	PZ, Geo
B08	South Rail Loop Area 4	Bedrock	--	CCR, Foundation Soils, Bedrock	PZ, Geo
B09	South Rail Loop Area 4	Bedrock	--	CCR, Foundation Soils, Bedrock	PZ, Geo

[1]VWPZ = Vibrating Wire Piezometer (grouted in place); No temporary well installed.
[2] PZ = Piezometric (Water) Levels in CCR; PW = Pore Water Sampling; Geo = Geotechnical Data

As shown in Figure 1, three (3) of the proposed borings (B01 to B03) are located within the footprint of Ash Disposal Area 1. As shown in Figure 2, six (6) of the proposed borings (B04 to B09) are located within the footprint of South Rail Loop Area 4. The purpose of these borings is to improve spatial coverage for CCR thickness, water levels, foundation type and thickness, top of bedrock elevations, and shallow bedrock characterization. Note that the exploratory drilling program at JOF does not necessitate cone penetration testing (CPT) in soil or downhole testing in rock.

In select borings, vibrating wire piezometers will be grouted in place in the major material zones encountered in the boring (e.g., CCR, foundation soil(s), bedrock). These vibrating wire piezometers will allow water level (i.e., pore water pressure) readings in the various materials and improve subsurface characterization of the CCR in this vicinity.

As shown in Figure 1, a total of eight (8) borings with temporary wells (labeled TW06 through TW13) are proposed within the footprints of Ash Disposal Area 1 (2 temporary wells), Coal Yard (3 temporary wells), and DuPont Road Dredge Cell (3 temporary wells). As shown in Figure 2, three (3) borings with temporary wells (labeled TW14 through TW16) are proposed within the footprint of South Rail Loop Area 4. As shown in Figure 3, five borings with temporary wells (TW01 through TW05) are proposed within the footprint of the Active Ash Pond 2. The temporary wells are located in accessible areas of the unit interiors to improve spatial coverage for CCR thickness and water levels, and to facilitate CCR material characterization. Each of the borings will also allow undisturbed tube sampling of CCR.

Borings will be advanced from the ground surface using a conventional rotary drill rig with standard penetration test (SPT) samples and/or undisturbed (Shelby) tube sampling until refusal, then rock coring will be performed in select borings for shallow bedrock characterization. SPT samples will be collected for general soil and CCR characterization. Undisturbed tube sampling (Shelby tubes) will be collected for laboratory testing. Rock coring in select borings will be performed to obtain approximately 10 feet of rock core to characterize the bedrock beneath the CCR units.

In order to answer TDEC's information requests regarding hydraulic conductivity and to improve the characterization of the pore water pressure regime around the perimeter of Active Ash Pond 2, slug tests will be performed in existing piezometers and existing monitoring wells (Figure 4) and proposed temporary wells (Figure 3). A total of 27 existing piezometers, 4 existing monitoring wells, and 5 proposed temporary wells are planned for slug testing. Materials to be tested include dike fill, hydraulic fill, CCR, and alluvium. The material to be tested in each slug test is listed with each existing piezometer and existing monitoring well in Figure 4, or in Table 2 above for proposed temporary wells. Note that slug testing in proposed monitoring wells at Active Ash Pond 2 is also planned; refer to the Hydrogeologic Investigation SAP for more information.

Supplemental laboratory testing is also proposed using surplus undisturbed (Shelby tube) samples from a recent exploration by Geocomp (2016). Borings were performed on the perimeter of Active Ash Pond 2. The actual testing program would be dependent upon review of tubes and extrusion of the samples to confirm the material type, available sample length, and sample condition.

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to advance borings, collect soil, and rock samples, install instruments, backfill borings, document field activities, and assist in providing scientifically defensible results.

Exploratory Drilling activities will adhere to applicable ASTM standards and TVA Environmental Technical Instruction (TI) documents. The field geologist/engineer will maintain a project field book and field forms (hard copy or electronic) to record field measurements and observations. Field activities will be documented in accordance with Section 5.2.3.

5.1 PREPARATION FOR FIELD ACTIVITIES

Truck or track-mounted CPT rigs and/or drill rigs are proposed to advance borings for this exploration phase of the Investigation. The boring locations will be located, and field utility cleared by TVA and/or Contractor personnel (using a field surveyor and the Excavation Permit process) prior to mobilizing the drill crews.

As part of field mobilization activities, the field sampling team will:

- Designate a Safety Officer and a Tennessee licensed professional engineer or professional geologist.
- Review applicable reference documents, including (but not limited to), TVA TIs (Section 5.5) and Standard Operating Procedures (SOPs), QAPP (Appendix C), SAPs, and HASP.
- Complete required health and safety paperwork, field readiness checklist, and confirm field team members have completed required training.
- Coordinate activities with the drill crew(s).
- Clear Access – Proposed boring locations will be marked using a wooden stake or survey flag with the position surveyed using the global positioning system (GPS). Suitability of each location will be evaluated for logistical issues including access, grubbing needs, overhead utility clearance, and proximity to Plant features. Access improvements, including clearing and grubbing or road building, will be completed prior to the investigation start date.
- If a boring will penetrate an engineered final cap component (e.g., low hydraulic conductivity soil layer, geosynthetic cap system, or vegetative soil layer), a temporary penetration will be prepared to allow drilling access. When applicable, field work plans will include detailed procedures for creating this temporary penetration.

- Perform Environmental Review - As required by the National Environmental Policy Act (NEPA), an environmental review must be completed to document and mitigate any potential impact of the work described herein. The level of review required for this work is anticipated to be a categorical exclusion, which would be documented by TVA with a categorical exclusion checklist (CEC). A CEC has a number of signatories from TVA. It is understood that the environmental review is to be completed before implementation of the field work. Additionally, plant staff will not issue an excavation permit ahead of the completed environmental review.

- Complete Utility Locate(s) / Excavation Permit(s) - Prior to initiating subsurface activities, subsurface utility clearance will be sought via the plant engineering department and/or the TN 811 service. At locations within the Plant, engineering will provide primary utility clearance assurance in addition to TN 811 being notified. At all other drilling locations, TVA or 3rd party underground locators will be engaged to clear boring locations. An excavation permit is required prior to initiating any digging or boring at the Plant. A key component to the completion of the excavation permit is consensus on the drilling locations with pertinent TVA staff.

- Identify Water Source – During implementation of the EIP, a source of potable water will be required to complete several investigation tasks, including certain drilling methods and decontamination procedures.

- Obtain required functional and calibrated field instruments, including health and safety equipment.

5.2 SAMPLING METHODS AND PROTOCOLS

TVA proposes to perform disturbed soil sampling (i.e., split-spoon sampling) and rock coring (only where specified) for the Investigation. Undisturbed soil sampling (Shelby tube) may be performed in selected borings if observed subsurface conditions and testing needs warrant. The sampling will allow TVA to develop a better understanding of the subsurface profile within the CCR and foundation materials and provide samples for subsequent laboratory testing to characterize materials. For geotechnical investigation borings and piezometer installations, a Tennessee licensed professional geologist (PG) or professional engineer (PE) will be present and will log the borings. The PG or PE will have suitable experience in geotechnical or geological engineering projects to support the work. This approach has been used at current investigations at other TVA Plants in Tennessee.

5.2.1 Drilling, Logging, and Surveying

5.2.1.1 Exploratory Borings

CPTs will be advanced using truck- or track-mounted rigs and data collected per ASTM D5778. Borings will be advanced using truck- or track-mounted rotary drill rigs. The borings are proposed to be advanced utilizing hollow-stem augering techniques (ASTM D6151) until boring termination depth or auger refusal, whichever is shallower. In some situations, drilling with a casing advancer may be a suitable alternative to augering.

If needed due to high water levels or underlying soils in the field, drilling will be performed using mud rotary techniques. Temporary casing will be set for mud circulation purposes and an upward discharge drag bit connected to drill rods will advance the boring through the soil materials.

The upward discharge bits are designed to direct the drilling fluid and cuttings upward and out of the boring. The drilling fluids are conveyed to the surface and into a recirculation tub where the suspended drill cuttings can settle out.

The recirculation tub employs a series of baffles to promote settling of the suspended particles allowing recirculation (recycling) of the drilling mud. The drilling fluid density and viscosity will be monitored at approximate 15-foot depth intervals using a mud balance and Marsh funnel, respectively.

If borings are to be advanced into rock, upon completion of drilling in overburden, temporary casing will be installed and seated into competent rock. The purpose of the casing is to separate the bedrock from the overburden (including saturated zones of CCR) while rock coring is performed and drilling fluid (water) is circulated. Appropriate drilling methods will be selected to seat the casing and achieve the objective of separating saturated CCR from bedrock. Rock coring tools will be inserted through the casing and coring will be performed in bedrock to the bottom of the hole. The diameters of drill tooling will be as necessary to facilitate soil sampling, rock coring, and/or temporary well installation.

5.2.1.2 Borehole Logging

The field geologist/engineer will prepare a written or electronic field log for each boring. In addition to describing each recovered soil or rock sample, the log will document boring location, drilling personnel, tooling/equipment used, drilling performance, depth to water, sample number, sample recovery, SPT blow counts, Rock Quality Designation (RQD), and other relevant observations. Soil color will be logged per the appropriate Munsell soil color chart.

Similarly, the field geologist/engineer will prepare a written or electronic installation log for each vibrating wire piezometer or temporary well. The log will document location, materials, depth, depth interval for each backfill material, and surface completion details (protective casing, concrete pad, bollards, etc.).

Field documentation will also be prepared for development and slug testing of each temporary well.

5.2.1.3 Surveying

Once completed, borings will be surveyed for horizontal and vertical control by survey grade GPS. The final survey of each location will be conducted following completion and abandonment of each individual sampling location. The survey data will be added to the final boring logs once available.

5.2.2 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Field Team Leader, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP (Appendix C).

5.2.3 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.2.3.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.3.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks. Boring log forms (hard copy or electronic) will be used to document lithologic conditions and field observations at each boring location.

5.2.3.3 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.4 Collection of Samples

5.2.4.1 Standard Penetration Test Sampling

The Standard Penetration Test (SPT) samples will provide information for developing the field boring logs/soil profiles, and soil specimens for laboratory natural moisture content and index testing. The SPT sampling will be conducted in accordance with ASTM D 1586 *Standard Method for Penetration Testing and Sampling for Soils* and consists of dropping a 140-pound hammer from a height of 30 inches, to drive a standard size 2-inch diameter split-spoon sampler to a depth of 18-inches.

In certain cases, larger diameter sampling devices (e.g., 3-inch diameter split-spoon samplers) may be utilized to obtain disturbed samples. Applications of larger samplers may include obtaining larger quantity of material per depth interval or collecting material with larger particles (e.g., gravel too large for SPT sampling). Although similar to an SPT sample, the in-situ penetration resistance is not equivalent to a SPT blowcount (i.e., SPT N-value).

5.2.4.2 Shelby Tube (ST) Sampling

The guidelines for performing ST sampling for geotechnical investigations are found in ASTM D 1587 and United States Army Corps of Engineers (USACE) Engineer Manual EM 1110-1-1804 *Geotechnical Investigations*, Appendix F. The USACE manual is intended as a guide of commonly accepted soil sampling practices and procedures used by geotechnical personnel performing field sampling operations for earthen dams.

5.2.4.3 Rock Core Sampling

Rock coring (only where specified) will be performed in select borings to provide samples that can be visually examined to characterize the rock strata type and structure. Rock coring will be performed in accordance with ASTM D 2113.

5.2.5 Preservation and Handling

5.2.5.1 SPT Samples

SPT samples will be logged and placed in glass jars. Once each jar is filled, the rim and threads will be cleaned, the jar capped, and a label (Section 5.2.5.4) will be applied to the jar. Each sample container will be checked to confirm that it is sealed, labeled legibly, and externally clean before placing the sample container in a box for transport.

5.2.5.2 Shelby Tube Samples

Upon extraction of a ST sample from the boring, the tube will be carefully handled to prevent disturbance. After logging the sample recovery and describing the soil that is visible at the end of the tube, the ends will be labeled (top and bottom), sealed and capped. The top and bottom of each tube will be sealed with molten microcrystalline petroleum wax. Expandable O-ring packers may be used in lieu of wax seals. Plastic caps will be placed at each end of the tube and will be sealed with electrician tape. Each tube will be labeled (Section 5.2.5.4) and stored upright in a rack (Section 5.2.5.5).

5.2.5.3 Rock Core Samples

The recovered rock core specimens will be placed in labeled, wooden core boxes. The core boxes will be protected from the weather and transported to an appropriate on-site or off-site storage facility.

5.2.5.4 Sample Labels and Identification System

Each SPT jar and ST will have a sample label affixed. Sample labels will contain the following information recorded in waterproof, non-erasable ink. Rock core boxes will have similar information written directly on the wooden core box in waterproof, non-erasable ink:

- Project number
- Sample location
- Boring ID number
- Depth of sampling interval

- Date of sample collection
- Sampler's initials

5.2.5.5 Packaging and Shipping

At appropriate intervals, assigned personnel will transport the samples to the testing laboratory or designated storage facility. SPT and other disturbed bulk samples (if any) will be treated as Group B samples as discussed in ASTM D4220.

The Shelby tubes will be stored vertically in padded racks constructed in accordance with ASTM D4220. Based on anticipated weather conditions during sampling operations, care will be taken in the storage of the samples to guard against the samples being exposed to extreme heat or cold. Prior to transport, the tubes will be transferred to a custom box built in accordance with ASTM D4220 guidelines for transporting Group D type soil samples.

Core boxes will be stacked for stable, secure transport to the laboratory, on-site, or off-site storage facility.

5.2.6 Sample Analyses

Select soil samples obtained during the geotechnical investigation will be subjected to geotechnical laboratory testing. Testing will be assigned to characterize the predominant CCR and soil materials recovered in each boring. The laboratory tests will be performed in accordance with applicable ASTM standard testing procedures.

The laboratory analyses are expected to include natural moisture content determinations (D2216), sieve and hydrometer analyses (D422), specific gravity (D854), and Atterberg Limits (D4318). The results of the testing will be used to assist in subsurface characterization and correlation with existing data. If other tests are found to be necessary, they will also be performed in accordance with applicable ASTM standard testing procedures. The Plant-specific laboratory testing program will be developed based on the recovery and spatial distribution of samples from the drilling and sampling program.

5.2.7 Equipment Decontamination Procedures

The decontamination procedures below apply to drilling and sampling in borings for temporary wells. For drilling and sampling in all other borings, as well as for all cone penetration testing, decontamination (per procedures listed in TVA TI ENV-05.80.05, Field Sampling Equipment Cleaning and Decontamination) will only occur before the first boring/CPT and after the last boring/CPT.

Documented decontamination will be performed for drilling equipment, tooling, and instruments in contact with subsurface materials in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination. Decontamination pads will be constructed for decontamination of large downhole tooling (augers, drill rods, etc.). Decontamination will be conducted using a high-pressure washer/steam cleaner.

Decontamination pads will be constructed at locations designated by TVA personnel using poly sheeting with sufficient berms to contain decontamination fluids and prevent potential runoff to uncontrolled areas. Following decontamination, fluids will be disposed of in accordance with Section 5.2.8. Decontamination activities will be performed away from surface water bodies and areas of potential impacts.

Decontamination of non-disposable sampling equipment or instruments can be performed using potable water and Liquinox® or other appropriate non-phosphatic detergent in 5-gallon buckets.

Decontamination of sampling equipment and instrument (e.g., split spoons, water level meters, pumps for well development, etc.) will be performed prior to use and between sampling locations. Decontamination activities will be documented in the logbook field notes. Additional information regarding equipment decontamination procedures is located in the QAPP.

5.2.8 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Soil cuttings
- Rock cuttings
- Drilling mud
- Well development water
- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*, the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

5.3 DOWNHOLE TESTING IN ROCK

5.3.1 Downhole Geophysics

In proposed borings with rock coring, the following suite of geophysical analyses will be performed (only where specified) to investigate groundwater conditions deeper in the bedrock.

Acoustic Televiewer: This tool generates an image of the borehole wall by transmitting acoustic pulses from a rotating sensor and records the subsequent amplitudes and travel times reflected at the borehole wall giving an unwrapped and continuous image of the borehole and allows for the mapping and evaluation of fractures.

The acoustic televiewer requires a fluid filled borehole as the fluid transmits the acoustic signal and data can only be collected in open borehole sections.

Heat Pulse Flow Meter: This instrument will measure the vertical direction and flow rate of fluids in a borehole. The instrument is lowered to a desired depth, typically above and below a known fracture, at which point a heat grid is released from the instrument into the water.

The travel time of the heat grid to either the sensor above or below is measured and used to calculate a flow rate.

Gamma: Natural gamma (or gamma) logging uses the scintillation properties of certain crystals to detect the presence of gamma radiation from unstable isotopes in the formations adjacent to the well or borehole. In aquifers that are not contaminated by artificial radioisotopes, the most significant naturally-derived radioisotopes that emit gamma radiation are potassium-40 (K40) and daughter products of the uranium and thorium series. It can be used in fluid filled or dry boreholes and is used for lithologic and stratigraphic correlation.

Fluid Resistivity log: Records the electric resistivity of water in the borehole. Changes in fluid resistivity reflect differences in dissolved-solids concentration of water. Fluid-resistivity logs are useful for delineating water-bearing zones and identifying vertical flow in the borehole.

Caliper Log: The caliper arms expand or contract to measure the diameter of the borehole as the probe is pulled up through the borehole. Surface equipment records the measurements transmitted up to the ground surface through the cable attached to the probe. Changes in diameter of the borehole indicate the size and location of fractures or irregularities caused by drilling or lithology. Often the caliper tools are not sensitive enough to detect small but hydraulically important fractures and it may not detect vertical fractures intersected by the borehole, unless one of the caliper arms happens to align with the vertical fracture.

In addition, pH, dissolved oxygen, temperature, and groundwater conductivity will be measured in the pilot holes. The purpose of these measurements is to provide a qualitative profile of changes in these parameters that might indicate the presents of different waters. Logs of these parameters are useful for delineating water-bearing zones and identifying vertical flow in the borehole between zones of differing hydraulic head penetrated by wells. Borehole flow between zones is indicated by changes in values of the parameters as instruments are lowered into and raised from the pilot holes.

5.3.2 Pressure Testing

Upon completion of rock coring and downhole geophysical testing (only where specified), targeted pressure testing (packer tests) will be conducted to provide a measure of hydraulic conductivity of bedrock. The intervals to be tested will be selected based on results of the geophysical tests.

TVA proposes that downhole water pressure tests (or field hydraulic conductivity tests) be performed in each rock core boring. These tests work by isolating an identified interval (generally a ten-foot interval) of the borehole with inflatable rubber packers. Potable water is then pumped into the interval at constant pressure for typically five minutes with volume of water lost being measured using a flow meter. The hydraulic conductivity values are then calculated from the field data using an appropriate formula that may be based on the rate of flow into the formation at each location.

5.4 WELL INSTALLATION AND BACKFILLING

After a boring is advanced to its intended bottom depth, one of the following actions may be taken:

- Backfill the borehole without installing a well or a vibrating wire piezometer.
- Install a vibrating wire piezometer and backfill the borehole around the instrument.
- Install a temporary well and backfill the annular space around the well materials,

In some cases, the lower portion of a borehole may be backfilled, followed by installing a vibrating wire piezometer or temporary well in the upper portion.

If a boring penetrates an engineered component (e.g., low hydraulic conductivity soil layer, geosynthetic cap system, or vegetative soil layer), these interval(s) will be backfilled such that equivalent or better performance is maintained. When applicable, field work plans will include procedures for repair of geosynthetics, protection around well riser pipes, and quality control monitoring and testing of such repairs.

5.4.1 Backfilling Boring without Instrumentation

Borings that do not include instrumentation (i.e., temporary well or vibrating wire piezometer) will generally be backfilled with a bentonite-cement grout. A tremie pipe will be lowered to the bottom of borehole and grout will be injected as the drilling tools are removed, to displace water and cuttings to appropriately seal the boring. Stage grouting is not anticipated due to the modest depths. Backfill grout will use the following mix:

- 30 gallons of water
- 94 lbs. of Portland Cement
- 25 lbs. of Bentonite
- This will produce a mix with a Water: Cement: Bentonite (W: C: B) ratio (by weight) of 2.5: 1.0: 0.3

If highly permeable zones are encountered (e.g., fractured rock), the grout mixture may be thickened. Bentonite pellets may be used to seal a permeable zone before resuming grouting above such a zone.

5.4.2 Temporary Wells

Within the context of the EIP, a temporary well may be used for measuring water levels, as well as obtaining pore water samples for analytical testing. Although constructed in the same way as a monitoring well, a temporary well serves a unique purpose for a limited duration and is thus differentiated in name.

Temporary wells will be installed by qualified drill crews using rotary or sonic drill units working under the direction of a licensed Tennessee driller. Additionally, field supervision will be provided by a Tennessee licensed PG or PE. The PG or PE will have suitable experience in geotechnical or geological engineering projects to support the work. This approach has been used at current investigations at other TVA Plants in Tennessee.

Temporary wells will be installed in accordance with TVA TI ENV-TI-05.80.25, *Monitoring Well and Piezometer Installation and Development*. Exact depth/location of each screen will be determined based on as-drilled conditions. A temporary well installation record will be drafted for each well and will include notes and details of the installation procedures.

5.4.2.1 Materials and Installation

The temporary wells will be installed using current industry and regulatory protocols to reduce potential for introducing contaminants during the drilling and installation process. Decontamination processes will be in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*. These procedures include, in part, decontamination of the drilling equipment and tools before and after each well by washing with hot, potable water delivered under high pressure, using a new well screen and riser that have been cleaned and sealed in plastic at the factory, and placing washed filter pack sand that is certified by NSF International. Other steps employed during the installations include the workers donning clean, nitrile gloves during the handling of downhole equipment and well materials and using potable water for grouting purposes.

A temporary well will consist of a four-inch diameter Schedule 40 PVC well screen (0.010-inch slots) and riser. The screen and riser will consist of flush-joint, threaded PVC pipe. The screen length will be selected based on the results of the boring and the target stratum but will not be longer than 10 feet. A pre-packed well screen may be used. A four-inch diameter Schedule 40 PVC bottom well plug measuring approximately six inches in length will be threaded onto the bottom of the screen. The PVC riser will extend above (2.5 feet minimum) the ground surface and will be capped with a temporary plug or slip cap.

The annular space will be backfilled with a sand filter pack (20/40 mesh) extending a minimum of two feet above and six inches below the screen. A minimum two-foot thick bentonite pellet seal will be placed on top of the sand filter pack. After the bentonite pellet seal has sufficiently hydrated, (minimum of 8 hours of hydration time when using cement grouts above the seal), the remaining annular space will be backfilled with a non-shrink, bentonite-cement grout.

It should be noted that the grout will be placed by tremie method through one-inch (minimum) diameter PVC pipe. The grout will be placed using pumps gauged to allow the installation crew to monitor pressures during the grouting process. In open (uncased) boreholes, the sand filter zones and bentonite pellets will be placed by tremie method through one-inch (minimum) diameter PVC. In cased boreholes (i.e., through hollow-stem augers or temporary casing), the sand filter zones and bentonite pellets may be placed by tremie method or may be poured slowly into the annular space of the drill tooling to prevent bridging.

If vibrating wire piezometers became necessary, one or more transducers (at multiple depths, if needed) can be installed in a boring and grouted in-place. These grouted in-place piezometers (GIPPs) will be attached to a sacrificial one-inch (minimum) diameter PVC pipe. The boring will be backfilled using the bentonite-cement grout described previously, placed by the tremie method.

If the well is not to be installed at the bottom of the borehole, the lower portion of the hole will be backfilled with bentonite-cement grout or bentonite pellets. After the grout cures enough to support the weight of the overlying well materials and backfill, the well can be installed above the grouted zone.

Subsequent wellhead construction will consist of an above-grade, steel locking protective cover anchored to a concrete surface pad. The protective cover will extend above the concrete pad and the annular space will be filled with sand or pea gravel to about six-inches below the top of PVC casing. Steel protective bollards filled with concrete will be installed near each corner of the concrete pad. If the installation is only expected to be used for a relatively short duration and it is located in an area of little vehicular activity (i.e., low risk of damage), the surface protection may be modified to allow for easier removal when the instrument is no longer needed. The top of each well casing will be surveyed and correlated to the vertical datum used by the Plant.

An example installation log is shown in Figure 5. A drawing of the wellhead construction is shown in Figure 6.

5.4.2.2 Well Development

Each new well will be developed by a combination of bailing, surging, and pumping after a minimum of 24 hours following completion. Equipment will be decontaminated per TVA TI ENV-TI-05.80.05. First, a bailer will be lowered and raised within the screened intervals to create a slight surging action to dislodge particles within the wells and sand filter packs. A baseline reading of turbidity, pH, temperature, and specific conductance will be measured using a properly calibrated Oakton® turbidity and PCSTestr 35 water testing meters (or equivalents). If the well contains heavy sediment, further bailing will be performed before continuation of development with surge blocks and submersible pumps.

A surge block will be used within the screened interval to move water and particles through the screen and sand filter packs. This process may be repeated several times to decrease the water turbidity within the wells.

Lastly, a submersible pump will be employed to further develop the wells until an acceptable level of turbidity is achieved. Target turbidity value of less than or equal to ten (10) Nephelometric turbidity units (NTUs) will be utilized for temporary wells per TVA TI ENV-TI-05.80.42. If the target turbidity value cannot practically be achieved, well development will be conducted according to the requirements listed in TVA TI ENV-TI-05.80.25, *Monitoring Well and Piezometer Installation and Development*.

5.4.2.3 Slug Testing

After development, TVA will perform a slug test in each temporary well to measure hydraulic conductivity. Equipment will be decontaminated per TVA TI ENV-TI-05.80.05. The slug tests will be performed in accordance with ASTM D 4044, *Standard Test Method for (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers*. A pressure transducer with a data recorder will be used to collect water level information from the wells.

As part of the slug testing, each well will be tested by taking an initial measurement of the static water level followed by the insertion of the pressure transducer into the well. After the transducer has been installed and the water level stabilizes, a solid slug (e.g., PVC pipe filled with sand) will be introduced into the well to cause a nearly instantaneous change in the water level. The water levels will then be recorded at regular intervals until reaching near static levels. After reaching static levels, the test will be terminated, and a second slug test will be conducted by instantaneously removing the slug and monitoring water levels until static levels are reached again. The results will be recorded electronically and downloaded into a data collector. Raw data will be checked in the field for discrepancies prior to demobilizing from the Plant.

The field data, once collected and returned to the office, will be reduced using a software program to estimate the hydraulic conductivity of the in-situ soils.

5.4.3 Monitoring and Sampling

Monitoring and/or sampling of temporary wells is not addressed in this SAP. Refer to the CCR Material Characteristics SAP.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to Exploratory Drilling.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to confirm that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Project Manager considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

The accuracy of the drilling, temporary well installation and slug testing processes must be maintained throughout the investigation. In addition, planned drilling and installation methods must be confirmed during field activities to provide confidence that porewater samples and water level measurements collected as part of other SAPs provide representative analytical results and data.

Field personnel will be responsible for performing checks to confirm that the SAP has been followed. This consists of the completion of applicable field forms and documentation of field activities.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 3. Preliminary Schedule for Exploratory Drilling SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Exploratory Drilling SAP Submittal		Completed
Prepare for Field Activities	20 Days	Following EIP Approval
Conduct Field Activities	100 Days	Following Field Preparation
Laboratory Analysis (if any)	40 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Plant-specific safety requirements are anticipated to include TVA specified training and attendance at a safety briefing. Only Field Team members and subcontractors performing work activities will be required to meet the above requirements.
- A dedicated Safety Officer will be present for this work.
- Assessment of suitability of areas and access to borings, including clearing and grubbing, will be provided by TVA, and will be completed prior to the exploration start date.
- Sampling methods and field locations may be adjusted based on actual field conditions. Changes made in the field will be reported in the Environmental Assessment Report (EAR) as appropriate.
- Well screen and riser pipe dimensions may be adjusted based on actual field conditions and sampling needs. Changes made in the field will be reported in the EAR as appropriate.
- Laboratory testing of surplus undisturbed samples assumes that samples are still suitable for testing. Suitability cannot be confirmed until samples are extruded from the tubes and visually evaluated.

9.0 REFERENCES

Geocomp Consulting, Inc. 2016. "Tennessee Valley Authority, EPA Seismic Assessment, Supplemental Site Exploration, Johnsonville Fossil Plant, Active Ash Pond 2, Final Report." Volume 1 - 4. Prepared for Tennessee Valley Authority. October.

Tennessee Valley Authority (TVA). 2017a. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017b. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017c. "Monitoring Well and Piezometer Installation and Development." Technical Instruction ENV-TI-05.80.25, Revision 0000. May 8.

Tennessee Valley Authority (TVA). 2017d. "Groundwater Sampling." Technical Instruction ENV-TI-05.80.42, Revision 0001. March 31.

United States Army Corps of Engineers (USACE). 2001. "Geotechnical Investigations." EM 1110-1-1804. January.

ATTACHMENT A
FIGURES

Figure No.
1

Title

Proposed Borings
South Rail Loop Area 4

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

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

Legend

- Proposed Boring with Piezometer Vibrating Wire
- Proposed Temporary Well (Screened Interval)
- Existing Piezometer Open Standpipe
- Existing Piezometer Vibrating Wire
- Unit Boundary (Approximate)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)

Stantec
TVA

Figure No.
2

Title **Proposed Temporary Wells Ash Disposal Area 1, Coal Yard, & DuPont Road Dredge Cell**

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location 175567296

New Johnsonville, Tennessee

Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Proposed Boring with Piezometer Vibrating Wire
- Proposed Temporary Well (Screened Interval)
- Existing Piezometer Open Standpipe
- Existing Piezometer Vibrating Wire
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)

Stantec TVA

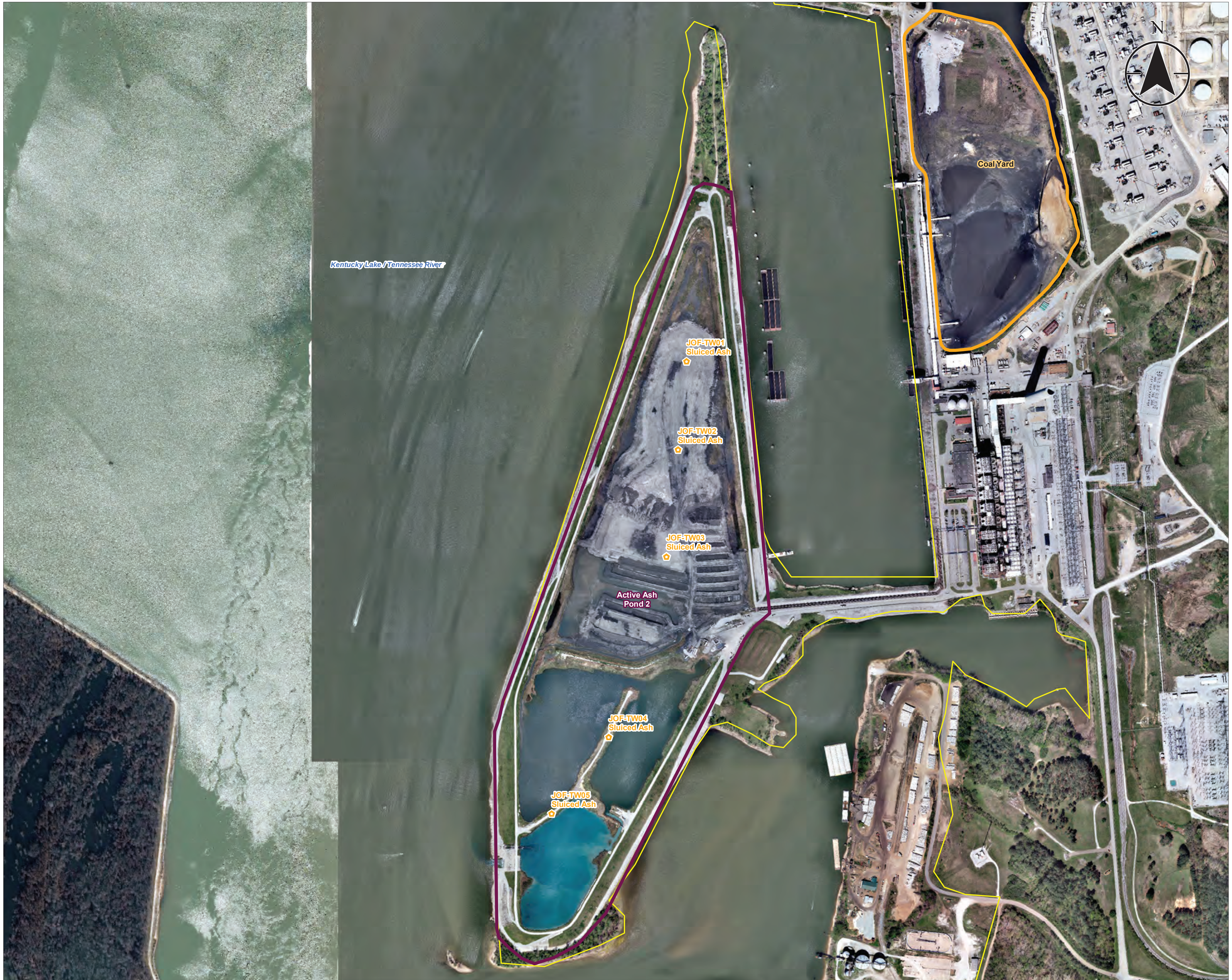


Figure No.
3

Title
Proposed Temporary Wells Active Ash Pond 2

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

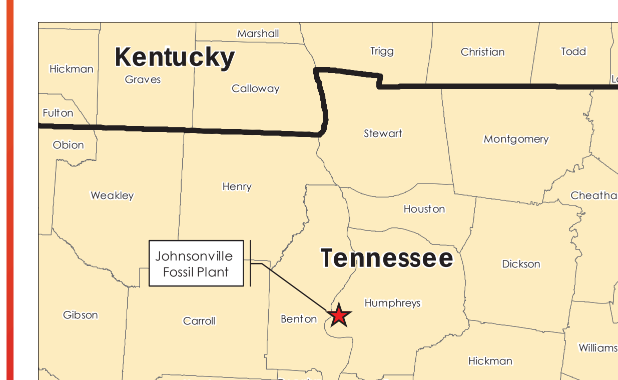
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Proposed Temporary Well (Screened Interval)
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



U:\TVA-EP\175567296\gis\mxds\JOF_TempWells_AshPond2.mxd Revised: 2018-12-06 By: mbough

Figure No.
4

Title **Proposed Slug Testing in Existing Piezometers and Monitoring Wells Active Ash Pond 2**

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

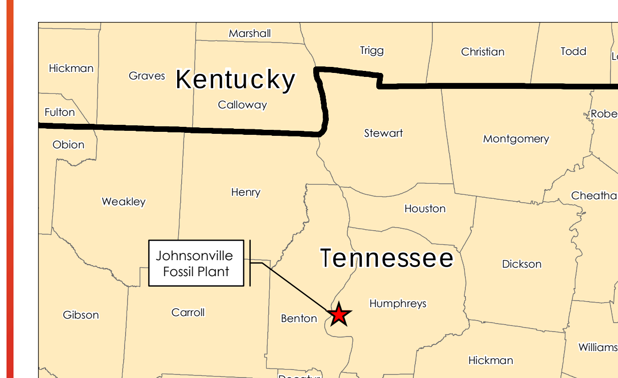
175567296
Prepared by LMB on 2018-05-02
Technical Review by ZW on 2018-05-02

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

Legend

- Existing Piezometer Open Standpipe (Screened Interval)
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

U:\TVA-EB\175567296\gis\mxds\JOF_Proposed_SlugTesting.mxd Revised: 2018-05-02 By: TRink

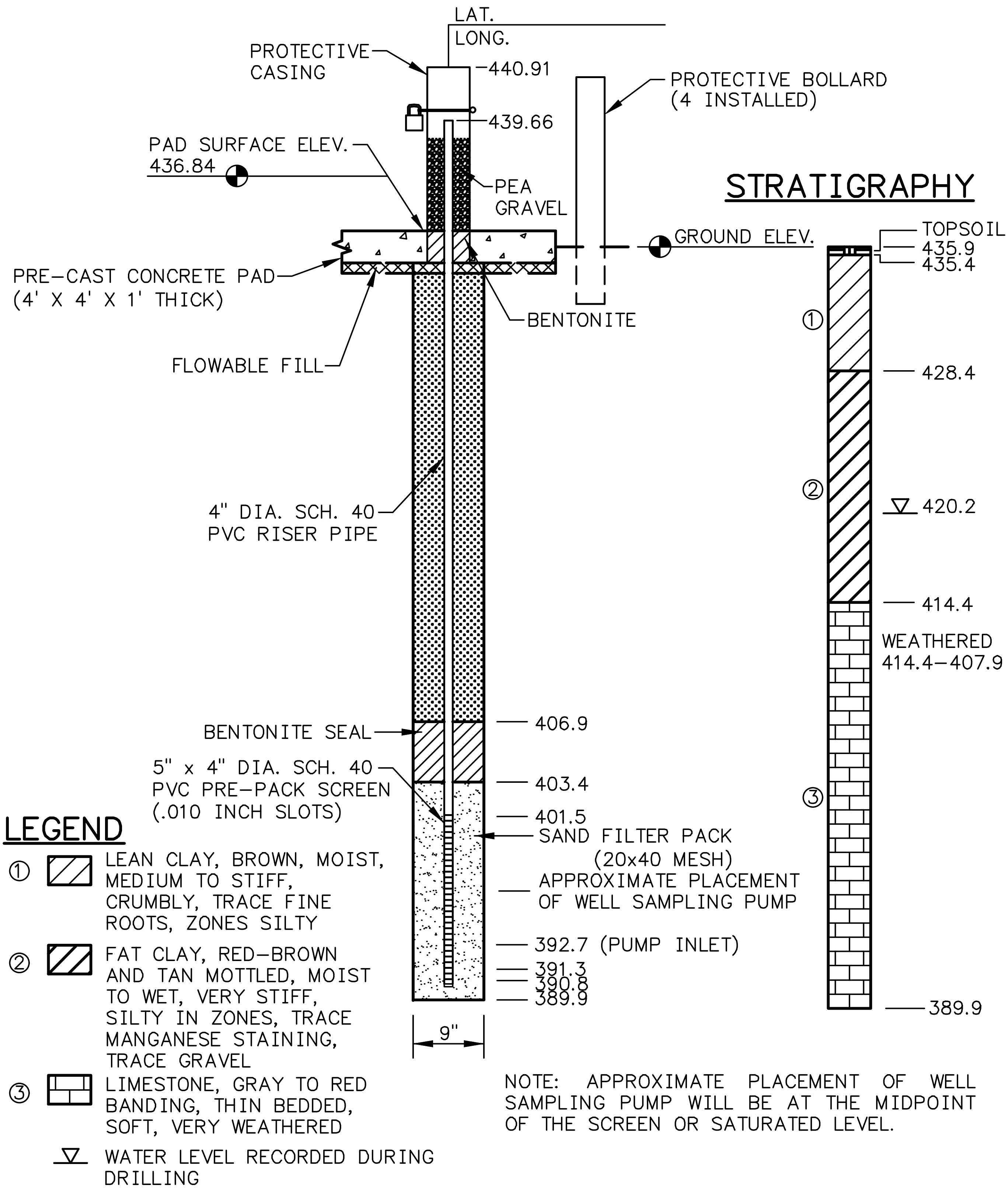


Figure 5. Temporary Well Installation Schematic

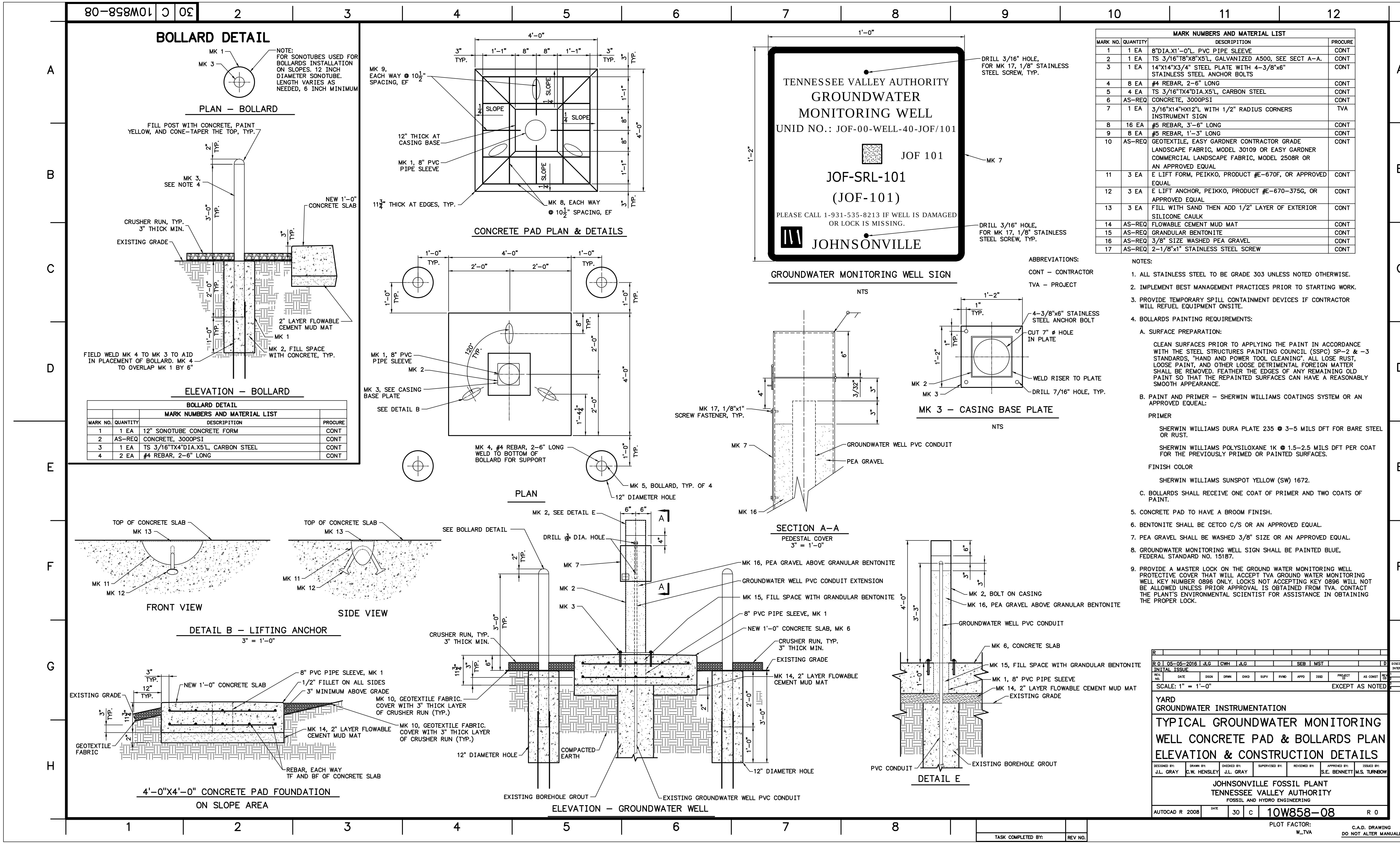


Figure 6. Typical Temporary Well Construction Details

ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Exploratory Drilling

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Cone penetrometer testing assembly
Hollow stem augers
Split-spoon sampler and associated rods
Shelby tube sampler
[1]Drilling Rig and associated equipment
Water pump and water tank
Core barrel
Tremie pipe
Cement
Bentonite
Piezometer screen
Sand
Piezometer standpipe
Water level indicator meter
Well pump (purging well) and tubing
Hand tools (e.g. wrench, hammer, etc.)
***These items are detailed in associated planning documents to avoid redundancy.**
[1]Drilling rig equipment will be selected based on site conditions, selected by the Drilling Contractor, and approved by TVA.

APPENDIX K
ANNUAL INSPECTION REPORTS

E. F. Thomas, Director of Power Production, 716 EB-C (2)

Roy H. Dunham, Director of Engineering Design, 505 UB-K

August 27, 1973

JOHNSONVILLE STEAM PLANT - ANNUAL ASH DISPOSAL AREA INSPECTION

Attached is a memorandum report from J. L. Glover to Frank D. Stansberry dated August 24, 1973, of the joint field inspection at Johnsonville Steam Plant, which includes recommendations for corrective work. I concur in these recommendations.

Original Signed By
Roy H. Dunham

Roy H. Dunham

JLG:BLH
Attachment
CC (Attachment):
R. G. Domer, 401 UB-K (3)
Power Manager's File, 630 PRB-C

Frank D. Stansberry, Head Civil Engineer (Highway and Railroad), 101 FB-K

J. L. Glover, Civil Engineer (Highway and Railroad), 100 FB-K

August 24, 1973

JOHNSONVILLE STEAM PLANT - ANNUAL ASH DISPOSAL AREA INSPECTION

On August 9, 1973, Meigs Brewer of Power Production and I inspected the ash disposal areas at Johnsonville Steam Plant. Findings were discussed with E. L. Sanderlin, Plant Superintendent, and J. C. Beasley, Assistant Plant Superintendent.

These areas were last inspected on August 31, 1972.

On the attached prints of drawings 10N503 and 10N527, the different areas are designated. This report covers observations and recommendations first for active ash disposal area 2, then separately for inactive areas A, B, and C.

AREA 2

Change in Dikes Since Last Inspection

There has been no change in the dikes since last year's inspection. The dikes are earth and were constructed according to design drawings. They appear to be in good shape. Plant personnel is attempting to reestablish vegetation on the slopes (see picture 1 and Action on Recommendations of Last Inspection, Nos. 3, 4, 5, and 6).

The ash surfacing on the top of the dikes is in good shape, and the top of the dikes is sloped to the inside.

Change in Pond Operation Since Last Inspection

All ash continues to be sluiced into area 2; however, a delta of deposited ash has divided the pond. All sluicing at the time of this inspection was to the south end of the pond. As reported in last year's report, two of the three spillways at each end of the pond have been raised above the water level so that only one spillway at each end is operating. Since the pond has been divided by ash, all discharge is through one spillway, with a head of approximately one foot. The velocity of the water over the spillway crest is high.

In the future as ash is deposited nearer the spillway, there is the probability that the high water velocity will cause ash to be discharged through the spillway. Air is also being pulled into and discharged through the outlet pipe causing some vibrations. There is the possibility that this vibration could damage the outlet pipe. The head on the spillway should be lowered (see Recommendations, No. 1).

Condition of Spillways, Skimmers, and Outlets

The standard spillways and skimmers appear to be in good shape. The outlets are submerged. There is no evidence of loss of ash.

Action on Recommendations of Last Inspection

1. Enough heavy bottom ash has not been available to raise the east dike of area 2 the one foot needed to reach elevation 378 (see Recommendations, No. 2).

2. Logs and debris had been removed from the outside slopes of the dikes, but others have been deposited (see Recommendations, No. 3).

3. Tests were made on the dike slopes, and the soil had a pH of 3.2. It was concluded by plant personnel that surface runoff had drained through the ash on top of the dike and created the acid condition in the soil on the dike slopes.

4. The inside slopes of the dikes have been seeded, fertilized, and mulched with no results (see picture 2). Some sprigging of bermuda grass and placing lime on the slopes have also been tried. The sprigging has produced some growth. Indications are that leeching from the ash surfacing on top of the dikes has subsided, and the remaining vegetation on the slopes is doing better and beginning to spread.

5. Since plant personnel concluded from the soil tests that leeching from the ash surfacing on top of the dikes was causing the vegetation to die, test areas suggested were not required.

6. The bare areas along the top of the outside slope were seeded with no results. Work continues on these slopes as noted in preceding item No. 4.

7. Erosion gullies along the inside dike slopes have been filled with dumped rock.

Recommendations

1. Activate another spillway at each end of the pond to reduce the water velocity over the spillway. The pond was designed to have no fewer than two spillways operating. To facilitate the measurement of the discharge from the pond, each spillway to be activated should have a weir as shown on standard drawing titled "Weir for Ash Disposal Spillway."

2. Plant personnel should go ahead with plans to raise the east dike of area 2 the one foot needed to reach elevation 378 with compacted earth instead of heavy bottom ash. The fill is to be thoroughly compacted in layers with loaded rubber-tired hauling equipment.

3. Continue to remove logs and other debris from the outside slope of the dikes.

4. Continue the concerted effort to establish vegetation on the dike slopes.

5. Trees on the upper 3:1 outside slopes of the dikes and on the inside slopes should be cut and removed. Trees on the lower 6:1 portion of the outside slope should be left in place to serve as a wave break. The various slopes can be seen in section D-D on the attached print of drawing 10N527.

AREAS A, B, AND C

Change in Dikes Since Last Inspection

There has been no change in the dikes since last year's inspection. The dikes of areas A and B appear to be in good condition even though the outside slopes are steep (see picture 4 and Recommendations, No. 1).

The dikes of area C are in good condition, having a good vegetative cover. Responsibility for area C, including the maintenance of its dikes, has been assumed by Dupont under an informal agreement with DPP.

Frank D. Stansberry
August 24, 1973

JOHNSONVILLE STEAM PLANT - ANNUAL ASH DISPOSAL AREA INSPECTION

Change in Pond Operation Since Last Inspection

There has been no change in TVA's use of these areas since last year's inspection. TVA does not discharge any ash or water into areas A, B, or C.

At the time of last year's inspection, only surface water entered area A. At the time of this year's inspection, Dupont was discharging a small amount of water into this area from a well-digging operation. At the time of this year's inspection, there was no discharge from this area. There is an overflow pipe from area A to area B to prevent excessive amounts of water from accumulating in area A.

At the time of last year's inspection, Dupont was constructing a harbor (see picture 5) outside the north end of area B. Dredged earth material was pumped into area B. This work has been completed, with a major portion of area B covered with dredged material. A heavy vegetative growth (see picture 3) has established itself on this material. At the time of last year's inspection, Dupont plant discharges passed through area B into area C. At the time of this year's inspection, all the Dupont plant discharges were directly into area C. The only sources of water into area B are surface runoff from rainfall and from sludge deposits being hauled by Dupont and dumped into area B. At the time of this year's inspection, there was no discharge from area B. Any discharges from area B are into overflow spillways to area C.

Area C is operated by Dupont. All Dupont plant discharges are into area C. The discharge from area C is into overflow spillways, constructed by Dupont, to Kentucky Reservoir.

Condition of Spillways, Skimmers, and Outlets

Spillways, skimmers, and outlets of area C were constructed and are operated by Dupont. They appear to be in good shape, and there are no signs of loss of ash from these areas.

Action on Recommendations of Last Inspection

1. Reclamation of areas A and B by TVA has not begun. This work was held up while Dupont was dredging material into area B and is now being held until the future use of these areas by Dupont can be determined.

2. Plant personnel observed the water level in area B to insure that the proper freeboard (±4 feet minimum) was maintained by Dupont during their dredging operations.

3. Logs and other debris have been removed from the outside dike slopes.

4. All drainpipes under the roads and all ditches along the sides of the roads have been cleaned out and are free draining.

Recommendations

1. As soon as possible, the reclamation of areas A and B should be started. DED along with DPP will further develop plans for this work.

2. Keep logs and other debris removed from the outside dike slopes.

3. Keep all drainpipes under the roads and all ditches along the sides of the roads clean and free draining.

J. L. Glover

JLG:BLH
Attachments

Concur:

Frank D. Stansberry

R. G. Domer

8/27/73--FDS:BLH
CC: R. G. Domer, 401 UB-K (Attachments)

8/27/73--RGD:NCH
CC: Roy H. Dunham, 505 UB-K (Attachments)

JOHNSONVILLE STEAM PLANT
1973

(1) Attempting to reestablish vegetation on slopes. Placing lime, seeding, sprigging grass and mulching. (8-9-73)

AREA 2

(2) Note bare inside slope of west dike.

AREA 2

JOHNSONVILLE STEAM PLANT 1973

③ Water in pond B and vegetation on area covered with dredged material.

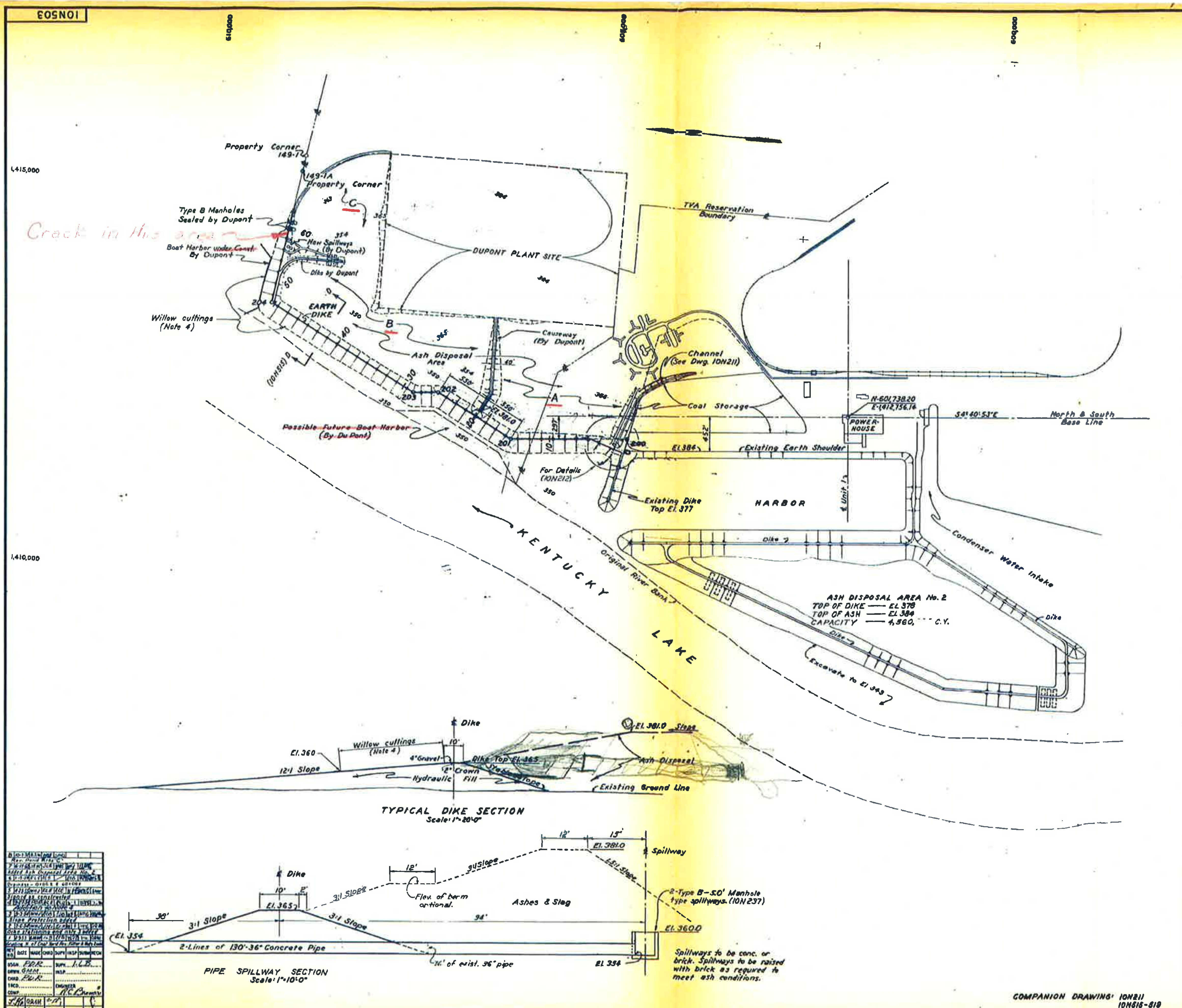
AREA B

④ Outside slope of pond A.

AREA A

⑤ Boat harbor constructed by Dupont north of area B.

AREA B



DIKE LOCATION				
POINT	AZIMUTH	DISTANCE	COORDINATES	
			EAST	NORTH
200			1,412,228	604,547
	175°19'	1470'		
201			1,412,108	606,012
	208°19'	1100'		
202			1,412,630	606,981
	175°19'	330'		
203			1,412,603	607,310
	208°19'	2150'		
204			1,413,623	609,202
	278°08'	1727'		
149-1A			1,415,333	608,958
	278°08'	205'		
149-1			1,415,536	608,929

APPROXIMATE QUANTITIES

Hydraulic Fill *375,000 Cu. Yds.
Gravel Surfacing 800 Cu. Yds.

*Net embankment quantity, based on 4:1 inside slope; 12:1 outside slope.

NOTE

① SURFACING Gravel surfacing 4" thick shall be applied for the full width of the dike, in accordance with section 210 of the T-1 Specifications.

② CLEARING Area bounded on North by Ash Dike (initial fill), East by El. 365, South and West by earth dikes to be cleared of all trees, no stumping required.

③ Profile of existing dike prior to July 1, 1954 and detailed cross sections, see dwgs. 10N515-519.

④ Willow cuttings to be planted on lake side of dike from elevation 360 to top of dike.

Areas of the dike slopes above elev. 360 that are bare of vegetation shall be planted in the fall of 1954 to Italian rye grass at the rate of 50 lbs per acre. No fertilizer or mulch is required

REFERENCE DRAWINGS:
10BM503-------BILL OF MATERIAL.
COMPANION DRAWINGS:
10N212---------Drainage & Dike Details - Ash Disposal Area

Scale: 1"=500' Except as noted.

MAIN PLANT

DIKE FOR ASH DISPOSAL AREA

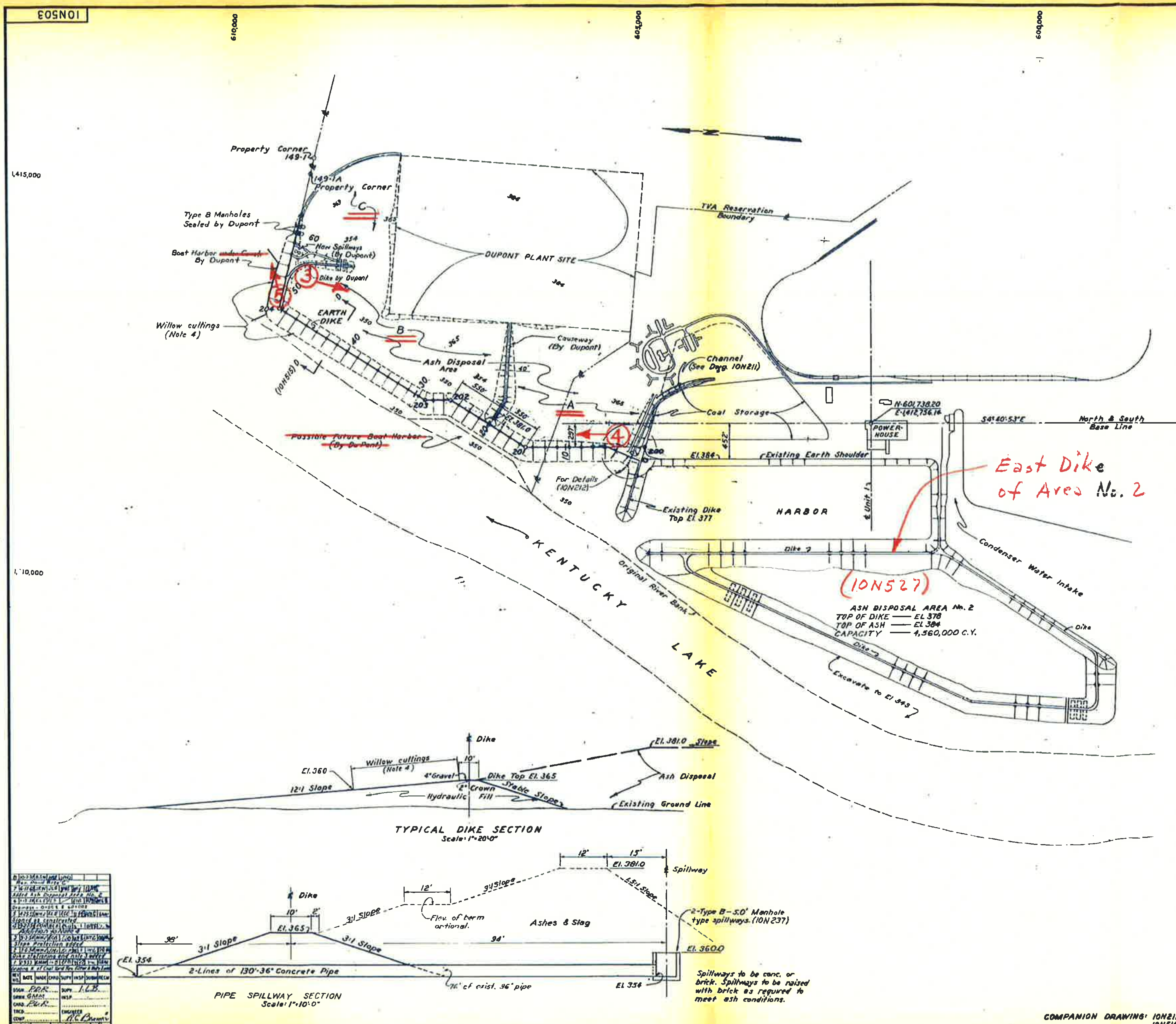
JOHNSONVILLE STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF DESIGN

SUBMITTED	RECOMMENDED	APPROVED
G.N. Oakes Jr	A.G. Mayer	R.A. Monroe

KNOXVILLE	7-16-52	30	C	4	10N503 R8

DRAWING AS CONSTRUCTED 11-15-54

10N503



DIKE LOCATION				
POINT	AZIMUTH	DISTANCE	COORDINATES EAST	COORDINATES NORTH
200			1,412,228	604,547
	175°19'	1470'		
201			1,412,108	606,012
	208°19'	1100'		
202			1,412,630	606,981
	175°19'	330'		
203			1,412,603	607,310
	208°19'	2150'		
204			1,413,623	609,202
	278°08'	1727'		
149-1A			1,415,333	608,958
	278°08'	205'		
149-1			1,415,536	608,929

APPROXIMATE QUANTITIES
Hydraulic Fill *375,000 Cu. Yds.
Gravel Surfacing 800 Cu. Yds.

*Net embankment quantity, based on 4:1 inside slope; 12:1 outside slope.

① → Photograph taken at this point in this direction.

NOTE
① SURFACING Gravel surfacing 4" thick shall be applied for the full width of the dike, in accordance with section 210 of the T-1 Specifications.
② CLEARING Area bounded on North by Ash Dike (Initial fill), East by EL 365, South and West by earth dikes to be cleared of all trees, no stumping required.
③ Profile of existing dike prior to July 1, 1954 and detailed cross sections, see dwgs. 10H515-519.
④ Willow cuttings to be planted on lake side of dike from elevation 360 to top of dike.
Areas of the dike slopes above elev. 360 that are bare of vegetation shall be planted in the fall of 1954 to Italian rye grass at the rate of 50 lbs per acre. No fertilizer or mulch is required.

REFERENCE DRAWINGS:
10BM503 -------BILL OF MATERIAL.
COMPANION DRAWINGS:
10N212 ----------Drainage & Dike Details - Ash Disposal Area

Scale: 1" = 500' Except as noted.

COMPANION DRAWING: 10N211
10H515-519

MAIN PLANT

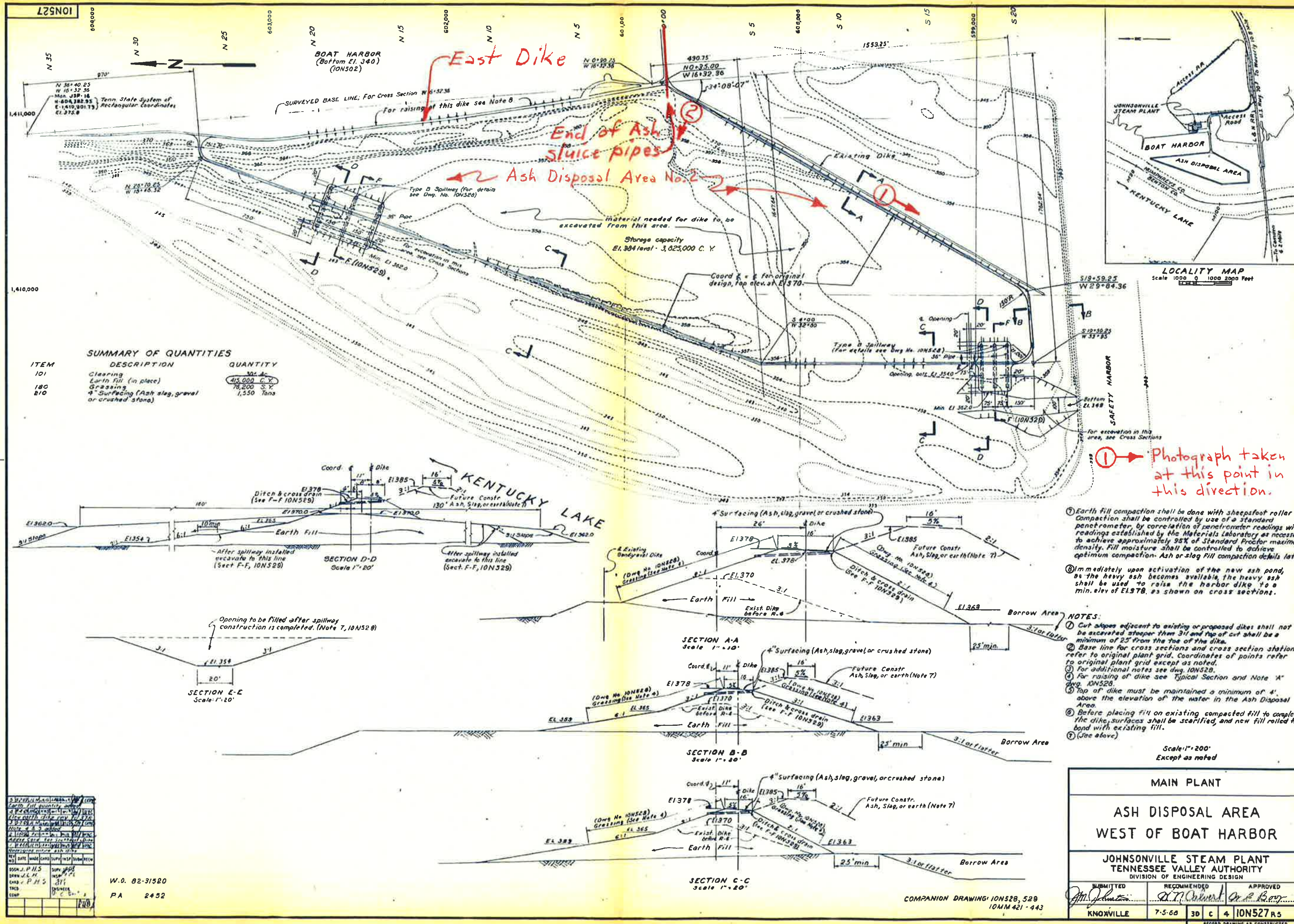
DIKE FOR ASH DISPOSAL AREA

JOHNSONVILLE STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF DESIGN

SUBMITTED	RECOMMENDED	APPROVED
[signature]	A.G. Mayer	[signature]

KNOXVILLE 7-18-52 30 C 4 10N503 R8

DRAWING AS CONSTRUCTED [signature] 11-18-64



10N527
East Dike
BOAT HARBOR
(Bottom El. 340)
(10N502)
N 36+40.25
W 16+32.36
Mon. JSP-16
N 604,282.95
E 1,410,901.73
El. 375.8
Tenn. State System of Rectangular Coordinates
SURVEYED BASE LINE; For Cross Section W 16+32.36
For raising of this dike see Note 8
N 0+35.00
W 16+32.36
490.75'
1553.25'
34°08'07"
End of Ash sluice pipes
Ash Disposal Area No. 2
Existing Dike
Type B Spillway (For details see Dwg. No. 10N528)
36" Pipe
Material needed for dike to be excavated from this area.
Storage capacity
El. 384 level - 3,625,000 C.Y.
Coord. E & E for original design, top elev. at El. 370
S 19+59.25
W 29+84.36
SAFETY HARBOR
Bottom El. 348
For excavation in this area, see Cross Sections
Photograph taken at this point in this direction.
KENTUCKY LAKE
LOCALITY MAP
JOHNSONVILLE STEAM PLANT
BOAT HARBOR
ASH DISPOSAL AREA
KENTUCKY LAKE
Access Road
SUMMARY OF QUANTITIES
ITEM | DESCRIPTION | QUANTITY
101 | Clearing | 30± Ac.
180 | Earth Fill (in place) | 415,000 C.Y.
 | Grassing | 76,200 S.Y.
210 | 4" Surfacing (Ash slag, gravel or crushed stone) | 1,550 Tons
SECTION D-D Scale 1"=20'
SECTION E-E Scale 1"=20'
Opening to be filled after spillway construction is completed. (Note 7, 10N528)
SECTION A-A Scale 1"=10'
SECTION B-B Scale 1"=20'
SECTION C-C Scale 1"=20'
4" Surfacing (Ash, slag, gravel, or crushed stone)
Future Constr. Ash, Slag, or earth (Note 7)
Earth Fill
Borrow Area
3:1 or flatter
25' min.
(1) Earth fill compaction shall be done with sheepsfoot roller. Compaction shall be controlled by use of a standard penetrometer, by correlation of penetrometer readings with readings established by the Materials Laboratory as necessary to achieve approximately 95% of Standard Proctor maximum density. Fill moisture shall be controlled to achieve optimum compaction. Ash or slag fill compaction details later.
(8) Immediately upon activation of the new ash pond, as the heavy ash becomes available, the heavy ash shall be used to raise the harbor dike to a min. elev. of El. 378 as shown on cross sections.
NOTES:
(1) Cut slopes adjacent to existing or proposed dikes shall not be excavated steeper than 3:1 and top of cut shall be a minimum of 25' from the toe of the dike.
(2) Base line for cross sections and cross section stations refer to original plant grid. Coordinates of points refer to original plant grid except as noted.
(3) For additional notes see dwg. 10N528.
(4) For raising of dike see Typical Section and Note "A" dwg. 10N528.
(5) Top of dike must be maintained a minimum of 4' above the elevation of the water in the Ash Disposal Area.
(6) Before placing fill on existing compacted fill to complete the dike, surfaces shall be scarified, and new fill rolled to bond with existing fill.
(7) (See above)
Scale 1"=200'
Except as noted
W.O. 82-31520
PA 2452
COMPANION DRAWING: 10N528, 529
10MM 421-443
MAIN PLANT
ASH DISPOSAL AREA
WEST OF BOAT HARBOR
JOHNSONVILLE STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN
SUBMITTED
RECOMMENDED
APPROVED
KNOXVILLE
7-5-60
3D C 4 10N527 R5
RECORD DRAWING AS CONSTRUCTED

761007A0012 Glover

H. S. Fox, Acting Director of Power Production, 716 EB-C (2)

Roy H. Dunham, Director of Engineering Design, W11A9 C-K

October 5, 1976

JOHNSONVILLE STEAM PLANT - ANNUAL ASH DISPOSAL AREA INSPECTION

Attached is a report from J. L. Glover to Frank D. Stansberry dated October 1, 1976, of the joint inspection at Johnsonville Steam Plant which includes recommendations for corrective work. Corrective work recommended to prevent seepage through the east dike of area 2 will require a substantial amount of work. I concur in these recommendations.

Original Signed By
F. P. Lacy

Roy H. Dunham

GLB:JLG:BLH
Attachment
CC (Attachment):
G. L. Buchanan, W3C126 C-K (2)
R. G. Domer, W9D224 C-K
MEDS, E4B37 C-K
B. S. Montgomery, 5100 MIB-K
Power Manager's File, 630 PRB-C
E. F. Thomas, 818 PRB-C

761007A0012

Frank D. Stansberry, Head Civil Engineer (Site Development, Highway, Railroad, and Bridge Design), W3A30 C-K

J. L. Glover, Civil Engineer (Site Development, Highway, and Railroad Design), W3A67 C-K

October 1, 1976

JOHNSONVILLE STEAM PLANT - ANNUAL ASH DISPOSAL AREA INSPECTION

On September 16, 1976, Larry Wall of P PROD and I inspected the ash disposal areas at Johnsonville Steam Plant. We were accompanied on the inspection by J. G. Beasley, Assistant Plant Superintendent, and J. E. Tracy, Power Plant Operations Supervisor. Findings were discussed with E. L. Sanderlin, Plant Superintendent.

Last year's annual inspection was made on October 2, 1975.

On the attached print of drawing 10N503, the different areas are designated. This report covers observations and recommendations, first for active ash disposal area 2, then, separately, for inactive areas A, B, and C.

AREA 2

Change in Dikes Since Last Year's Inspection

There has been no change in the dikes since last year's inspection. The earth dikes were constructed by CONST in accordance with EN DES plans.

The outside dike slope is 3:1 above elevation 365 and 6:1 below. Plant employees have removed all trees from the 3:1 portion of the slope. They have also continued to keep logs and other debris removed from the dike slopes.

The tops of the dikes have been surfaced with chert, and an excellent vegetative cover has been established on the outside slope (picture 1).

Although there is only a sparse vegetative cover on the inside dike slopes (picture 2), there is very little erosion of these slopes. Extreme care is used to keep a smooth grade on the top of dike to prevent concentration of rainfall runoff, and crushed stone (crusher rejects from Sangravl, a local sand and gravel supplier) has previously been placed on any areas of erosion. No crushed stone was placed on the inside slope during the past year.

The east dike (harbor dike) of area 2 (picture 3) has been raised by plant employees 1 foot to elevation 378 (see Action on Recommendations of Last Inspection No. 1). This was necessary to protect this area from the 100-year flood level.

Plant employees reported that after raising the water level (4± feet to elevation 371±) in the north end of disposal area 2, there was seepage through the east dike (see attached 10N503) for most of its length. Immediately after becoming aware of this seepage (3 to 4 days after raising the water level), plant employees removed the steel weir and one 2-foot section of pipe from the standard spillways lowering the water level in this end of the disposal area approximately 3 feet. At this lower water level (elevation 368±), the seepage stopped; however, another 2-foot section of pipe was removed from the spillway lowering the water level to approximate elevation 366, 1 foot below the level prior to the dike raising by plant employees. There had been no seepage at the previous water level (elevation 367±).

At the time of this inspection, there was no seepage. The water level in the disposal area remained at elevation 366, approximately 5 feet lower than at the time seepage was seen. Elevations taken at the time of this inspection indicate that the water level in the disposal area at the time of the seepage was approximately 371 and the seepage was appearing on the outside slope at approximate elevation 366.

There is no evidence of sloughing of the dike slopes, and there appears to be no threat of dike failure at this time.

This dike (east dike of area 2) was originally constructed by CONST as a protective dike for the harbor. The attached sketch JIG92076 shows a typical section through the east dike. This dike has been in place for approximately 25 years. The major portion of this dike (to maximum elevation 368±) was constructed in about 1950 of hydraulic fill as the harbor was dredged. Approximately 2 years later the upper portion of the dike (to elevation 377) was constructed on top of the hydraulic fill. Apparently no particular placement or compaction requirements were specified by EN DES since there were no plans at that time for this to be a water retaining structure. The final 1 foot to raise this dike to its present elevation 378 was added during this past year by plant employees (see Action on Recommendations of Last Inspection No. 1).

It is suspected that there is a pervious layer of material at approximate elevation 368 between the hydraulic fill and the original earthfill of the upper portion of the dike through which the seepage is passing. The water level in this portion of disposal area 2 is to be raised no higher than its present elevation 366± until dike corrections can be made (see Recommendations No. 1).

Frank D. Stansberry
October 1, 1976

JOHNSONVILLE STEAM PLANT - ANNUAL ASH DISPOSAL AREA INSPECTION

Change in Pond Operation Since Last Inspection

There has been no change in pond operation since last year's inspection. The divider dike (previously constructed of ash by plant employees) separates the disposal area into two separate ponds. There are three standard spillways and skimmers in each of the two ponds (see attached drawing 10N503) allowing the two ponds to be operated independently of each other.

All ash is now sluiced to the pond at the south end of area 2. The sluice water is discharged through standard spillways and skimmers directly into Kentucky Lake.

At present, there are no plant discharges to the pond at the north end of area 2. Due to seepage through the east dike of this area, all sluicing to this area will be discontinued until repairs have been completed (see Recommendations No. 1).

Condition of Spillways, Skimmers, and Outlets

The standard spillways and skimmers appear to be in good condition. The outlets are submerged so could not be inspected. There is no evidence of loss of ash.

Action on Recommendations of Last Inspection

1. The east dike has been raised by plant employees the 1 foot needed to reach elevation 378 with compacted earth. This earthfill was obtained from excavation for construction of gas turbines at the plant. The fill was thoroughly compacted in layers with the loaded rubber-tired hauling equipment. The top of this raised dike has been surfaced with chert (picture 3).

2. Plant employees have continued to remove logs and other debris from the outside dike slopes (see Recommendations No. 2).

Recommendations

1. Corrections are to be made to the east dike of area 2 to prevent seepage through this dike when the water level in this portion of area 2 is raised. It is recommended that corrective action be taken along the entire length of the pond side of disposal area 2 east dike. Since special equipment is required, this work is to be done by CSB or a qualified contractor as determined by P PROD to expedite the work.

Recommended corrective action is discussed below:

a. Attached sketch JL792076 shows the present dike arrangement. The recommended corrective action is indicated in red on the sketch.

b. Lower the water level in this portion of area 2 an additional 2 feet to elevation 364.

c. The work is to extend to a good connection with impervious soil of the main dike.

d. As indicated in the sketch, excavate along the pond side of the existing dike (trench with 12-foot bottom width) to at least elevation 364.

e. Carefully compact clay backfill (10-foot top width) along the inside of the dike.

f. The clay backfill is to be obtained from the material excavated from the gas turbine area and stockpiled in abandoned disposal area A.

g. The clay is to be placed in loose layers not more than 9 inches thick and thoroughly compacted with tamping (sheepsfoot-type) rollers in accordance with General Construction Specification No. G-9. Moisture content is to be controlled to enable good compaction.

h. Dike slopes are to be seeded with type 6, mixture E, ~~next spring~~. For a temporary winter cover, type 9 is to be used. All seeded areas are to be fertilized and mulched in accordance with sections 180 and 182, respectively, of the T-1 specifications.

2. Continue to keep logs and other debris removed from the outside dike slopes. This will continue to be a problem.

AREAS A, B, AND C

Change in Dikes Since Last Year's Inspection

There has been no change in these dikes since last year's inspection. Reclamation of areas A and B was previously done by CONST according to EN DES plans. The outside slopes were flattened to 2.5:1 or flatter.

Also to decrease the waterload on these dikes, positive drainage of areas A and B was provided by excavating a drainage ditch along the inside of the dike (pictures 5 and 6). E. I. du Pont de Nemours and Company, Inc., installed pipe culverts through the dike at various locations (see attached 10H503) in accordance with agreements with P PROD and EN DES.

Du Pont assumed responsibility for the pipe culverts. Concrete end walls were constructed at the pipe inlets, and all pipe outlets have been riprapped. There is no evidence of erosion at the pipe outlets.

The tops of the dikes of areas A and B have been surfaced with chert (picture 4) and are sloped to the inside. The dikes appear to be in good condition.

There is an almost complete lack of vegetation (picture 4) on the outside slopes of the dikes of areas A and B. The inspection report of 1974 noted a good vegetative cover on these slopes, and last year's report noted only a sparse vegetative cover on these slopes. It appears that there is not enough earth cover on these slopes to support a vegetative cover. Also due to the lack of a vegetative cover, erosion gullies are beginning to form down the outside slopes. Plant employees are planning to place more earth on these slopes and reseed them (see Action on Recommendations of Last Inspection No. 1 and Recommendations No. 1).

Earth excavation from installation of gas turbines (by General Electric) and from construction of a drainage ditch around the coal storage area (by plant employees) has been graded smooth since last year's inspection (see Action on Recommendations of Last Inspection No. 1). The drainage ditch along the inside of the dike for area A has been regraded (picture 6) and seeded.

The dikes of area C appear to be in good condition. Responsibility for area C, including the maintenance of its dikes, has been assumed by du Pont under an informal agreement with P PROD.

Change in Pond Operation Since Last Inspection

There has been no change in TVA's use of these areas since last year's inspection. TVA does not discharge any ash or water into areas A, B, or C.

Du Pont discharges some water into area B. This discharge is not ponded in area B but is diverted into a concrete sump and pumped back to the du Pont plant for recirculation. Rainfall is the only other water in and the only discharge from area A or area B.

Condition of Spillways, Skimmers, and Outlets

Spillways and skimmers of areas A and B were removed in the reclamation of these areas. Du Pont has installed pipe culverts through the dikes at various locations for the discharges from areas A and B. There is no evidence of loss of ash from these areas.

Spillways, skimmers, and outlets of area C were constructed and are operated by du Pont. They appear to be in good shape.

Action on Recommendations of Last Inspection

Areas A and B have been graded smooth; but the areas, except for the drainage ditch in area A, have not been seeded (see Recommendations No. 2). The dike slopes have not been covered with earth and seeded (see Recommendations No. 1). However, plant employees report that they are ready to do this work and will soon have it completed.

Recommendations

1. Plant employees should continue with their plans to cover the dike slopes (outside) of areas A and B with earth and seed the slopes. This work needs to be completed this fall.

2. Plant employees should continue with their plans to seed the newly graded areas A and B.

3. Plant employees should continue to keep logs and other debris removed from the outside dike slopes.

J. L. Glover

J. L. Glover

JLG:BLH
Attachments

Concur:

Original Signed By
F. D. Stansberry

Frank D. Stansberry

Original Signed By
G. L. Buchanan

G. L. Buchanan

10/1/76--FDS:BLH
CC: G. L. Buchanan, W3C126 C-K
(Attachments)

10/1/76--GLB:NCH
CC (Attachments):
R. G. Domer, W9D224 C-K
Roy H. Dunham, W11A9 C-K
MEDS, E4B37 C-K
B. S. Montgomery, 5100 MIB-K

JOHNSONVILLE STEAM PLANT
1976

(1)

Area 2
Outside slope of dike.
Note chert surfacing on top of dike and vegetative cover on slope.

(2)

Area 2
Standard spillways and skimmers
Note sparse vegetation on inside dike slopes in background.

(3)

Area 2
East dike after being raised 1-foot to elevation 378±.
Note chert surfacing and vegetation.

JOHNSONVILLE STEAM PLANT
1976

④

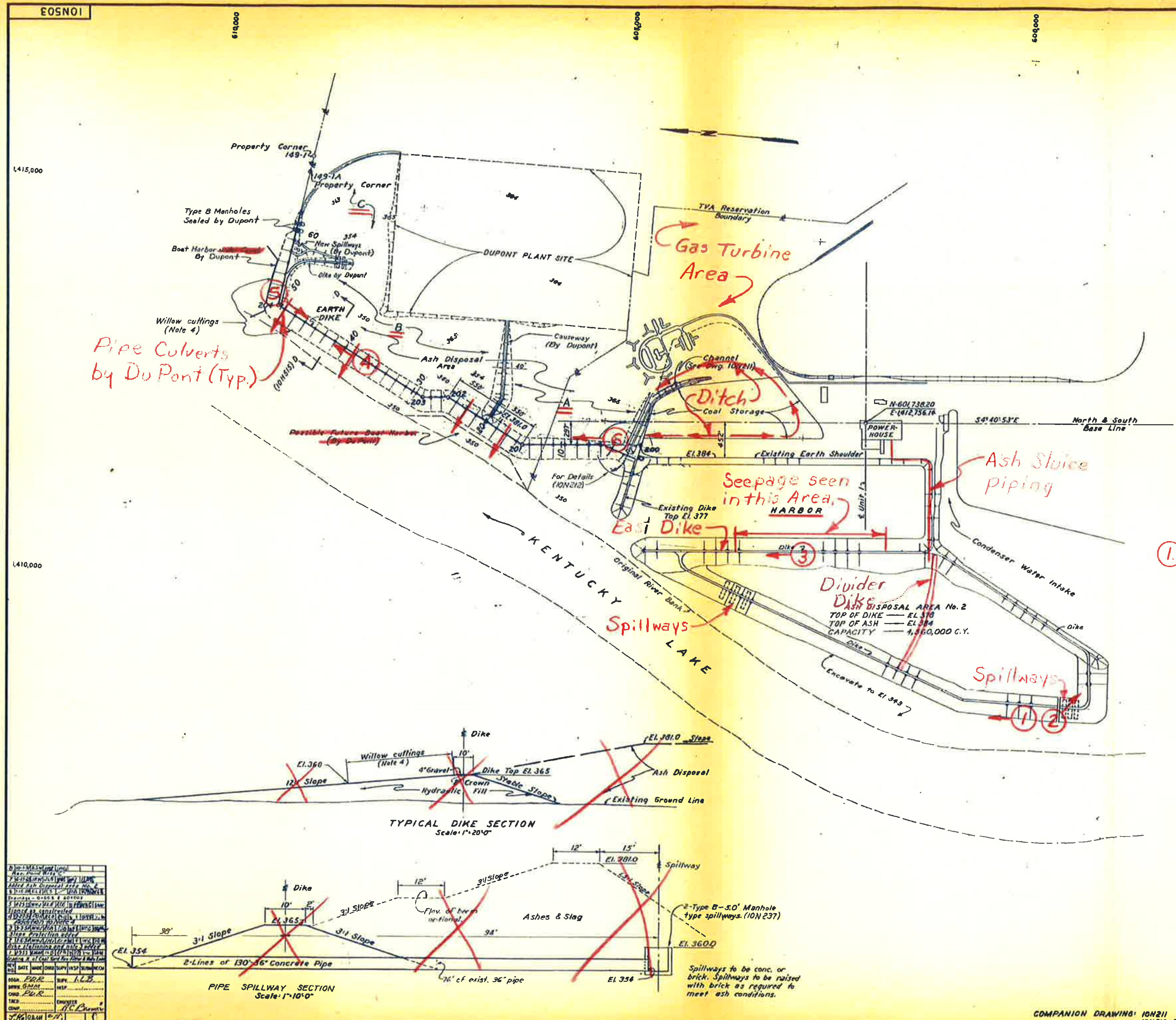
Area B
Outside slope
Note lack of vegetation and surfacing on top of dike.

⑤

Area B
Drainage ditch along inside of dike. Note vegetation in this area.

⑥

Area A
Ditch along inside of dike. Earth has just been placed and ditch seeded. Note straw along slope to be placed on seeded areas.



DIKE LOCATION				
POINT	AZIMUTH	DISTANCE	COORDINATES	
			EAST	NORTH
200			1,412,228	604,547
	175°19'	1470'		
201			1,412,108	606,012
	208°19'	1100'		
202			1,412,630	606,981
	175°19'	330'		
203			1,412,603	607,310
	208°19'	2150'		
204			1,413,623	609,202
	278°08'	1727'		
149-1A			1,415,333	608,958
	278°08'	205'		
149-1			1,415,536	608,929

APPROXIMATE QUANTITIES
Hydraulic Fill *375,000 Cu. Yds.
Gravel Surfacing 800 Cu. Yds.

*Net embankment quantity, based on 4:1 inside slope; 12:1 outside slope.

1. → Photograph taken at this point in this direction.

NOTE
① SURFACING Gravel surfacing 4" thick shall be applied for the full width of the dike, in accordance with section 210 of the T-1 Specifications.
② CLEARING Area bounded on North by Ash Dike (initial fill), East by El. 365, South and West by earth dikes to be cleared of all trees, no stumping required.
③ Profile of existing dike prior to July 1, 1954 and detailed cross sections, see dwgs. 10H515-519.
④ Willow cuttings to be planted on lake side of dike from elevation 360 to top of dike.
Areas of the dike slopes above elev. 360 that are bare of vegetation shall be planted in the fall of 1954 to Italian rye grass at the rate of 50 lbs. per acre. No fertilizer or mulch is required

REFERENCE DRAWINGS:
10BM503-------BILL OF MATERIAL.
COMPANION DRAWINGS:
10N212---- - ----Drainage & Dike Details - Ash Disposal Area

Scale: 1"=500' Except as noted.

COMPANION DRAWING: 10N211
10H515-519

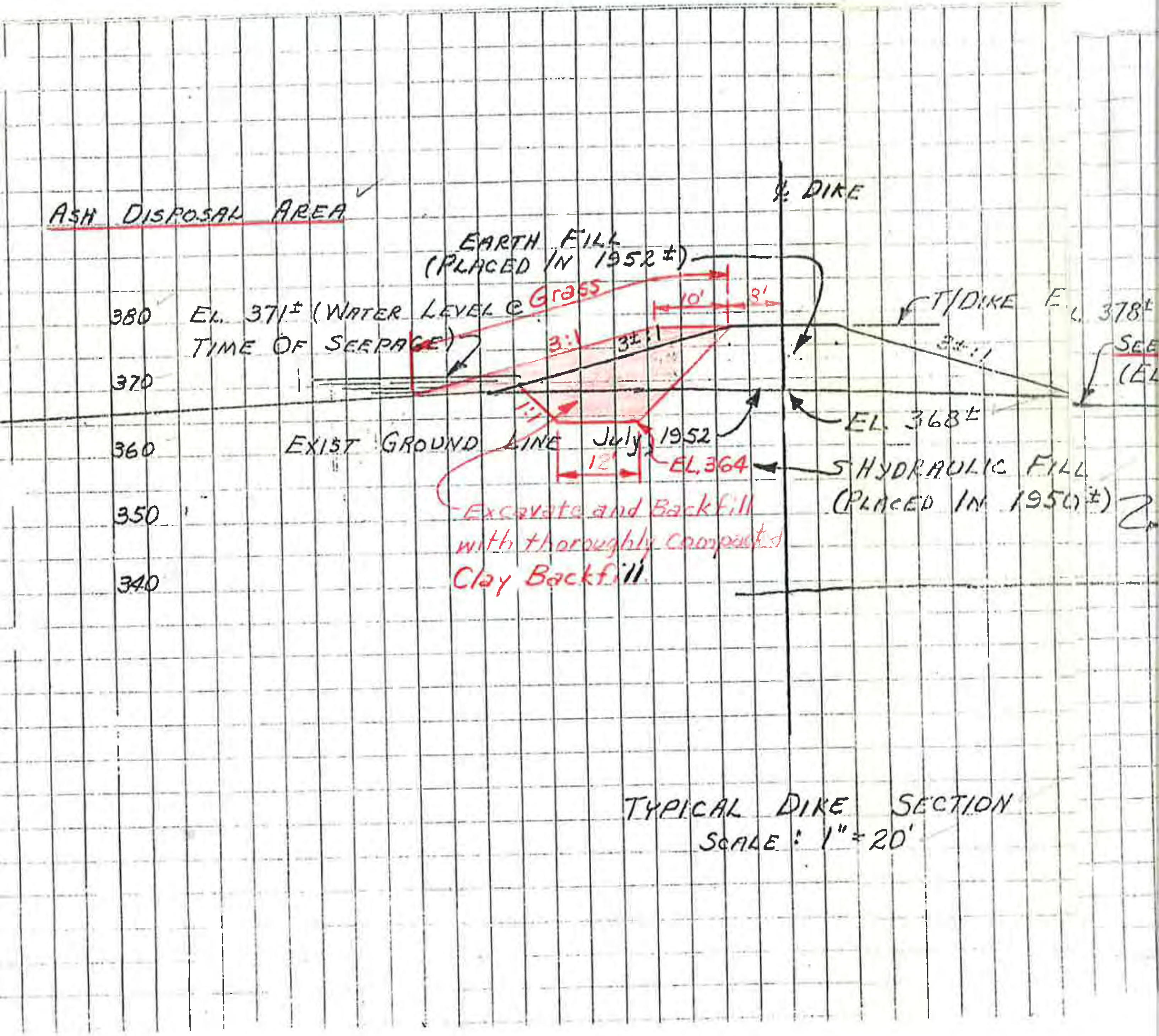
MAIN PLANT

DIKE FOR ASH DISPOSAL AREA

JOHNSONVILLE STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF DESIGN

SUBMITTED	RECOMMENDED	APPROVED
W. N. Colbert Jr.	A. A. Meyer	R. A. Monroe

KNOXVILLE	7-16-52	30	C	4	10N503 R8


ASH DISPOSAL AREA
℄ DIKE
EARTH FILL (PLACED IN 1952±)
Grass
10'
8'
T/DIKE EL. 378±
EL. 371± (WATER LEVEL @ TIME OF SEEPAGE)
3:1
3±:1
2±:1
1:1
380
370
360
350
340
EXIST GROUND LINE
July 1952
12'
EL. 364
EL. 368±
HYDRAULIC FILL (PLACED IN 1950±)
Excavate and Backfill with thoroughly compacted Clay Backfill
TYPICAL DIKE SECTION
SCALE: 1" = 20'

TVA 489A (DES-2-59)

TENNESSEE VALLEY AUTHORITY

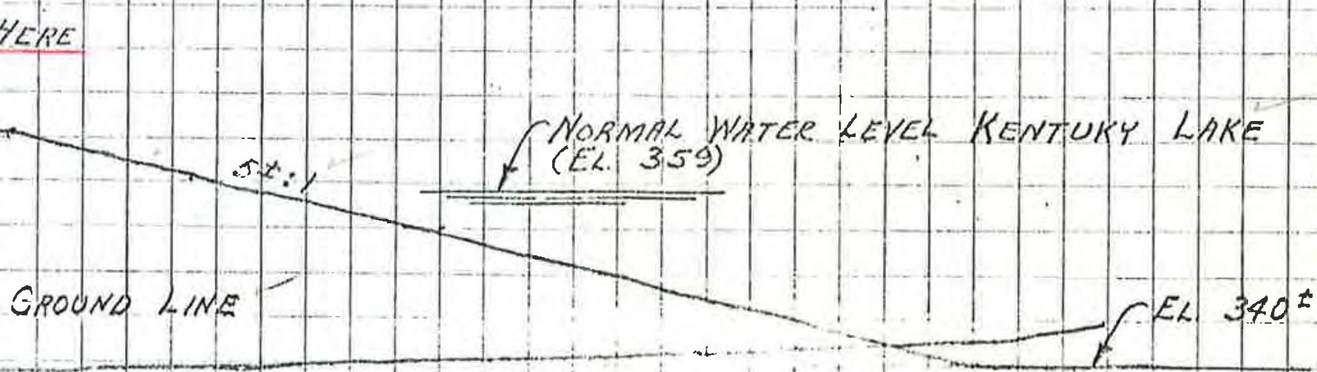
SHEET OF

SUBJECT SEEPAGE THROUGH ASH DIKE @ BOAT HARBOR

PROJECT JOHNSONVILLE S.P.

COMPUTED BY JL GLOVER DATE 9/20/76 CHECKED BY DATE

BOAT HARBOR



Dike Repairs are indicated in Red:

Dike Excavation 20,700± C.Y.

Earth Borrow for Dike Fill 44,600± C.Y.

SKETCH JLG92076

B65 950511 202

JDP

Master File

May 16, 1995

C. N. Dammann, Johnsonville Fossil Plant

JOHNSONVILLE FOSSIL PLANT - ANNUAL FOSSIL ENGINEERING INSPECTION OF ASH DISPOSAL AREAS

The ash disposal areas at Johnsonville Fossil Plant were inspected March 9, 1995. Attached is a report of the findings including recommendations for corrective work.

RG Johnson

Ralph G. Johnson
Manager, Fossil Engineering
LP 2G-C

KWB:JDP:MBW
Attachment
cc: J. S. Baugh, LP 5G-C
RIMS, CST 13B-C

t:\jofash.jdp

JOHNSONVILLE FOSSIL PLANT
ANNUAL FOSSIL ENGINEERING REPORT
INSPECTION OF ASH DISPOSAL AREAS

1.0 GENERAL

1.1 This inspection of the ash disposal areas was conducted on March 9, 1995 by the following personnel:

Joel Paris, Fossil Engineering
Melissa Hedgecoth and Dave Robinson of Fossil Fuels
Tony Hunt, Johnsonville Fossil Plant

1.2 The last annual inspection was made on February 28, 1994.

1.3 The areas inspected are designated on the attached prints of drawings 10N503, 10N527, 10N530-1, and 10N530-2.

2.0 AREAS A, B, AND C

2.1 Areas A and B were reclaimed in 1975-76 with additional earth added to the dike's exterior slopes in 1978. DuPont installed a fence and gate across area A in 1977, and no formal inspections have been made since 1981.

2.2 Area C has been the sole responsibility of DuPont under an informal agreement since 1972.

2.3 The exterior slope of the Area A dike has notable redwater leachate seeping from the layered ash. TVA is collecting data and performing various studies on this area in order to formulate a corrective action plan.

3.0 ASH DISPOSAL -WET

3.1 CHANGE IN POND OPERATION SINCE LAST INSPECTION

3.1.1 AREA NO. 2

3.1.1.1 There has been no change in the pond operation since the last inspection. All ash is sluiced directly to this area.

3.1.1.2 The bottom ash is removed from the ash sluice channel by a dragline and stacked inside the northern portion of this area

3.1.2 RAILROAD LOOP AREA DREDGE POND (AREA 3)

3.1.2.1 The railroad loop area dredge pond has been dredged full with ash from area No 2.

3.1.2.2 Bids have been solicited by Fossil Engineering to remove 700,000 cubic yards of fly ash from area No 2 and stack and cover it in the railroad loop area by October 1, 1996.

3.1.3 ASH DREDGE POND EAST OF GAS TURBINES

3.1.3.1 There has been no change in pond operation. At the present time this pond is full of fly ash.

3.1.3.2 If they were dredging to this area, all sluice water would discharge through a spillway and then by gravity flow through an 18-inch pipe to settling Pond C in the railroad loop.

3.2 CHANGE IN DIKES SINCE LAST INSPECTION

3.2.1 AREA NO. 2

3.2.1.1 In general the dikes appear to be stable. (see 3.2.1.5) There has been very little change in the structural integrity of the exterior dike since the last inspection. The 300 feet long seepage area at the toe of the east dike, west of the construction harbor dock, and as referenced in "the redwater investigation program" has decreased in flow (see 3.2.1.2).

3.2.1.2 A bulge has developed near the toe of the slope (150 feet north of the construction dock). We feel that this bulge is the result of the heavy truck loads when hauling riprap for the dike repairs. The bulge does not pose a structural problem at this time (see 3.5.1.3).

3.2.1.3 Seven(7) seeps were noted on the east dike north of the causeway and two(2) on the east dike south of the causeway during this inspection. None of these pose a structural problem.

3.2.1.4 In general the dike's exterior slopes are inundated with briers, therefore, much of the inspection is made from the timberline route at the dike's base and top of dike. Small tree and bush sprouting continues to be an annual occurrence along the dikes' slope. (see 3.5.1.1 and 3.5.1.2)

3.2.1.5 The top of the dikes have an adequate rock surface and they are graded for positive drainage.

3.2.1.6 There are two(2) additional areas of erosion on the west dike. One area is 100 feet wide and starts at the south end of the 1994 repairs. The second area is 200 feet wide and starts 800 feet south of the 1994 repairs (see 3.5.1.4).

3.2.2 RAILROAD LOOP AREA DREDGE POND (AREA 3)

3.2.2.1 There has been no change in the dredge pond dikes or the exterior dikes in the railroad loop area. All the dikes appear to be stable.

3.2.2.2 The dredge pond is full of dredged ash and has a bottom ash cover to keep the fly ash from blowing.

3.2.2.3 The exterior dikes of the plant constructed dredge cell have eroded again due to steep slopes, lack of compaction on edges, and lack of vegetation. The safety factor for stability of these dikes is unknown (see 3.5.2.1 and 3.5.2.2).

3.2.3 ASH DREDGE POND EAST OF GAS TURBINE

3.2.3.1 The dikes appears to be stable. The tops of the exterior dikes have a good crushed stone surface. All dikes appear to be in good condition with no visible signs of instability.

3.2.3.2 There is a small seepage on the south east dike approximately 100 feet from the gate (see 3.5.3.1).

3.2.3.3 This disposal site is full. On occasions the wind blows up clouds of flyash (see 3.5.3.2).

3.3 CONDITION OF SPILLWAYS, SKIMMERS AND OUTLET STRUCTURES

3.3.1 AREA NO. 2

3.3.1.1 There are three groups of three type B spillway structures each. The north group in the west dike and the group in the east dike have been raised and there is no discharge. The south group in the west dike are active. The north and south spillway of this group are in good condition with no visible signs of loss of ash. The middle spillway of this group has been taken out of service.

3.3.1.2 The spillway outlets from the stilling pool area are in good condition with no visible signs of loss of ash.

3.3.2 RAILROAD LOOP AREA STILLING POOL AND DREDGE POND (AREA 3)

3.3.2.1 The standard type B spillway, skimmer, and outlet pipe in the stilling pond ("D") appears to be in good condition.

3.3.2.2 The metal spillway in the dredge cell appears to be in good shape and functioning properly. There is no signs of loss of ash.

3.3.3 ASH DREDGE POND EAST OF GAS TURBINE

3.3.3.1 The spillway appears to be functioning properly. There is no signs of loss of ash.

3.4 ACTION ON RECOMMENDATION OF LAST INSPECTION

3.4.1 AREA NO. 2

3.4.1.1 The slopes have been cleared of briers; however, they have grown back. (see 3.5.1.1)

3.4.1.2 The small trees and bushes on the slopes have not been removed(see 3.5.1.2).

3.4.1.3 Repair for the 660 foot section of excessive erosion along the exterior of the west dike, was completed in May 1994.

3.4.1.4 The holes on the outer slope of the west dike at the south spillway was repaired along with the dike erosion repairs.

3.4.1.5 Repairs (put back to original shape and condition) to the bench cut in the dike slope at the south spillway was completed along with the dike erosion repairs.

3.4.2 RAILROAD LOOP AREA DREDGE POND (AREA 3)

3.4.2.1 The plant has repaired the exterior dikes on the northeast side that had eroded due to steep slopes, lack of compaction on the edge, and lack of vegetation. (see 3.5.2.1 and 3.5.2.2)

3.4.3 ASH DREDGE POND EAST OF GAS TURBINE

3.4.3.1 Plant personnel have monitored the area of seepage in the southeast dike (see 3.5.3.1).

3.4.3.2 The area of deposited ash that was outside of the southeast corner of the dredge pond has been cleaned up.

3.5 RECOMMENDATION

3.5.1 AREA NO. 2

3.5.1.1 Plant personnel should clear the briers from the slopes in order to maintain free access and insure visible inspection to better identify and evaluate any potential problem areas.

3.5.1.2 Plant personnel should remove all small trees and bushes from the 3:1 dike slopes. The 6:1 slopes do not need to have the trees removed. When removing trees, the roots should be removed to ensure against resprouting and the prevention of root penetration through the dike.

3.5.1.3 Plant personnel should observe the bulge that is 150 feet north of the construction dock and report any increase in seepage quantity or increase in bulge size to contact Ken Burnett of Fossil Engineering at 615/751-6607.

3.5.1.4 Fossil Engineering is in the process of awarding a contract to repair the two areas, totaling 300 feet long, of the ash pond dike on the west side of the active ash pond and the east shore of Kentucky Lake.

3.5.2 RAILROAD LOOP AREA DREDGE POND (AREA 3)

3.5.2.1 The exterior dikes will be covered according to the closure plan as a part of the contract presently being evaluated by Fossil Engineering. This should be completed by October 1,1996.

3.5.2.2 Plant personnel should continue to monitor the dikes very closely as ash is pumped into and removed from the pond for seepage and slope failure. If these do occur, stop dredging immediately and contact Ken Burnett of Fossil Engineering at 615/751-6607.

3.5.3 ASH DREDGE POND EAST OF GAS TURBINE

3.5.3.1 Plant personnel should monitor the southeast toe of dike very closely for signs of seepage in the seepage area until the repairs are completed according to the contract presently being evaluated by Fossil Engineering. These repairs should be completed this calendar year.

3.5.3.2 Ash is to be removed from this area in order to stack within the railroad loop. The contract presently being evaluated by Fossil Engineering will cover the pond with bottom ash when the dredging is complete.

4.0 CHEMICAL TREATMENT POND

4.1 The chemical pond is located adjacent to the harbor causeway and condensing water intake channel. The chemical pond dikes appears to be stable with a good vegetation cover on them.

4.2 The pond is half full of water and will be pumped out at a later date. All pump discharges from this pond are discharged into Area No. 2 ash pond.

5.0 COAL YARD DRAINAGE BASIN

5.1 General

5.1.1 The coal yard drainage basin is located at the north end of the coal pile. This basin was excavated below grade; therefore, there are no exterior dikes.

5.1.2 All discharges from this basin is pumped beneath the harbor to Ash Pond Area No 2.

5.1.3 The coal yard drainage basin contains a considerable amount of silt and coal (see 5.2.1).

5.2 Recommendations

5.2.1 The coal yard drainage basin should be cleaned out to increase the storage for rainfall runoff and provide positive flow in the ditch.

6.0 ASH DISPOSAL-DRY

6.1 CHANGE IN DRY FLY ASH STACK SINCE LAST INSPECTION

6.1.1 RAILROAD LOOP AREA (AREA 1)

6.1.1.1 Fly ash was last stacked in this area by TVA's construction partner in late 1994. This area has been covered and closed per plans submitted to the State of Tennessee.

6.1.2 RAILROAD LOOP AREA (AREA 2)

6.1.2.1 Fly ash was stacked in this area by TVA's construction partner in late 1994.

6.1.2.2 Bids are presently being evaluated by Fossil Engineering to stack 700,000 cubic yards of fly ash in this area and cover the ash, in accordance with plans submitted to the State of Tennessee, by October 1,1996.

6.2 CHANGE IN DIKES SINCE LAST INSPECTION

6.2.1 RAILROAD LOOP AREA (AREA 1)

6.2.1.1 The dikes appear to be stable.

6.2.1.2 The exterior dike, along the south end of Area 1, was raised by TVA's construction partner when covering the stacked ash. All drainage was directed across the road as sheet flow. Several areas have eroded down the slopes as a results of this action (see 6.4.1.1).

6.2.2 RAILROAD LOOP AREA (AREA 2)

6.2.2.1 The original earth dikes appear to be stable and in good condition.

6.2.2.2 Ash has been dry stacked in this area according to Engineering Plans.

6.3 ACTION ON RECOMMENDATION OF LAST INSPECTION

6.3.1 RAILROAD LOOP AREA (AREA 1)

6.3.1.1 The ash stacked in this area was covered per plans submitted to the State of Tennessee.

6.3.2 RAILROAD LOOP AREA (AREA 2)

6.3.2.1 A vegetative cover has been established over the permanent covered area. Plans (see 6.1.2.2) are to stack additional ash over the temporary covered area.

6.3.2.2 The eroded area of the interior ash dike was repaired.

6.4 RECOMMENDATION

6.4.1 RAILROAD LOOP AREA (AREA 1)

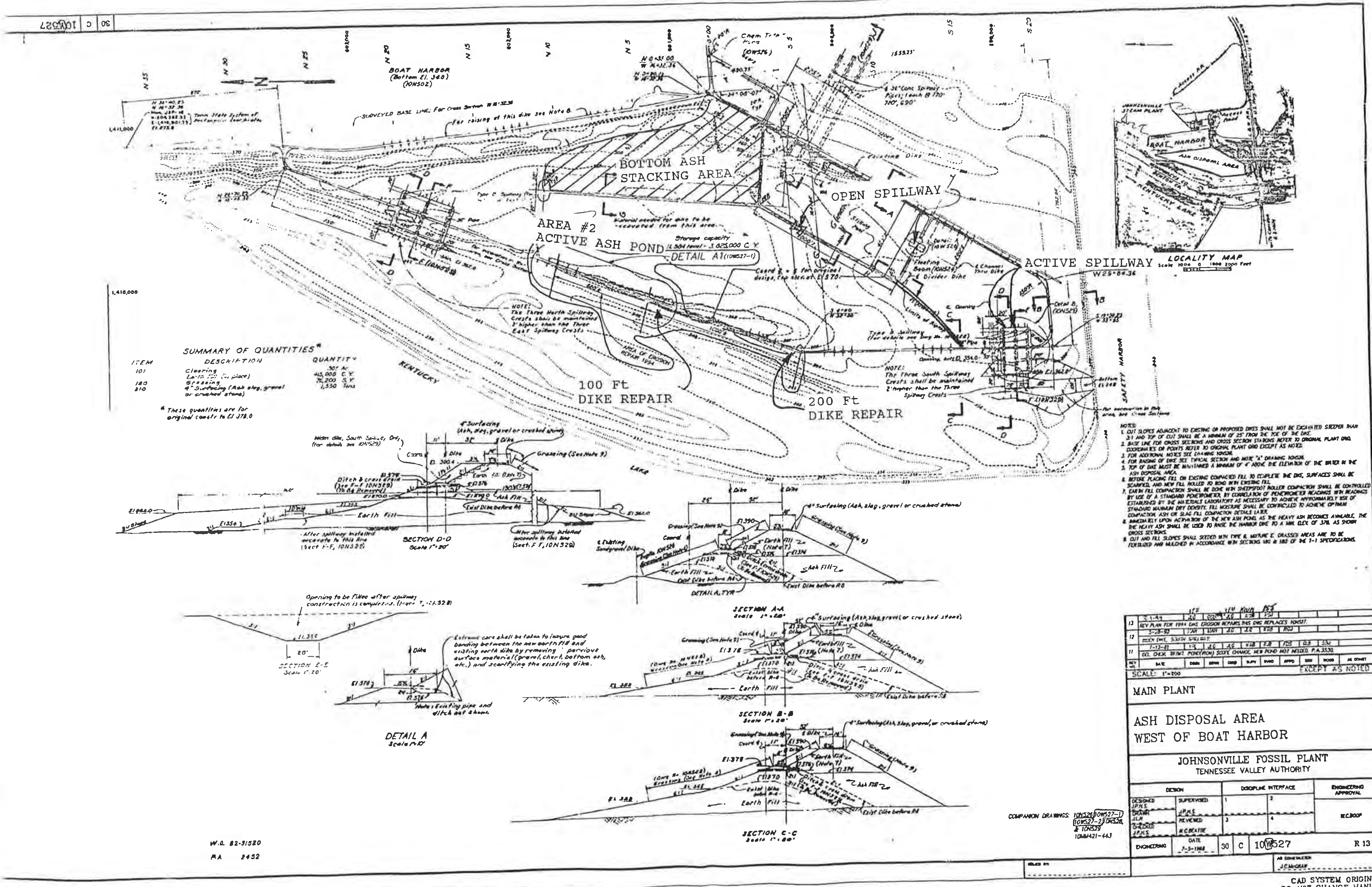
6.4.1.1 Bids are presently being evaluated by Fossil Engineering to repair the south end of this area, adjust the drainage, add pipe culverts with riprap down the banks and provide a crushed stone surface for the roadway. This work is to be completed by October 1, 1996.

6.4.2.4 RAILROAD LOOP AREA (AREA 2)

6.4.1.1 There are no recommendations for repairs in this area.

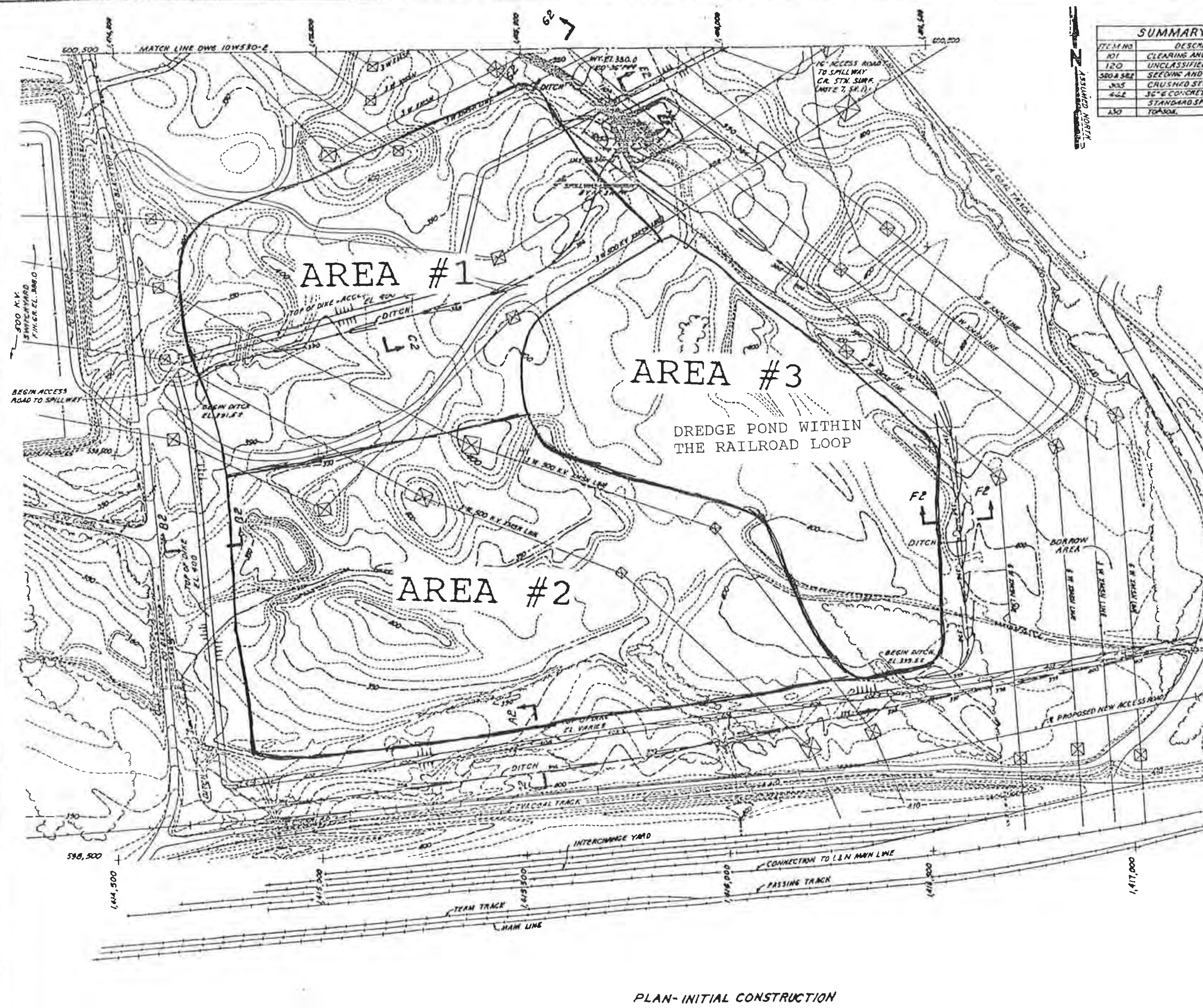
Joel D. Paris

Joel D. Paris
Site Engineering
LP 2G-C



BOAT HARBOR
(Bottom El. 340)
(10N502)
BOTTOM ASH
STACKING AREA
OPEN SPILLWAY
AREA #2
ACTIVE ASH POND
DETAIL A1(10W527-1)
ACTIVE SPILLWAY
LOCALITY MAP
100 Ft
DIKE REPAIR
200 Ft
DIKE REPAIR
KENTUCKY
LAKE
SAFETY HARBOR
SUMMARY OF QUANTITIES*
ITEM
DESCRIPTION
QUANTITY
101 Clearing
180 Grassing
210 4" Surfacing (Ash, slag, gravel or crushed stone)
* These quantities are for original constr. to El 378.0
SECTION D-D
SECTION E-E
DETAIL A
SECTION A-A
SECTION B-B
SECTION C-C
DETAIL A, TYP.
NOTES:
COMPANION DRAWINGS
W.O. 82-31520
MAIN PLANT
ASH DISPOSAL AREA
WEST OF BOAT HARBOR
JOHNSONVILLE FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
SCALE: 1"=200
EXCEPT AS NOTED
30 C 10W527
R 13
CAD SYSTEM ORIGINAL
DO NOT CHANGE MANUALLY

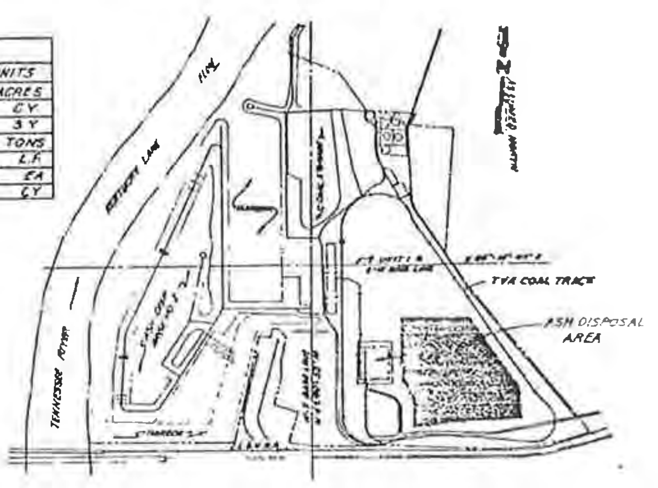
10W530-1



PLAN- INITIAL CONSTRUCTION

SUMMARY OF QUANTITIES

ITEM NO	DESCRIPTION	QUANTITY	UNITS
101	CLEARING AND GRUBBING	16	ACRES
120	UNCLASSIFIED EXCAVATION	165,160	CY
580 & 582	SEEDING AND MULCHING	51,000	SY
305	CRUSHED STONE SURFACE	1,266	TONS
462	36" Ø CONCRETE PIPE CLASS III	256	LF
	STANDARD SPILLWAY & SKIMMER	1	EA
130	TOPSOIL	2,074	CY



LOCATION MAP
NTS

NOTES:

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE T-1 SPECIFICATIONS, UNLESS OTHERWISE NOTED.
2. THE SOLID CONTOURS REPRESENT FINISHED GRADE; DASHED CONTOURS INDICATE EXISTING GROUND.
3. BORROW MATERIAL FOR THE DIKE SHALL BE OBTAINED FROM INSIDE THE LOOP. CUT SLOPES ADJACENT TO STRUCTURES OR EMBANKMENTS SHALL NOT BE EXCAVATED STEEPER THAN 3:1 AND TOP OF CUT SHALL BE A MINIMUM OF 25 FEET FROM STRUCTURES OR TOE OF EMBANKMENT.
4. FOUNDATION PREPARATION FOR EARTH EMBANKMENTS SHALL CONSIST OF CLEARING AND REMOVING ALL ROOTS, VEGETATION, AND ORGANIC TOP SOIL. FOUNDATION AREA SHALL BE COMPACTED BY USING SHEEP'S FOOT ROLLER FOLLOWED BY FLAT WHEELED ROLLER UNTIL DISTURBED AREA WILL SUPPORT HEAVY EQUIPMENT WITHOUT RUTTING INTO THE GROUND AND WITHOUT HEAVING THE GROUND SO AS TO REDUCE ITS STABILITY.
5. DIKE CONSTRUCTION SHALL BE IN ACCORDANCE WITH GENERAL CONSTRUCTION SPECIFICATION NO. G-- ROLLED EARTH FILL DAMS AND POWER PLANTS.
   (A) EARTHFILL COMPACTION SHALL BE AT LEAST STANDARD MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D698. FILL MOISTURE CONTENT SHALL BE WITHIN ±3% OF THE OPTIMUM MOISTURE CONTENT.
   (B) GRANULAR FILL WITH LESS THAN 20% FINES SHALL BE COMPACTED TO AN AVERAGE RELATIVE DENSITY OF 85% OR GREATER WITH A MINIMUM RELATIVE DENSITY OF 80% AS DETERMINED BY ASTM D2049 PROCEDURES. GRANULAR MATERIAL WITH MORE THEN 20% BUT LESS THAT 35% FINES SHALL BE COMPACTED TO AT LEAST 9- OF STANDARD MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D698 (METHOD D) PROCEDURES. FILL CONTROL CURVES (FAMILY OF COMPACTION CURVES AND RELATIVE DENSITY CURVE) PREVIOUSLY PREPARED FOR CHIMNEY BACKFILL SHALL BE OBTAINED FROM SINGLETON MATERIALS ENGINEERING LABORATORY.
6. DIKE SLOPES SHALL BE SEEDED WITH TYPE 6 MIXTURE. SEEDED AREAS ARE TO BE FERTILIZED AND MULCHED IN ACCORDANCE WITH SECTIONS 580 AND 582.
7. 4" CRUSHED STONE SURFACE SHALL BE IN ACCORDANCE WITH SECTION 305.
8. MAXIMUM WATER LEVEL DURING DREDGING OPERATION SHALL BE 396.
9. THE ASH DISPOSAL AREA SHALL BE CLEARED IN ACCORDANCE WITH SECTION 101. NO GRUBBING IS REQUIRED EXCEPT FOR AREAS OF DIKE FOUNDATIONS.

FIRST ISSUE FOR P.A. NO. 3583

COMPANION DRAWINGS:
10W530-2 THRU 10W530-4
10N528 & 10N531

1 P.A. NO. 3583 11/9/83 AS CONSTRUCTED.

K. W. Burnett

SCALE 1"=100' EXCEPT AS N

YARD

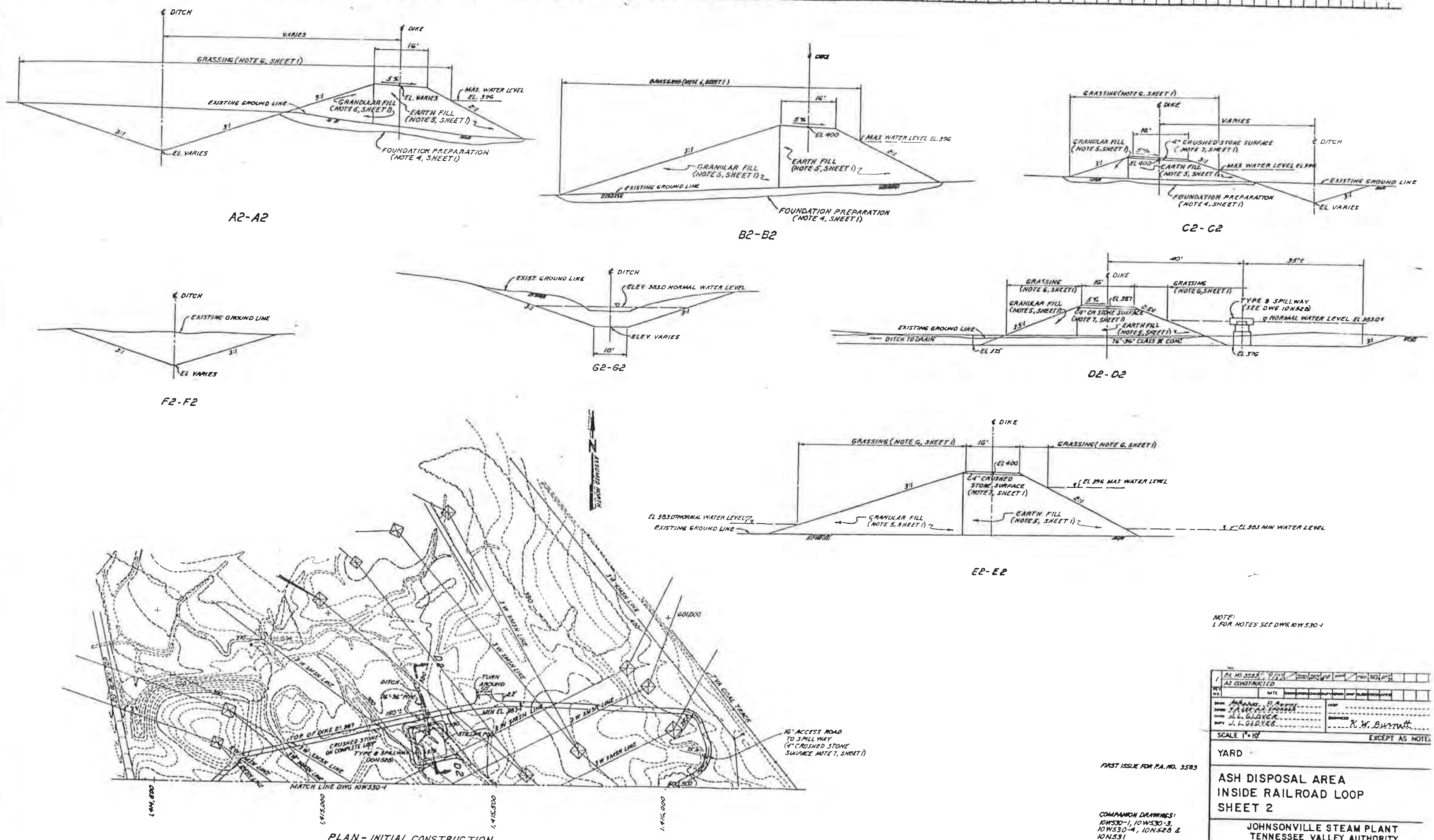
ASH DISPOSAL AREA
INSIDE RAILROAD LOOP
SHEET 1

JOHNSONVILLE STEAM PLA
TENNESSEE VALLEY AUTHORI
DIVISION OF ENGINEERING DESIGN

SUBMITTED RECOMMENDED APPROVE

INSPECTED AND APPROVED FOR ISSUE
J. B. Jack

KNOXVILLE 12-5-81 30 C 10W530-1



NOTE:
1. FOR NOTES SEE DWG 10W530-1

FIRST ISSUE FOR P.A. NO. 3583

COMPANION DRAWINGS:
10W530-1, 10W530-3,
10W530-4, 10N528 &
10N531

A2 CONSTRUCTED

SCALE 1" = 10' EXCEPT AS NOTED

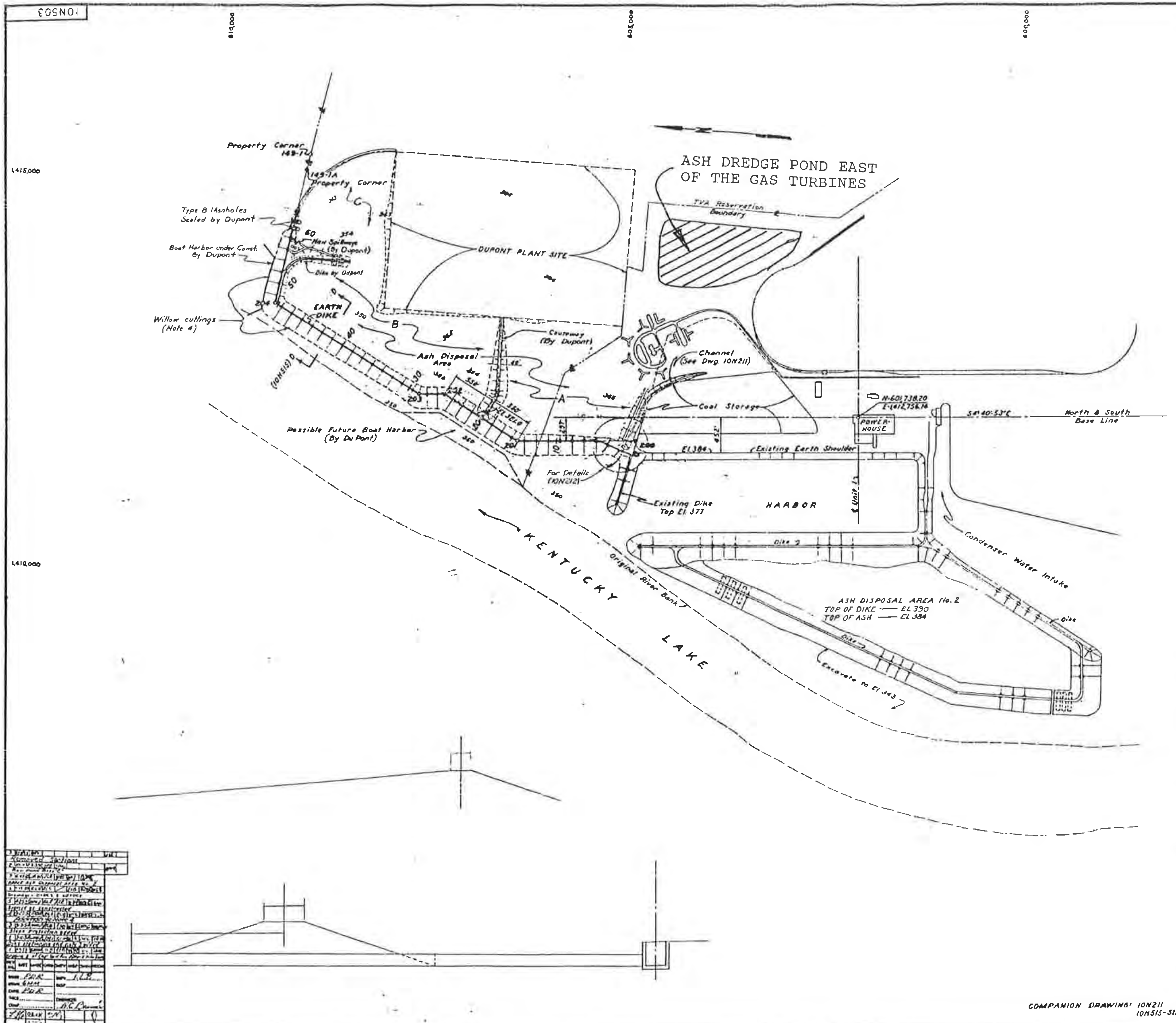
YARD

ASH DISPOSAL AREA
INSIDE RAILROAD LOOP
SHEET 2

JOHNSONVILLE STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

INSPECTED AND APPROVED FOR ISSUE

KNOXVILLE 12-3-81 30 C 10W530-2



DIKE LOCATION				
POINT	AZIMUTH	DISTANCE	COORDINATES	
			EAST	NORTH
200			1,412,228	604,547
	175°19'	1470'		
201			1,412,108	606,012
	208°19'	1100'		
202			1,412,630	606,981
	175°19'	330'		
203			1,412,603	607,310
	208°19'	2150'		
204			1,413,623	609,202
	278°08'	1727'		
149-1A			1,415,333	608,958
	278°08'	205'		
149-1			1,415,536	608,929

APPROXIMATE QUANTITIES

Hydraulic Fill *373,000 Cu. Yds.
Gravel Surfacing 800 Cu. Yds.

*Net embankment quantity, based on 4:1 inside slope; 12:1 outside slope.

NOTE

① SURFACING Gravel surfacing 4" thick shall be applied for the full width of the dike, in accordance with section 210 of the T.I. Specifications.

② CLEARING Area bounded on North by Ash Dike (initial fill), East by El 365, South and West by earth dikes to be cleared of all trees, no stumping required.

③ Profile of existing dike prior to July 1, 1954 and detailed cross sections, see dwgs. 10N515-518

④ Willow cuttings to be planted on lake side of dike from elevation 360 to top of dike

Areas of the dike slopes above elev. 360 that are bare of vegetation shall be planted in the fall of 1954 to Italian rye grass at the rate of 50 lbs per acre. No fertilizer or mulch is required.

REFERENCE DRAWINGS:
10 BM 503-------BILL OF MATERIAL.
COMPANION DRAWINGS
10N212--------Drainage & Dike Details - Ash Disposal Area

Scale: 1"=500' Except as noted.

MAIN PLANT

DIKE FOR ASH DISPOSAL AREA

JOHNSONVILLE STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF DESIGN

SUBMITTED	RECOMMENDED	APPROVED
[signature]	A.A. Meyer	[signature]

KNOXVILLE | 7-16-52 | 30 | C | 4 | 10N503 R9

11-16-54

R6 R9

APPENDIX L
HISTORICAL DOCUMENTS

TVA 64 (OS-9-65)
UNITED STATES GOVERNMENT
Memorandum
TENNESSEE VALLEY AUTHORITY

TO : F. P. Lacy, Chief, Civil Design Branch, 405 UB, Knoxville (3)

FROM : J. C. McCraw, Chief, Construction Services Branch, 709 UB, Knoxville

DATE : September 17, 1969

SUBJECT: JOHNSONVILLE STEAM PLANT - ASH POND - SOIL AND FOUNDATION EXPLORATION

The soil investigation on the above project, authorized July 3, 1969, by W. N. Calvert, was carried out during the period of July 7-24, 1969, and included six undisturbed sample borings and 14 auger holes.

The stratigraphy of this site indicates the presence of a surficial river alluvium, of Pleistocene to recent age, consisting of silts or clays, which grade into sand and gravel. The recent alluvium, according to a 1948 exploration, is up to 70 feet thick in the flood plain, and bedrock is the Camden chert, which consists of blocks of chert parted by clay seams.

Dike Foundation and Partial Embankment

Six undisturbed borings, US-1 through US-6, were drilled along the centerline and lakeside of the dike between stations 30+00 and 75+00, on approximately 900-foot centers. The plan of the soils investigation is shown on laboratory drawing 605-B-143. At the time of the exploration, fill was placed to about elevation 366, and original soil was encountered between elevations 355 and 358. Laboratory drawing 605-B-144 shows the profile of the foundation and that of partial fill. Only one of these borings, US-1, extended into the sand gravel layer at elevation 354. In boring US-2, a one-foot layer of non-plastic, silty gravel, representing surface material above the original soil, exists between elevations 357 and 358. With the exception of a fully saturated silt layer of low plasticity, ML, in boring US-1, practically all soils according to the Unified System classified lean clay, CL, of tan to medium gray color. By particle size distribution, these are clayey silts with liquid limits from 34 to 45 percent and plastic indices averaging about 17 percent. The sand fraction is as low as 4 percent and as high as 21 percent. Dry densities range from about 90 pcf to 107 pcf. Void ratios vary from 0.6 to 0.9.

The lake level during July fluctuated from elevation 356.5 to 358.1, with an average of 357.2. A water table in the dike foundation was not encountered but was expected between elevations 350 and 355.

Selected samples obtained from both the foundation and completed portions of the dike embankment were tested for shear strength. Results of unconsolidated-undrained Q and saturated consolidated-undrained R tests show a fairly wide range of friction angles and cohesion. Overall, there is a similarity of index and engineering properties of fill and foundation soils, despite slightly higher density-compaction of the fill. Under Q-test conditions, foundation soils are of moderately low to medium strength; under R-test conditions, medium shear strength is indicated.

Laboratory testing of index and engineering properties of foundation and embankment soils is tabulated in the attached "Summary of Laboratory Test Data - Ash Dike Foundation."

Borrow Soils

Of primary interest are soils from borrow area A in the settlement pond area within the dike, comprising approximately 88 acres. Moderately high moisture contents were encountered in soils from the south and west portions, as established in borings AHP-1, -2, -3, -4, and -14. In the northeastern sector of the area, which is boggy in places, the water table is shallow, and high natural moisture contents are common. These are gray to blue, lean clays, as found in AHP-8 through AHP-12. The borrow soil profile is shown in laboratory drawing 605-FF-145.

To date most of the borrowing is concentrated on the southern end and along the western edge of the pond area. Surface elevations at the time of the exploration ranged from 345 to 355, and the water table was established between elevations 335 and 346, indicating the availability of about 10 additional feet of suitable soils in the immediate area. Suitable soils from the south end, comprising 40 acres, will yield about 550,000 cubic yards. The wet northeastern half of the area will require special attention to reduce moisture contents to within acceptable limits. Upon careful drying, this area can produce about 0.5 million cubic yards.

The two classes of borrow soils determined have very similar characteristics in particle size distribution, plasticity, and compactibility except that class I is somewhat leaner and therefore has a maximum density two pounds higher than class II soils. A slight increase in the friction angle under triaxial R test conditions is also noted. About 80 percent of the borrow will be of class I. A minor discrepancy exists in the comparison of the penetration resistance of the two soil classes at optimum moisture. The leaner class I soils have about 100 psi less resistance than class II soils.

A substitute borrow area, B, was located in the vicinity of the old campground and would entail a hauling distance of about 7,000 feet. Twelve acres of soils yielding 300,000 cubic yards are available. These soils are generally dry of optimum and consist of lean to medium clays. The soil profile of borrow area B is shown in laboratory drawing 605-B-146.

Laboratory testing of the two borrow classes included consolidated-undrained R test at two percent moisture above optimum. Shear test results show friction angles within less than two degrees of each other and of similar values for cohesion.

Laboratory testing of index and engineering properties of borrow soils are tabulated in the attached "Summary of Laboratory Test Data - Borrow Soil Classes."

Evaluation

The soil foundation of the dike for the ash settlement pond presently under construction is composed of alluvial, lean clay of medium plasticity and low permeability, grading into sand and gravel of undetermined depth.

The scope of this exploration only warranted drilling to shallow depth to compare properties of the original subsoil with those of the already placed and compacted fill. Limited testing indicates adequate and equal strength of both foundation and fill, with the foundation being slightly weaker. Isolated pockets of subsoils of pronounced weakness which were noted had been excavated by construction crews prior to the exploration. This investigation did not reveal any particular unstable foundation conditions.

The area inside the dike and the old campground area will yield well over one million cubic yards of additional fill. Portions of the borrow material, especially from the northeast section of the pond, will require considerable drying before they can be compacted to the required density.

A laboratory approximation of the stability of 1 on 2 embankment inside slope, based on the critical circle through the toe, resulted in $F_S = 1.6$. Below elevation 365, the outside slope of six horizontal to one vertical is considered adequate.

Proposed design values are as follows:

Foundation

Density		Triaxial Q Strength	Triaxial R Strength Saturated
γ_w	123 pcf	4° friction	14° friction
γ_s	126 pcf	0.40 tsf cohesion	0.40 tsf cohesion
Embankment			
γ_w	123 pcf	4° friction	12° friction
γ_s	126 pcf	0.50 tsf cohesion	0.50 tsf cohesion

J. C. McCraw

ROL:ARC
Attachments
CC (Attachments):
R. O. Lane, SMW-K
H. H. Mull, 603 UB-K

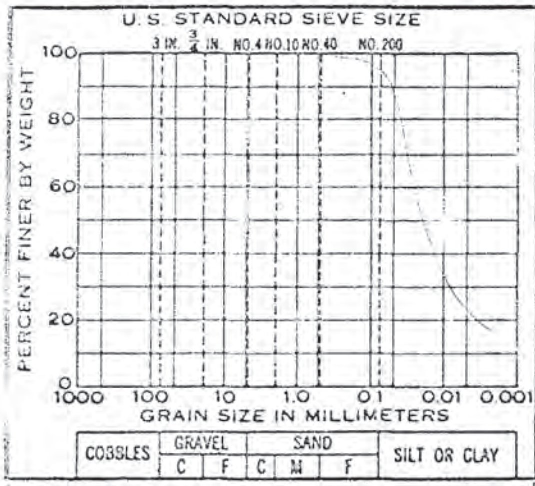
JOHNSONVILLE STEAM PLANT - ASH DIKE FOUNDATION*

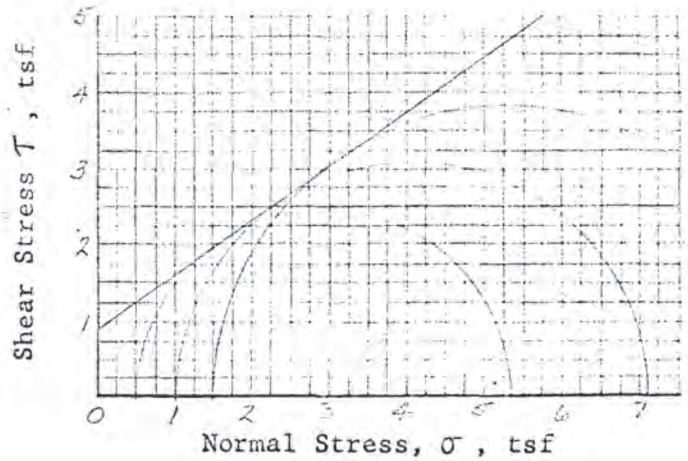
SUMMARY OF LABORATORY TEST DATA

Elevation	Soil Symbol	Natural Moisture %	Grain Size Analysis Gravel %	Sand %	Silt %	Clay %	D_{10} mm	Atterberg Limits Liquid Limit %	Plasticity Index %	Density pcf	Void Ratio	Triaxial Q $\emptyset$ Deg.	C tsf	Triaxial R $\emptyset$ Deg.	C tsf
Boring US-1, Station 75+00 ℄, Surface Elevation 365.0															
362.0-359.7	CL	19.6	9	37	34	20	--	28.8	9.3	108.2	0.535				
357.0-355.0	ML	28.7	0	1	79	20	--	31.0	5.5	93.3	0.805			35.6	0.91
Boring US-2, Station 67+00 ℄, Surface Elevation 366.0															
364.0-361.6	CL	21.3	0	6	50	44	--	43.3	18.2	97.9	0.727			23.3	0.25
358.0-356.3	GM	14.6	45	31	22	9	.006	NP	NP	--	--				
356.3-355.8	CL	21.6	0	12	47	41	--	37.7	17.3	107.1	0.598				
354.0-351.6	CL	24.8	0	8	48	44	--	38.1	17.2	98.1	0.732	3.3	0.90		
Boring US-3, Station 59+50, 8 Ft. Left, Surface Elevation 366.0															
364.0-362.1	CL	19.1	0	8	50	42	--	40.3	16.4	102.1	0.651				
360.0-357.8	CL	24.6	0	15	44	41	--	38.3	15.7	97.4	0.737			16.7	0.35
356.0-355.5	CL	24.4	0	31	35	34	--	30.3	12.5	97.7	0.720	2.7	0.44		
355.5-353.6	CL	21.0	0	21	43	36	--	34.6	17.4	102.7	0.641			9.6	0.74
352.0-351.0	CL	26.5	0	10	45	45	--	42.7	19.1	96.6	0.762	7.5	0.38		
351.0-349.6	CL	25.0	0	6	50	44	--	46.1	22.6	98.8	0.719				
Boring US-4, Station 50+00 ℄, Surface Elevation 366.5															
363.5-362.4	CL	21.7	0	14	44	42	--	38.0	16.0	104.8	0.617				
358.5-356.1	CL	26.3	0	11	49	40	--	39.2	16.3	96.2	0.763	2.7	0.38	15.7	0.40
354.5-352.2	CL	23.8	0	5	52	43	--	40.7	18.7	102.1	0.676				
Boring US-5, Station 39+00 ℄, Surface Elevation 367.5															
364.5-363.1	CL	21.8	0	8	51	41	--	43.4	17.5	97.7	0.739	22.0	0.80	6.7	0.94
359.5-357.1	CL	27.3	0	10	45	45	--	40.5	19.2	94.2	0.802	9.1	0.17		
355.5-354.0	CL	22.1	0	16	42	42	--	39.8	16.5	104.6	0.611				
Boring US-6, Station 30+00 ℄, Surface Elevation 365.5															
362.5-361.0	CL	22.4	0	11	53	36	--	38.8	15.2	98.4	0.726			16.5	0.26
357.5-355.3	CL	22.3	0	16	39	45	--	35.2	16.3	102.7	0.634			15.2	0.58
353.5-352.2	CL	27.0	0	4	52	44	--	45.3	19.7	89.6	0.904				

*Foundation soils below average elevation 356.

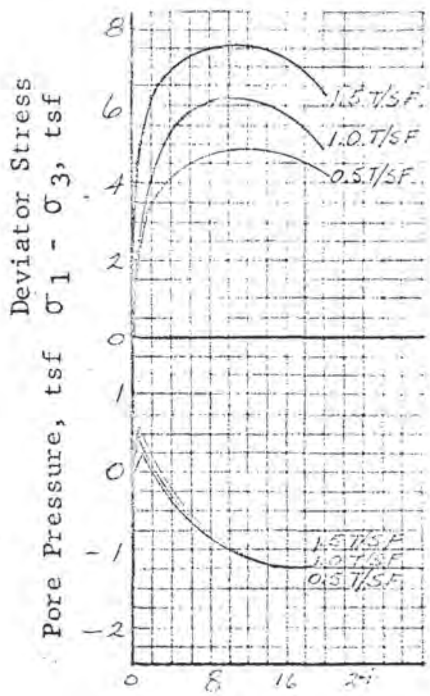
TVA 10016 (CON-1-69)





Type of Specimen UNDISTURBED	
Classification ML	
LL. 31.0	G 2.70
PI. [illegible]	D_{10} —

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	35.6	.72	0.91
Effective	31.0	.60	0.45



Specimen Number		1	2	3	4
Initial	Moisture Content, %	29.1	[illegible]	[illegible]	
	Dry Density, pcf	[illegible]	[illegible]	[illegible]	
	Void Ratio		[illegible]	[illegible]	
	Saturation, %	[illegible]	[illegible]	[illegible]	
Before Shearing	Moisture Content after Saturation, %	29.9	[illegible]	30.4	
	Saturation, %	100	100	100	
	Moisture Content after Consolidation, %	28.1	27.5	26.8	
	Void Ratio after Consolidation	.765	[illegible]	.723	
Final Moisture Content, %		28.1	27.5	[illegible]	
Minor Principal Stress, σ_3, tsf		0.50	1.00	1.50	
Major Principal Stress, σ_1, tsf		[illegible]	[illegible]	[illegible]	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		1.57	2.09	2.77	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		6.41	8.1[illegible]	10.25	
Time to Failure, min.		50	40	50	
Rate of Strain, %/min.		0.2	0.2	[illegible]	
Specimen Height, in.		3.18	3.18	3.18	
Specimen Diameter, in.		1.40	[illegible]	[illegible]	

Remarks:

Project: JOHNSONVILLE S. P.

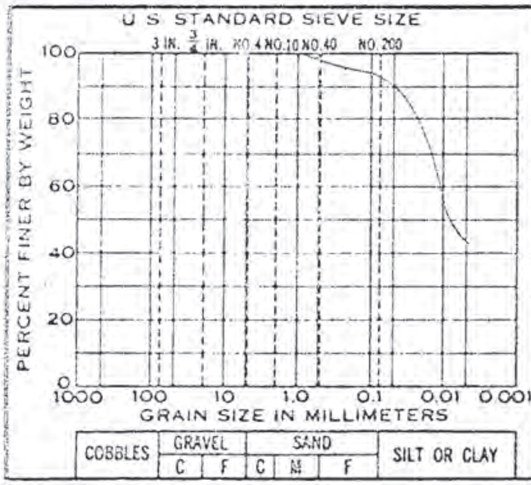
Feature ASH DIKE

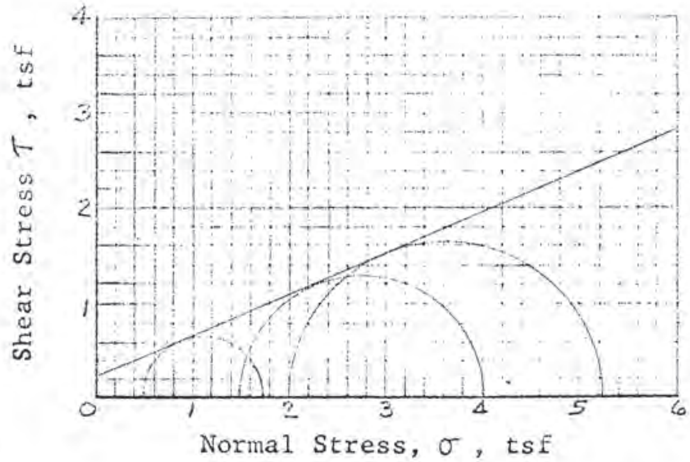
Boring No. [illegible]	Sample No. [illegible]
Station 75+00	Offset ℄
Date 8-21-69	Elev. 357.7-[illegible]

TRIAXIAL COMPRESSION TEST (R)

Soil Form 9

TVA 10016 (CON-1-69)

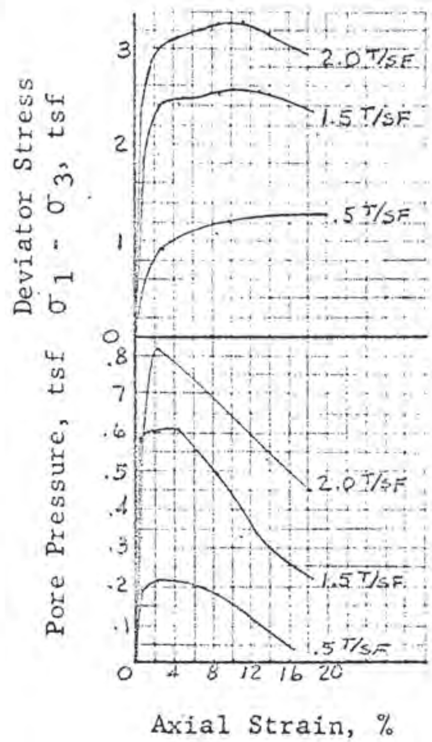




Type of Specimen UNDISTURBED	
Classification CL	
LL. 43.3	G 2.71
PI. 18.2	D_{10} —

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	23.3°	0.43	0.25
Effective	32.0°	0.62	0.05

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	21.0	21.0	22.0	
	Dry Density, pcf	96.5	99.1	98.3	
	Void Ratio	0.753	0.708	0.721	
	Saturation, %	75.5	80.4	82.7	
Before Shearing	Moisture Content after Saturation, %	27.8	26.1	26.6	
	Saturation, %	100.0	100.0	100.0	
	Moisture Content after Consolidation, %	25.9	24.5	25.6	
	Void Ratio after Consolidation	0.720	0.669	0.670	
Final Moisture Content, %		25.9	24.5	25.6	
Minor Principal Stress, σ_3, tsf		0.50	1.50	2.00	
Major Principal Stress, σ_1, tsf		1.76	4.06	5.23	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		0.50	1.16	1.37	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		1.76	3.68	4.60	
Time to Failure, min.		100	60	50	
Rate of Strain, %/min.		0.2	0.2	0.2	
Specimen Height, in.		3.18	3.18	3.18	
Specimen Diameter, in.		1.41	1.41	1.41	

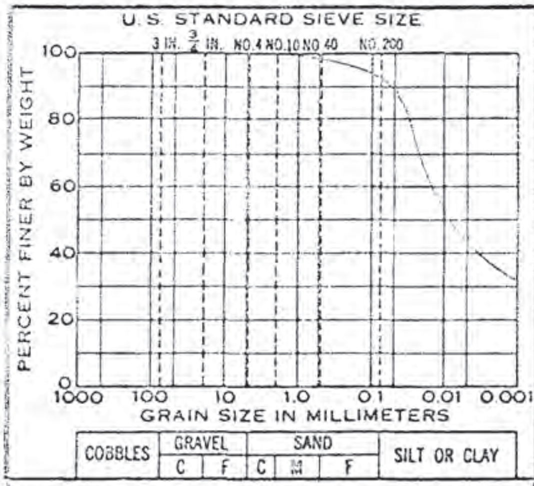


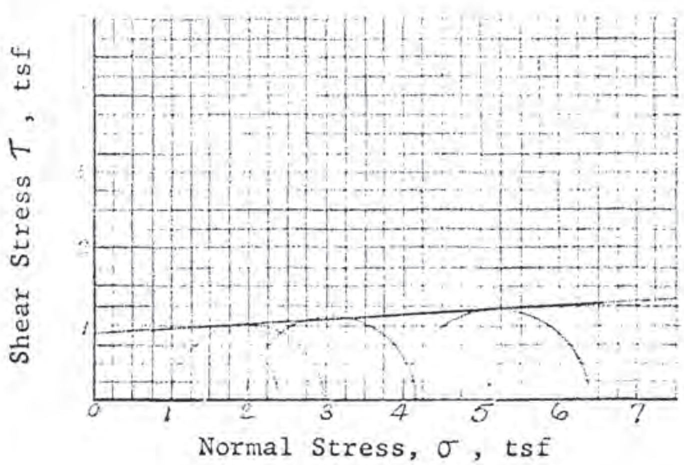
Remarks:

Project: JOHNSONVILLE STEAM PLANT	
Feature ASH DIKE	
Boring No. 2	Sample No. 1
Station 67+00	Offset ℄
Date 9-8-69	Elev. 363.5-363.0

TRIAXIAL COMPRESSION TEST (R)

Soil Form 9

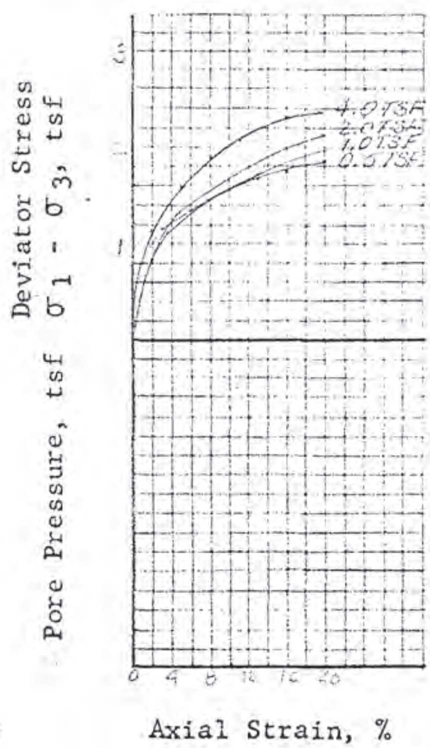




Type of Specimen [illegible]	
Classification [illegible]	
LL. 38.1	G 2.72
PI. 17.2	D_{10} —

Shear Strength	φ Deg.	Tan φ	C, tsf
Apparent	3.3 [illegible]	.0[illegible]	[illegible]
Effective	—	—	—

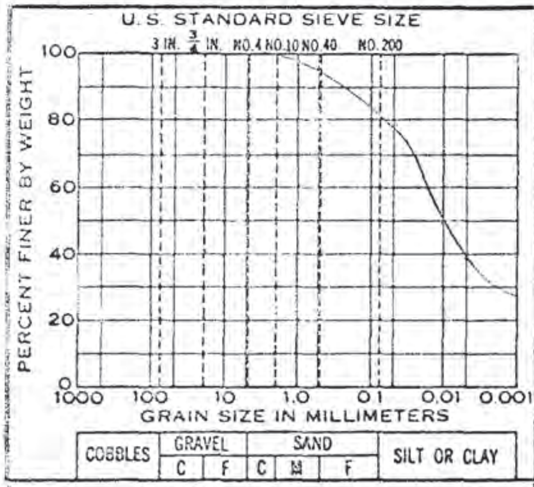
Specimen Number		1	2	3	4
Initial	Moisture Content, %	24.[illegible]	[illegible]	[illegible]	[illegible]
	Dry Density, pcf	99.9	[illegible]	[illegible]	[illegible]
	Void Ratio	0.7[illegible]	[illegible]	[illegible]	[illegible]
	Saturation, %	[illegible]	91.0	[illegible]	[illegible]
Before Shearing	Moisture Content after Saturation, %	—	—	—	—
	Saturation, %	—	—	—	—
	Moisture Content after Consolidation, %	—	—	—	—
	Void Ratio after Consolidation	—	—	—	—
Final Moisture Content, %		[illegible]	[illegible]	24.[illegible]	[illegible]
Minor Principal Stress, σ_3, tsf		[illegible]	[illegible]	2.00	[illegible]
Major Principal Stress, σ_1, tsf		2.24	[illegible]	[illegible]14	[illegible]
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		—	—	—	—
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		—	—	—	—
Time to Failure, min.		[illegible]	[illegible]	[illegible]	[illegible]
Rate of Strain, %/min.		[illegible]	[illegible]	[illegible]	[illegible]
Specimen Height, in.		[illegible]	[illegible].142	3.142	[illegible]
Specimen Diameter, in.		[illegible]	1.398	1.398	[illegible]

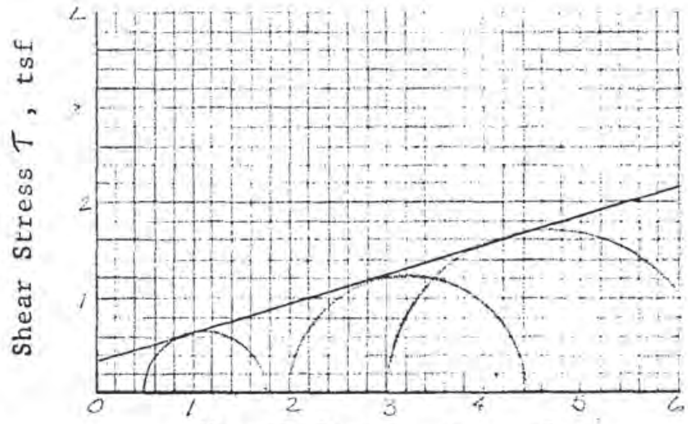


Remarks:

Project: JOHNSONVILLE S.P.	
Feature ASH DIKE	
Boring No. US-2	Sample No. [illegible]
Station [illegible]	Offset [illegible]
Date 8/7/69	Elev. [illegible]

TRIAXIAL COMPRESSION TEST (Q)

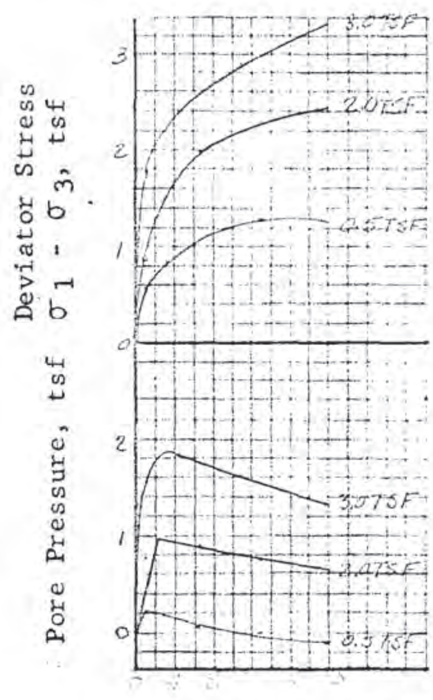




Type of Specimen UNDISTURBED	
Classification CL	
LL. [illegible]	G [illegible]
PI. [illegible]	D_{10} —

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	16.7°	0.30	0.35
Effective	23.5°	[illegible]	0.00

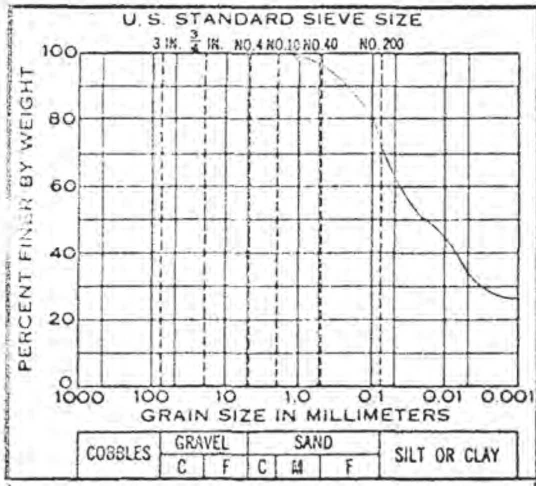
Specimen Number		1	2	3	4
Initial	Moisture Content, %	[illegible]	23.9	24.7	
	Dry Density, pcf	96.2	93.5	91.4	
	Void Ratio	[illegible]	[illegible]	[illegible]	
	Saturation, %	99.3	[illegible]	[illegible]	
Before Shearing	Moisture Content after Saturation, %	27.9	[illegible]	27.2	
	Saturation, %	[illegible]	[illegible]	100.7	
	Moisture Content after Consolidation, %	[illegible]	[illegible]	23.1	
	Void Ratio after Consolidation	[illegible]	[illegible]	[illegible]	
Final Moisture Content, %		[illegible]		23.1	
Minor Principal Stress, σ_3, tsf		1.50	[illegible]	3.00	
Major Principal Stress, σ_1, tsf		[illegible]	[illegible]	[illegible]	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		[illegible]	[illegible]	1.29	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		[illegible]	[illegible]	5.06	
Time to Failure, min.		[illegible]	[illegible]	[illegible]	
Rate of Strain, %/min.		.02		[illegible]	
Specimen Height, in.		3.14	[illegible]	3.12	
Specimen Diameter, in.		1.41	[illegible]	1.40	

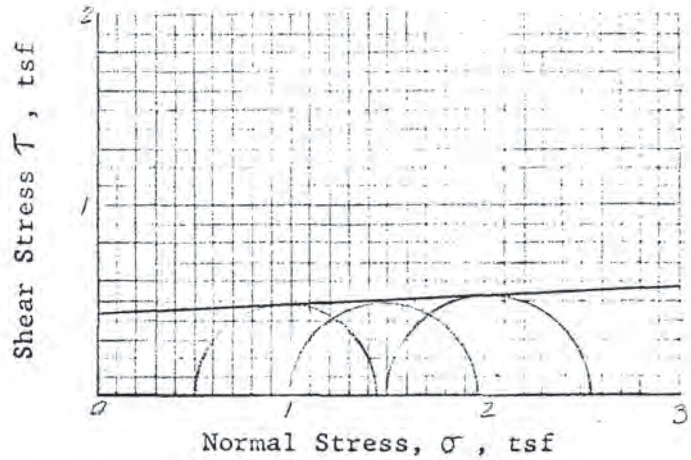


Remarks:

Project: JOHNS[illegible]	
Feature ASH DIKE	
Boring No. [illegible]	Sample No. [illegible]
Station [illegible]	Offset [illegible]
Date [illegible]	Elev. [illegible]

TRIAXIAL COMPRESSION TEST (R)

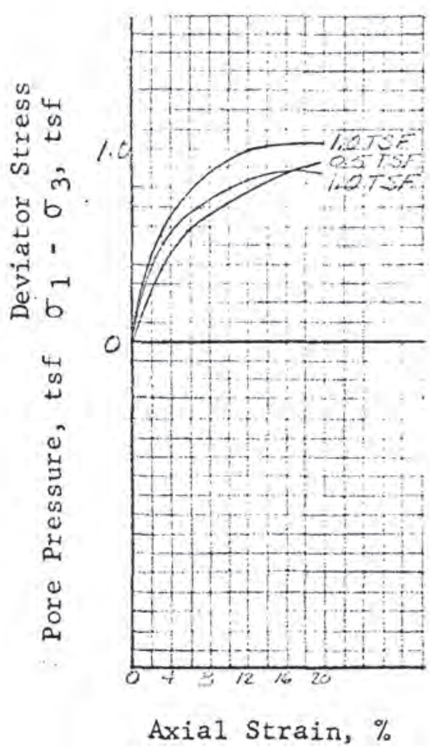




Type of Specimen UNDISTURBED	
Classification CL	
LL. 30.3	G 2.69
PI. [illegible]	D_{10} —

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	2.7°	.046	0.44
Effective			

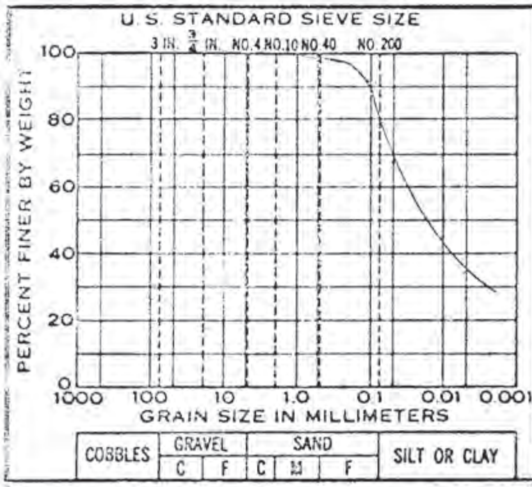
	Specimen Number	1	2	3	4
Initial	Moisture Content, %	23.9	[illegible]	28.4	
	Dry Density, pcf	97.9	96.3	[illegible]	
	Void Ratio	0.715	0.744	[illegible]	
	Saturation, %	89.9	92.0	[illegible]	
Before Shearing	Moisture Content after Saturation, %	—	—	—	
	Saturation, %	—	—	—	
	Moisture Content after Consolidation, %	—	—	—	
	Void Ratio after Consolidation	—	—	—	
	Final Moisture Content, %	23.4	25.0	[illegible]	
	Minor Principal Stress, σ_3, tsf	0.50	1.00	[illegible]	
	Major Principal Stress, σ_1, tsf	1.43	1.94	[illegible]	
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	—	—	—	
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	—	—	—	
	Time to Failure, min.	19	14	14	
	Rate of Strain, %/min.	1.0	[illegible]	1.0	
	Specimen Height, in.	3.142	[illegible]	3.142	
	Specimen Diameter, in.	1.393	[illegible]	1.396	

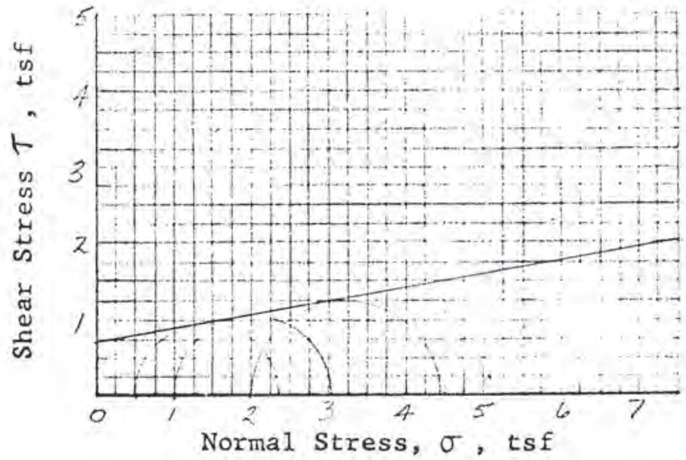


Remarks:

Project: JOHNSONVILLE S.P.	
Feature ASH DIKE	
Boring No. US-3	Sample No. 3
Station [illegible]	Offset [illegible]
Date 2/7/69	Elev. 356.0 – [illegible]

TRIAXIAL COMPRESSION TEST (Q)

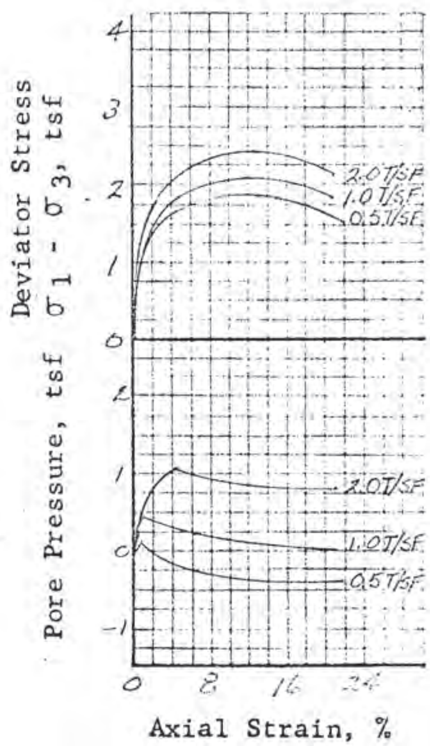




Type of Specimen *UNDISTURBED*	
Classification *CL*	
LL. *34.6*	G *2.70*
PI. *17.4*	D10 —

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	9.6	.17	0.74
Effective	28.4	.54	0.14

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	21.1	20.5	21.5	
	Dry Density, pcf	103.2	103.4	[illegible]	
	Void Ratio	.633	[illegible]	[illegible]	
	Saturation, %	[illegible]	[illegible]	[illegible]	
Before Shearing	Moisture Content after Saturation, %	22.5	23.4	24.4	
	Saturation, %	100	100	100	
	Moisture Content after Consolidation, %	22.5	22.6	22.8	
	Void Ratio after Consolidation	.594	.575	.55?	
Final Moisture Content, %		[illegible]	22.6	22.8	
Minor Principal Stress, σ_3, tsf		0.50	1.00	2.00	
Major Principal Stress, σ_1, tsf		2.34	3.03	4.44	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		0.79	0.59	1.11	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		2.63	2.92	3.55	
Time to Failure, min.		60	50	60	
Rate of Strain, %/min.		0.2	0.2	0.2	
Specimen Height, in.		3.18	3.18	3.18	
Specimen Diameter, in.		1.40	1.40	1.40	

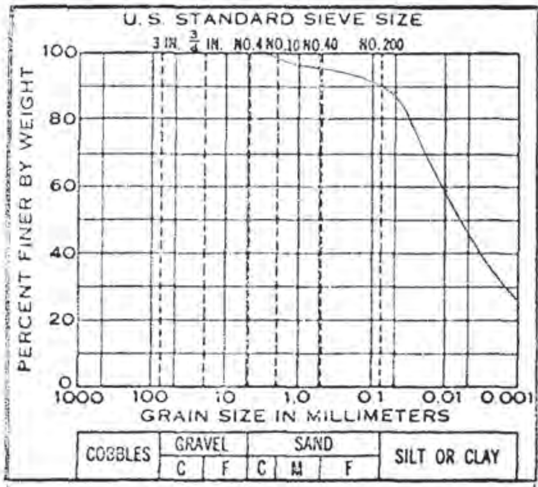


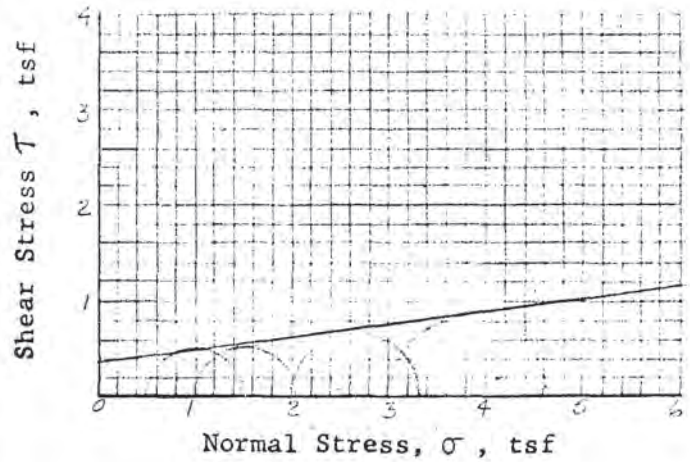
Remarks:

Project:	*JOHNSONVILLE S.P.*		
Feature	*ASH DIKE*		
Boring No.	*US-3*	Sample No.	*3*
Station	*59+50*	Offset	*8' LT*
Date	*8-19-69*	Elev.	*354.5-354.0*

TRIAXIAL COMPRESSION TEST *(R)*

TVA 10016 (CON-1-69)

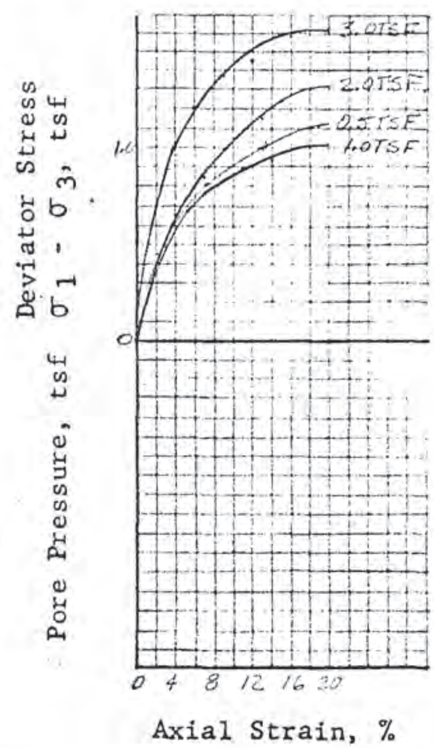




Type of Specimen UNDISTURBED	
Classification CL	
LL. [illegible]	G 2.72
PI. 19.1	D_{10} —

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	1.5°	0.13	0.38
Effective	—	—	—

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	26.2	27.5	27.4	24.7
	Dry Density, pcf	97.2	95.[illegible]	95.9	98.0
	Void Ratio	0.754	[illegible]	0.77[illegible]	0.733
	Saturation, %	94.8	95.3	96.2	91.8
Before Shearing	Moisture Content after Saturation, %	—	—	—	—
	Saturation, %	—	—	—	—
	Moisture Content after Consolidation, %	—	—	—	—
	Void Ratio after Consolidation	—	—	—	—
Final Moisture Content, %		26.4	27.4	27.5	24.9
Minor Principal Stress, σ_3, tsf		0.50	1.00	2.00	3.00
Major Principal Stress, σ_1, tsf		1.49	2.05	[illegible]	[illegible]
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		—	—	—	—
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		—	—	—	—
Time to Failure, min.		12	20	19	[illegible]
Rate of Strain, %/min.		1.0	1.0	[illegible]	[illegible]
Specimen Height, in.		[illegible]	[illegible]	[illegible]	[illegible]
Specimen Diameter, in.		[illegible]	1.40	[illegible]	1.40



Remarks:

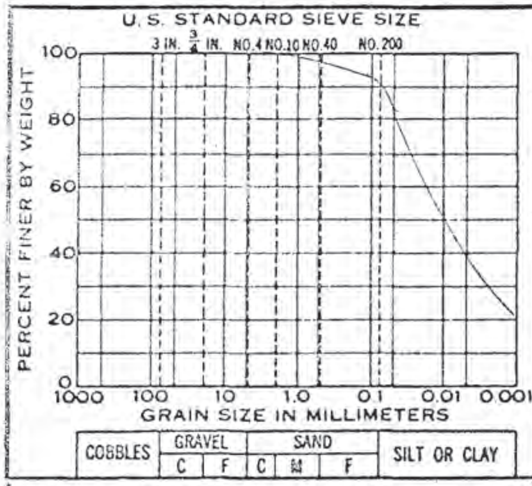
Project: JOHNSONVILLE [illegible]

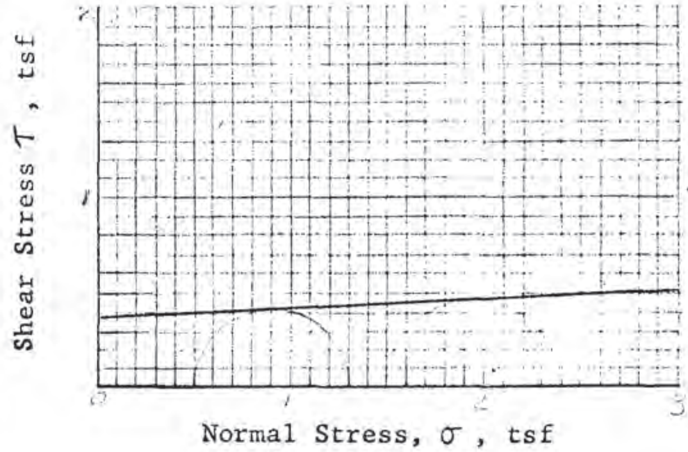
Feature [illegible]

Boring No. US-3	Sample No. 4
Station 59+50	Offset [illegible]
Date 9/3/69	Elev. 352.0-351.[illegible]

TRIAXIAL COMPRESSION TEST (C)

Soil Form 9

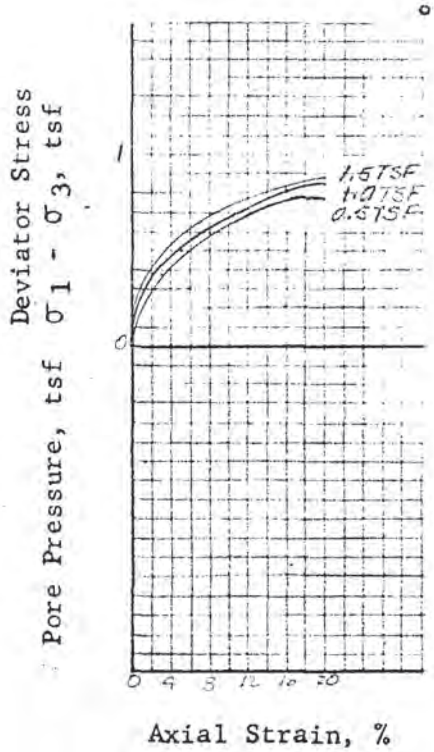




Type of Specimen	UNDISTURBED
Classification	CL
LL. [illegible]	G 2.71
PI.	D10 —

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	27°	0.05	0.38
Effective	—	—	—

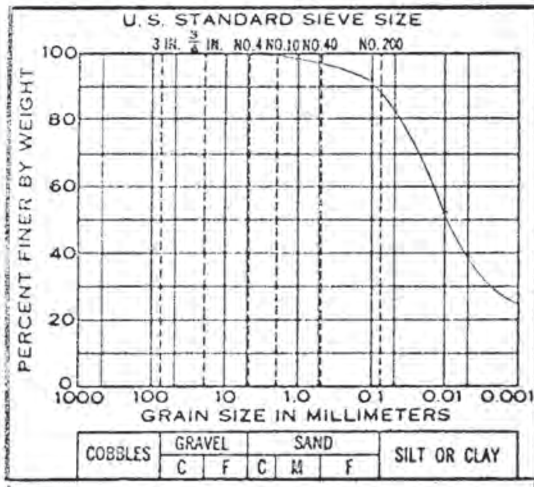
	Specimen Number	1	2	3	4
Initial	Moisture Content, %	30.1	29.2	28.8	
	Dry Density, pcf	90.9	92.4	93.2	
	Void Ratio	[illegible]	0.83	0.81	
	Saturation, %	[illegible]	95.1	[illegible]	
Before Shearing	Moisture Content after Saturation, %	—	—	—	
	Saturation, %	—	—	—	
	Moisture Content after Consolidation, %	—	—	—	
	Void Ratio after Consolidation	—	—	—	
	Final Moisture Content, %	29.0	29.0	[illegible]	
	Minor Principal Stress, σ_3, tsf	0.50	1.00	1.50	
	Major Principal Stress, σ_1, tsf	1.30	1.[illegible]	[illegible]	
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	—	—	—	
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	—	—	—	
	Time to Failure, min.	17	17	[illegible]	
	Rate of Strain, %/min.	1.0	1.0	1.0	
	Specimen Height, in.	3.142	[illegible]	2.[illegible]	
	Specimen Diameter, in.	1.40	1.40	1.40	

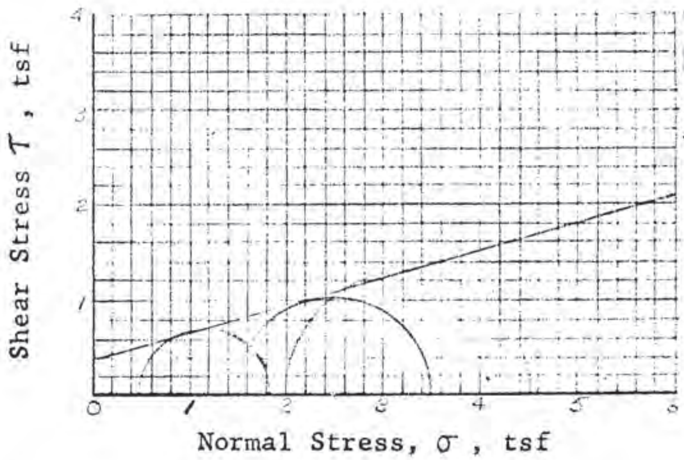


Remarks:

Project: JOHNSONVILLE S P	
Feature ASH DIKE	
Boring No. US-4	Sample No. [illegible]
Station [illegible]	Offset [illegible]
Date [illegible]	Elev. [illegible]

TRIAXIAL COMPRESSION TEST (Q)

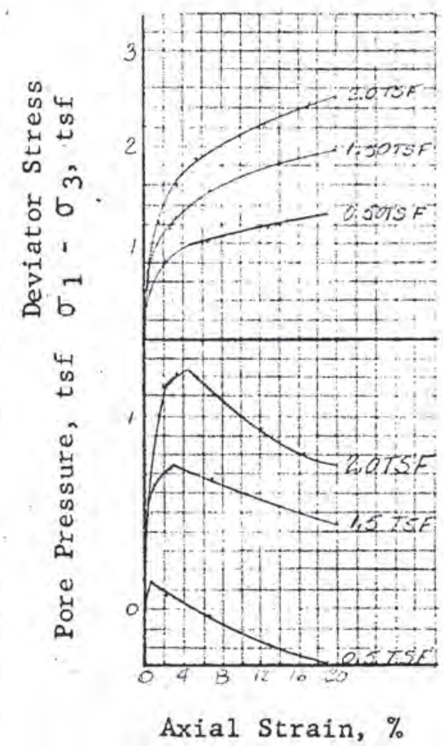




Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	15.7°	0.28	0.4[illegible]
Effective	29.7°	0.57	0.0

Type of Specimen UNDISTURBED	
Classification CL	
LL. 39.2	G 2.71
PI. [illegible]	D_{10} —

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	23.8	23.6	22.1	
	Dry Density, pcf	98.2	99.9	102.[illegible]	
	Void Ratio	0.7[illegible]	0.694	0.6[illegible]	
	Saturation, %	8[illegible]	92.0	91.8	
Before Shearing	Moisture Content after Saturation, %	26.7	25.6	24.1	
	Saturation, %	100.0	100.[illegible]	100.0	
	Moisture Content after Consolidation, %	23.8	23.1	22.1	
	Void Ratio after Consolidation	0.7[illegible]	[illegible]	0.575	
Final Moisture Content, %		[illegible]	23.1	22.1	
Minor Principal Stress, σ_3, tsf		0.[illegible]	1.50	2.[illegible]	
Major Principal Stress, σ_1, tsf		1.[illegible]	3.49	[illegible]	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		[illegible]	1.27	1.[illegible]	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		[illegible]	[illegible]	[illegible]	
Time to Failure, min.		90	100	[illegible]	
Rate of Strain, %/min.		0.2	[illegible]	[illegible]	
Specimen Height, in.		[illegible]	[illegible]	[illegible]	
Specimen Diameter, in.		1.40	[illegible]	1.40	

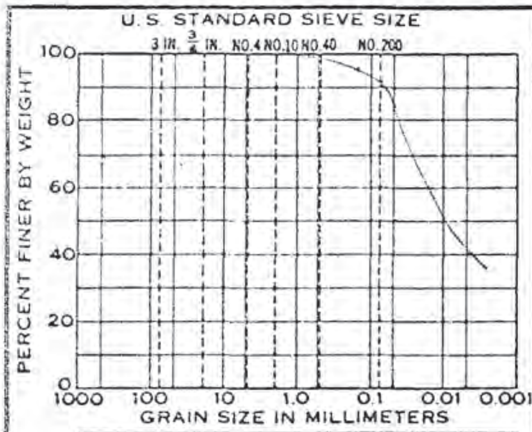


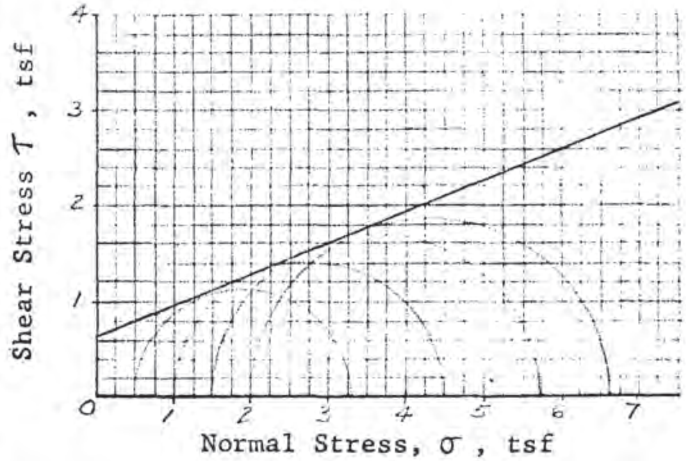
Remarks:

Project: JOHNSONVIL[illegible]	
Feature ASH DI[illegible]	
Boring No. US-4	Sample No. 2
Station 5[illegible]+0[illegible]	Offset [illegible]
Date 8/14/69	Elev. 3[illegible]

TRIAXIAL COMPRESSION TEST (R)

Soil Form 9

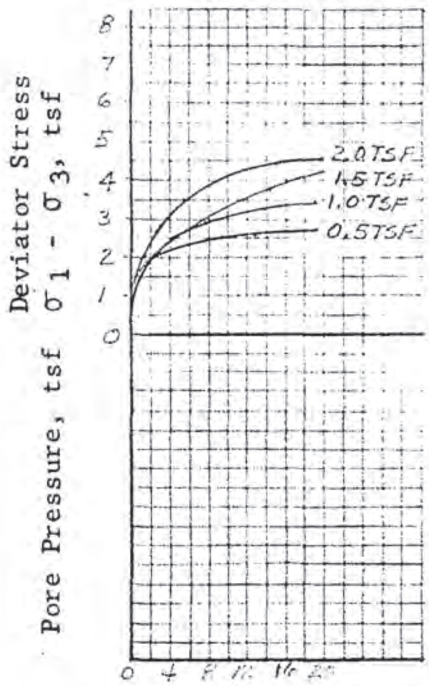




Type of Specimen UNDISTURBED	
Classification CL	
LL. 43.4	G 2.72
PI. 17.5	D_{10} —

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	22.0	.40	0.80
Effective	—	—	—

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	22.4	21.8	22.2	21.4
	Dry Density, pcf	95.5	95.8	95.5	96.5
	Void Ratio	.773	.772	.778	.759
	Saturation, %	73.7	75.8	77.6	76.6
Before Shearing	Moisture Content after Saturation, %	—	—	—	—
	Saturation, %	—	—	—	—
	Moisture Content after Consolidation, %	—	—	—	—
	Void Ratio after Consolidation	—	—	—	—
	Final Moisture Content, %	22.2	21.6	22.2	21.3
	Minor Principal Stress, σ_3, tsf	0.50	1.00	1.50	2.00
	Major Principal Stress, σ_1, tsf	3.28	4.48	5.74	6.60
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	—	—	—	—
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	—	—	—	—
	Time to Failure, min.	19	19	21	20
	Rate of Strain, %/min.	1.0	1.0	1.0	1.0
	Specimen Height, in.	3.14	3.14	3.14	3.14
	Specimen Diameter, in.	1.40	1.40	1.40	1.40



Axial Strain, %

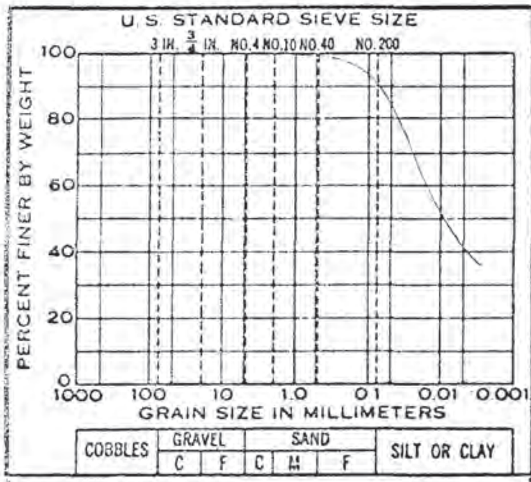
Remarks:

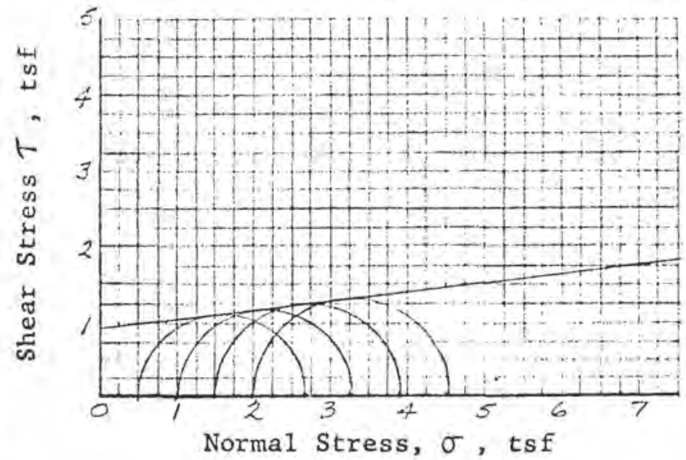
Project: JOHNSONVILLE S.P.	
Feature ASH DIKE	
Boring No. US-5	Sample No. 1
Station 39+60	Offset ℄
Date AUG. 20, 1969	Elev. 364.0-363.5

TRIAXIAL COMPRESSION TEST (Q)

Soil Form 9

TVA 10016 (CON-1-69)

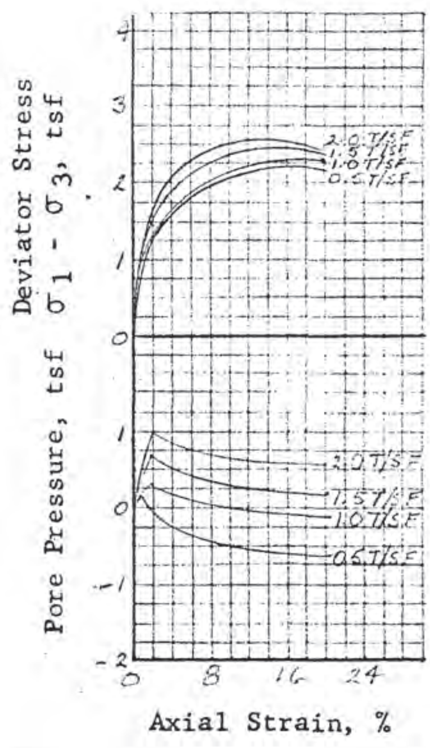




Type of Specimen UNDISTURBED	
Classification CL	
LL. 43.4	G 2.72
PI. 17.5	D10 —

Shear Strength	φ Deg.	Tan φ	C, tsf
Apparent	6.7	.12	0.94
Effective	20.3	.37	0.38

Specimen Number		1	2	3	4
Initial	Moisture Content, %	22.2	21.6	22.3	20.8
	Dry Density, pcf	98.7	99.3	99.3	101.0
	Void Ratio	.721	.710	.710	.682
	Saturation, %	83.6	82.9	85.2	83.1
Before Shearing	Moisture Content after Saturation, %	26.5	26.1	26.1	25.1
	Saturation, %	100	100	100	100
	Moisture Content after Consolidation, %	26.3	24.7	25.3	24.0
	Void Ratio after Consolidation	.706	[illegible]	.691	.643
Final Moisture Content, %		26.3	24.7	25.3	24.0
Minor Principal Stress, σ_3, tsf		0.50	1.00	1.50	2.00
Major Principal Stress, σ_1, tsf		2.69	3.27	3.91	4.52
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		1.04	1.13	1.20	1.28
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		3.23	3.40	3.61	3.80
Time to Failure, min.		80	100	70	60
Rate of Strain, %/min.		0.2	0.2	0.2	0.2
Specimen Height, in.		3.18	3.18	3.18	3.18
Specimen Diameter, in.		1.40	1.40	1.40	1.40

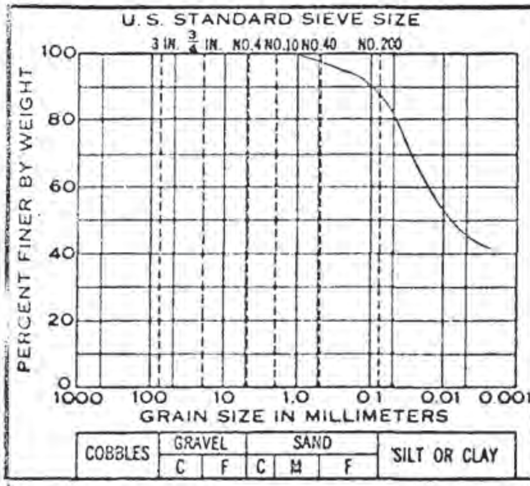


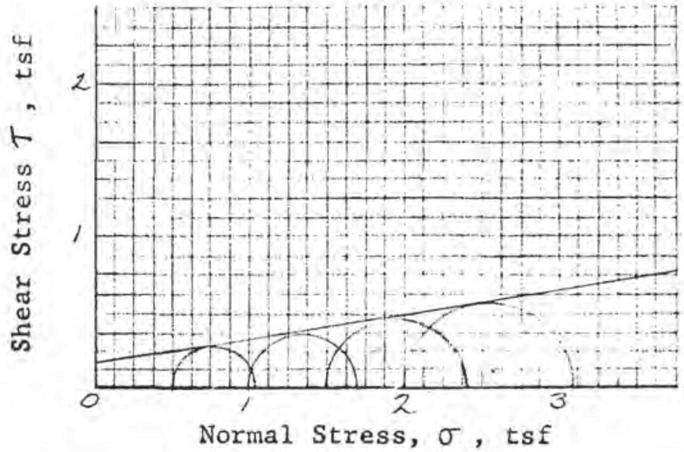
Remarks:

Project: JOHNSONVILLE S. P.	
Feature ASH DIKE	
Boring No. US-5	Sample No. 1
Station 39+00	Offset ℄
Date 8-21-69	Elev. 363.5-363.1

TRIAXIAL COMPRESSION TEST (R)

Soil Form 9

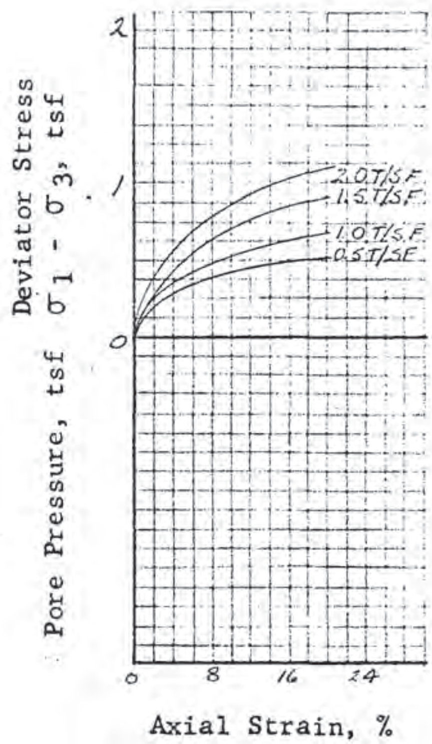




Type of Specimen	UNDISTURBED
Classification	CL
LL. 40.5	G 2.72
PI. 19.2	D_{10} —

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	9.1	.16	0.17
Effective	—	—	—

Specimen Number		1	2	3	4
Initial	Moisture Content, %	28.2	27.3	27.6	26.1
	Dry Density, pcf	94.1	95.1	93.3	94.4
	Void Ratio	.805	.784	[illegible]	.799
	Saturation, %	95.4	94.7	91.7	88.9
Before Shearing	Moisture Content after Saturation, %	—	—	—	—
	Saturation, %	—	—	—	—
	Moisture Content after Consolidation, %	—	—	—	—
	Void Ratio after Consolidation	—	—	—	—
Final Moisture Content, %		27.6	26.9	26.9	25.6
Minor Principal Stress, σ_3, tsf		0.50	1.00	1.50	2.00
Major Principal Stress, σ_1, tsf		1.03	1.70	2.41	3.09
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		—	—	—	—
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		—	—	—	—
Time to Failure, min.		20	20	20	20
Rate of Strain, %/min.		1.0	1.0	1.0	1.0
Specimen Height, in.		3.14	3.14	3.14	3.14
Specimen Diameter, in.		1.40	1.40	1.40	1.40

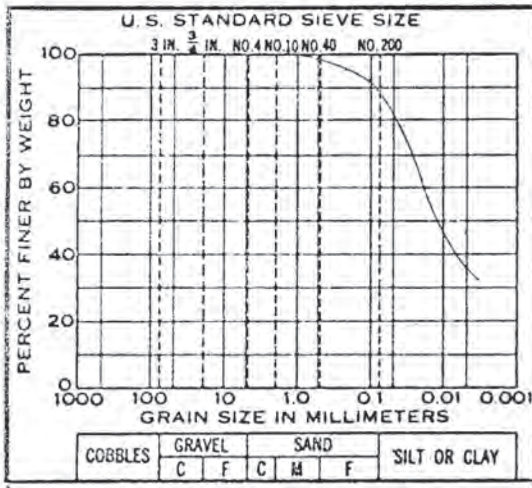


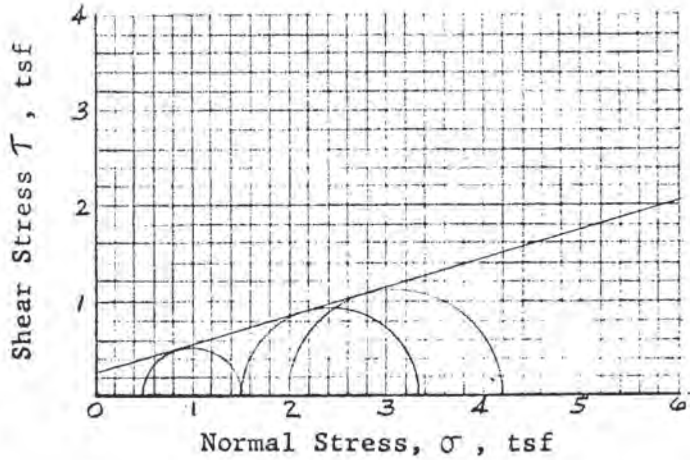
Remarks:

Project: JOHNSONVILLE S.P.	
Feature ASH DIKE	
Boring No. US-5	Sample No. 2
Station 39+00	Offset 4
Date 8-18-69	Elev. [illegible]

TRIAXIAL COMPRESSION TEST (Q)

TVA 10016 (CON-1-69)

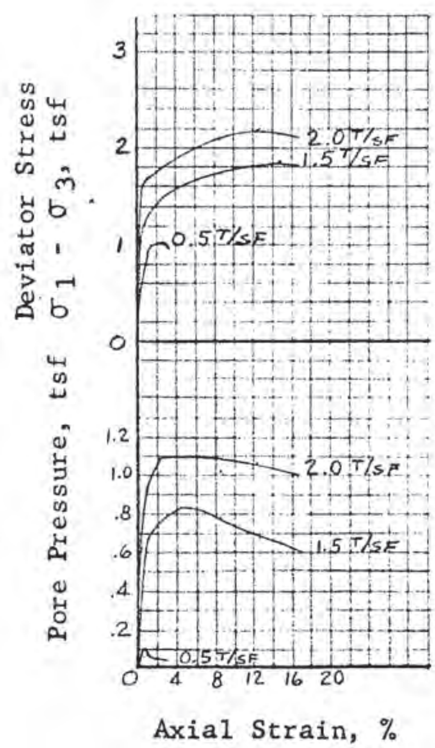




Type of Specimen UNDISTURBED	
Classification CL	
LL. 38.8	G 2.72
PI. 15.2	D_{10} —

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	16.5	0.30	0.26
Effective	29.8	0.58	0.04

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	22.7	22.2	22.3	
Initial	Dry Density, pcf	98.1	98.9	98.2	
Initial	Void Ratio	0.732	0.718	0.729	
Initial	Saturation, %	84.5	84.0	83.1	
Before Shearing	Moisture Content after Saturation, %	26.9	26.4	26.8	
Before Shearing	Saturation, %	100.0	100.0	100.0	
Before Shearing	Moisture Content after Consolidation, %	26.0	24.2	24.2	
Before Shearing	Void Ratio after Consolidation	0.697	0.665	0.653	
	Final Moisture Content, %	26.0	24.2	24.2	
	Minor Principal Stress, σ_3, tsf	0.50	1.50	2.00	
	Major Principal Stress, σ_1, tsf	1.50	3.33	4.19	
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	0.46	0.85	0.93	
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	1.46	2.68	3.26	
	Time to Failure, min.	10	70	60	
	Rate of Strain, %/min.	0.2	0.2	0.2	
	Specimen Height, in.	3.18	3.18	3.18	
	Specimen Diameter, in.	1.41	1.41	1.41	



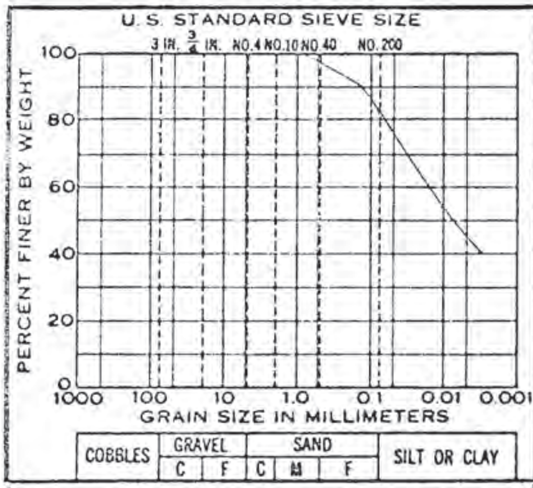
Remarks:

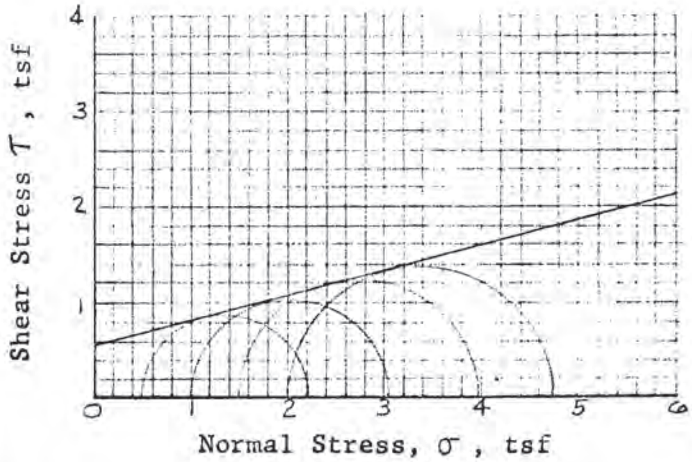
Project: JOHNSONVILLE SP	
Feature ASH DIKE	
Boring No. 6	Sample No. 1
Station 30+00	Offset ℄
Date 9-3-69	Elev. 362.0-361.5

TRIAXIAL COMPRESSION TEST (R)

Soil Form 9

TVA 10016 (CON-1-69)

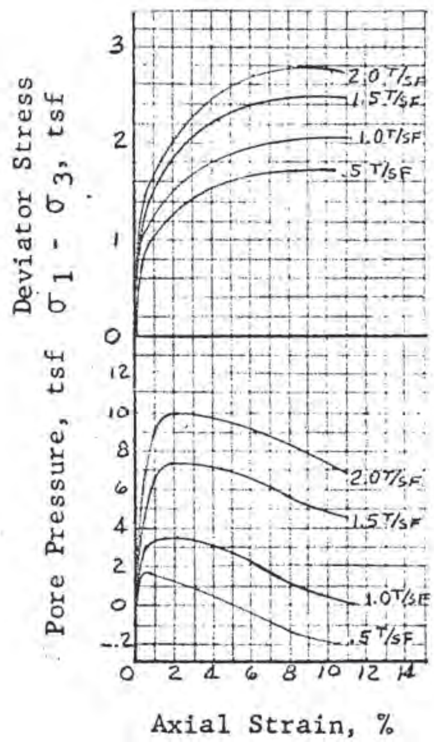




Type of Specimen UNDISTURBED	
Classification CL	
LL. 35.2	G 2.68
PI. 16.3	D_{10} —

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	15.2	0.27	0.58
Effective	28.0	0.53	0.18

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	22.7	22.3	22.4	22.1
Initial	Dry Density, pcf	101.8	102.7	103.5	102.8
Initial	Void Ratio	0.664	0.628	0.617	0.628
Initial	Saturation, %	94.4	95.2	97.2	94.3
Before Shearing	Moisture Content after Saturation, %	24.0	23.4	23.0	23.4
Before Shearing	Saturation, %	100.0	100.0	100.0	100.0
Before Shearing	Moisture Content after Consolidation, %	23.5	23.3	23.3	22.4
Before Shearing	Void Ratio after Consolidation	0.618	0.602	0.555	0.577
	Final Moisture Content, %	23.5	23.3	23.3	22.4
	Minor Principal Stress, σ_3, tsf	0.50	1.00	1.50	2.00
	Major Principal Stress, σ_1, tsf	2.21	3.04	3.98	4.75
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	0.64	1.00	0.97	1.29
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	2.35	3.03	3.45	4.04
	Time to Failure, min.	40	50	40	
	Rate of Strain, %/min.	0.2	0.2	0.2	0.2
	Specimen Height, in.	3.18	3.18	3.18	3.18
	Specimen Diameter, in.	1.41	1.41	1.41	1.41



Remarks:

Project: JOHNSONVILLE S P	
Feature ASH DIKE	
Boring No. 6	Sample No. 2
Station 30+00	Offset ¢
Date 8-27-69	Elev. 355.[illegible]-355.3

TRIAXIAL COMPRESSION TEST (R)

Soil Form 9

JOHNSONVILLE STEAM PLANT

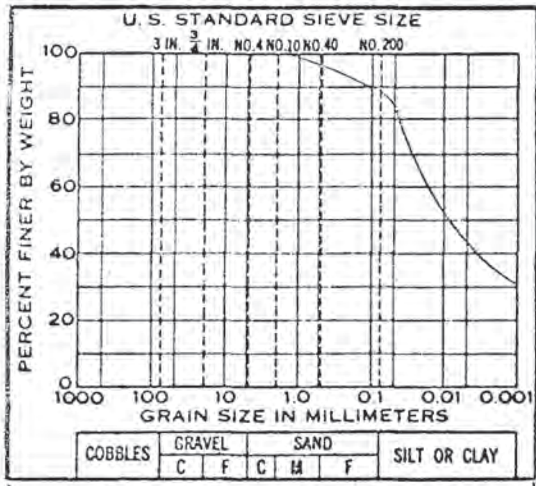
ASH POND DIKE

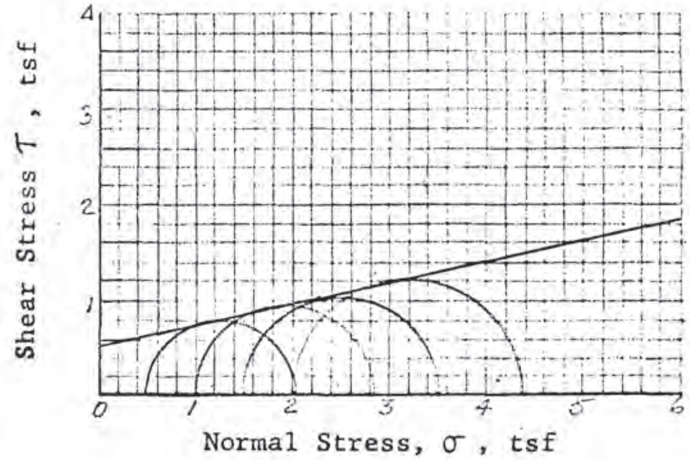
SUMMARY OF LABORATORY TEST DATA

BORROW SOIL CLASSES

Class	I	II
Symbol	CL	CL
Mechanical and hydrometer analysis		
Gravel, percent	0	0
Sand, percent	13	13
Silt, percent	43	35
Clay, percent	44	52
Atterberg Limits		
Liquid limit, percent	40.9	42.9
Plastic limit, percent	21.1	22.1
Plasticity index, percent	19.8	20.8
Shrinkage limit, percent	16.7	16.4
Standard Proctor Compaction		
Optimum Moisture, percent	19.8	20.8
Maximum Density, pcf	104.5	102.4
Penetration Resistance, psi	360	475
Shear strength at 2 percent above optimum		
Triaxial R: Ø, degrees	12.5	10.8
C, tsf	0.53	0.50

TVA 10016 (CON-1-69)

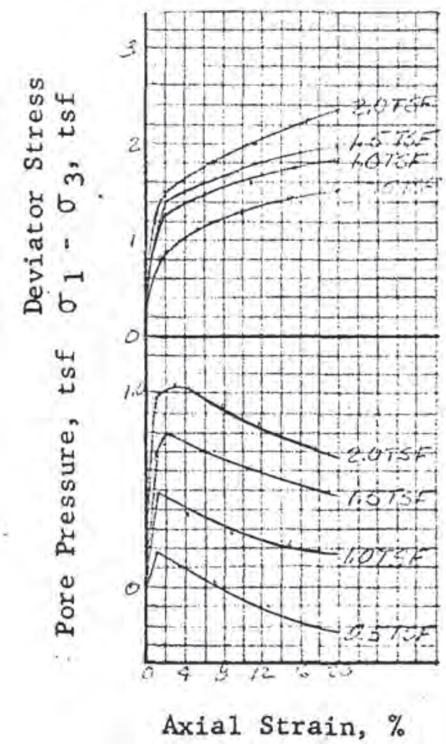




Type of Specimen *REMOLDED*	
Classification *CL*	
LL. *40.9*	G *2.73*
PI. *19.8*	D_{10} —

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	*12.5°*	*0.22*	*0.53*
Effective	*23.8°*	*0.41*	*0.25*

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	*22.0*	*22.3*	*21.7*	*21.7*
	Dry Density, pcf	*102.4*	*102.3*	*103.[illegible]*	*102.9*
	Void Ratio	*0.664*	[illegible]	[illegible]	[illegible]
	Saturation, %	*91.5*	*91.3*	*90.3*	*90.2*
Before Shearing	Moisture Content after Saturation, %	[illegible]	[illegible]	*24.0*	[illegible]
	Saturation, %	*100.0*	*100.0*	*100.0*	*100.0*
	Moisture Content after Consolidation, %	*22.9*	[illegible]	[illegible]	[illegible]
	Void Ratio after Consolidation	[illegible]	[illegible]	[illegible]	[illegible]
Final Moisture Content, %		[illegible]	[illegible]	[illegible]	[illegible]
Minor Principal Stress, σ_3, tsf		[illegible]	[illegible]	[illegible]	[illegible]
Major Principal Stress, σ_1, tsf		*2.01*	*2.81*	*3.50*	*4.28*
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		*0.72*	*0.82*	*1.02*	*1.40*
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		*2.23*	[illegible]	*3.02*	[illegible]
Time to Failure, min.		*80*	*100*	*100*	*100*
Rate of Strain, %/min.		[illegible]	[illegible]	[illegible]	[illegible]
Specimen Height, in.		[illegible]	[illegible]	[illegible]	[illegible]
Specimen Diameter, in.		[illegible]	[illegible]	[illegible]	[illegible]



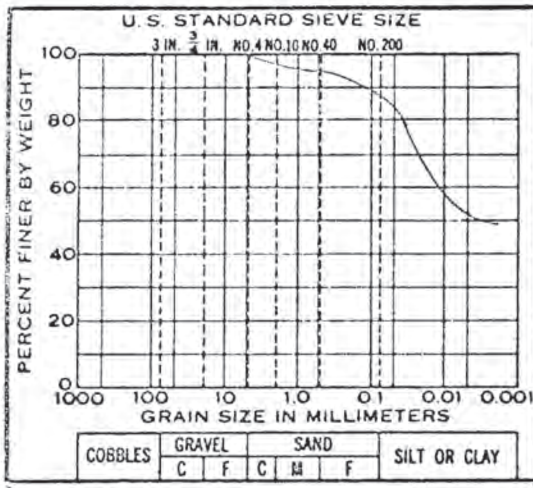
Remarks: *REMOLDED AT 2% ABOVE OPTIMUM MOISTURE CONTENT STANDARD PROCTOR [illegible]*

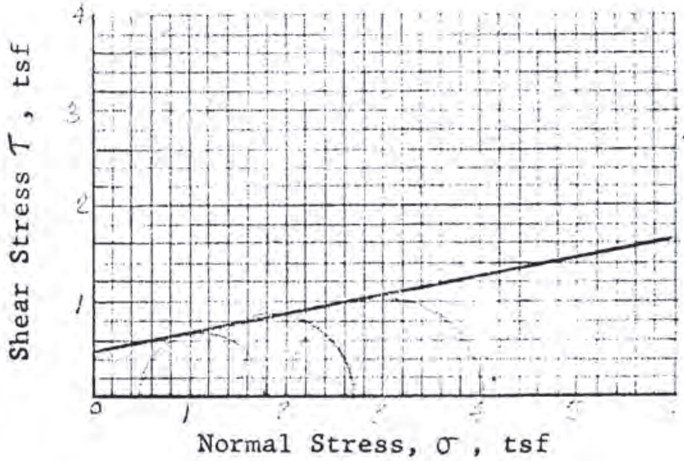
Project: *JOHNSONVILLE SP BORROW AREA*	
Feature *ASH DIKE*	
Boring No.	Sample No. *[illegible]*
Station	Offset
Date *9/3/[illegible]*	Elev.

TRIAXIAL COMPRESSION TEST (R)

Soil Form 9

TVA 10016 (CON-1-69)

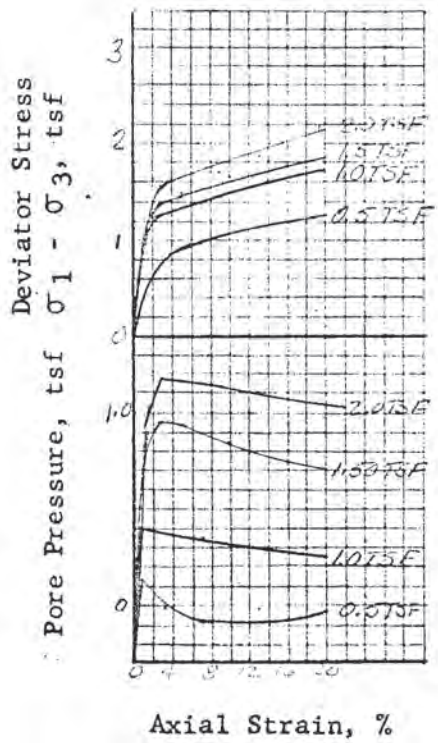




Type of Specimen REMOLDED	
Classification CL	
LL. [illegible]	G 2.75
PI. [illegible]	D_{10} —

Shear Strength	ϕ Deg.	Tan ϕ	C, tsf
Apparent	10.8°	0.19	0.50
Effective	29.3	0.49	0.18

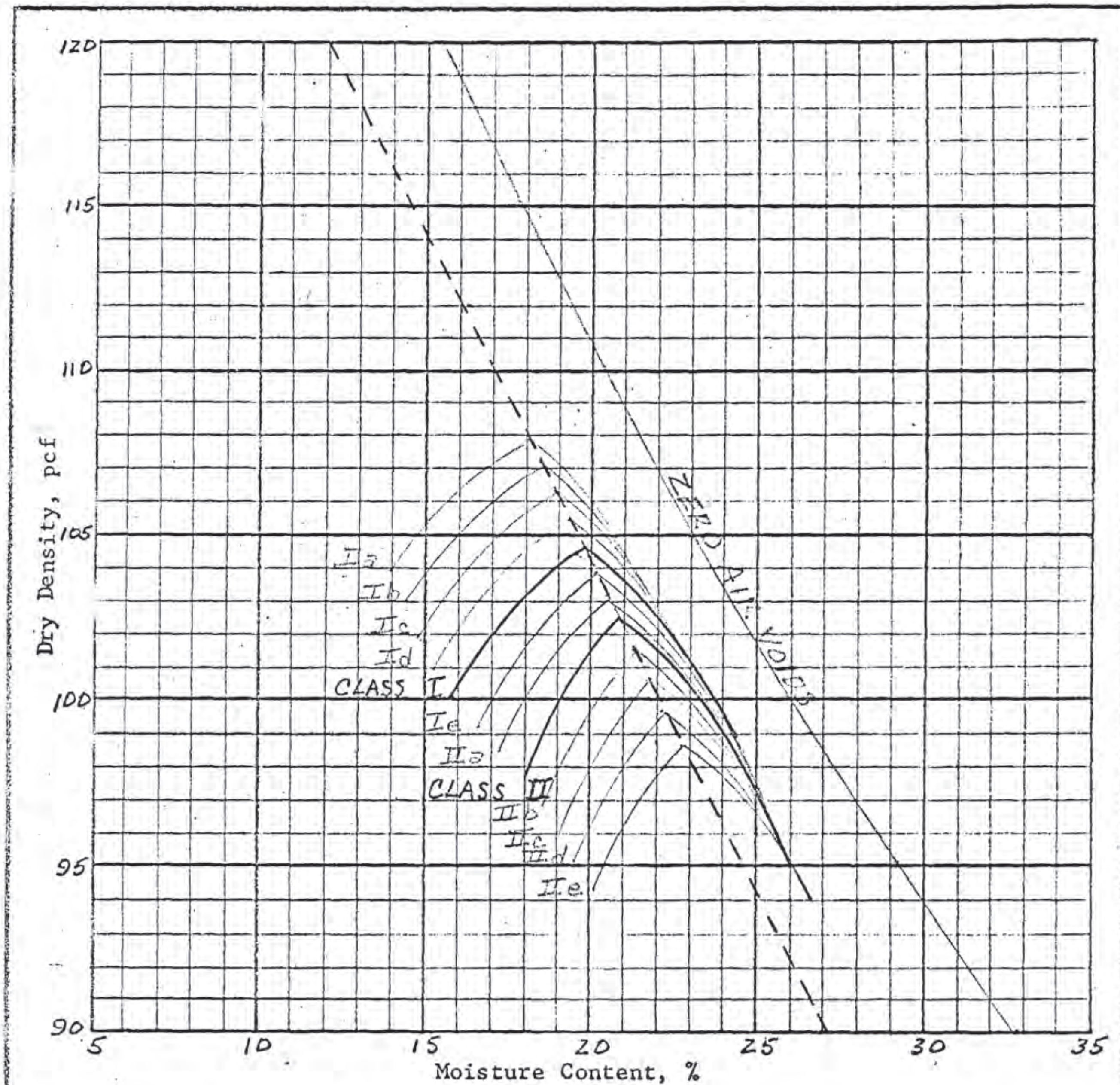
Specimen Number		1	2	3	4
Initial	Moisture Content, %	[illegible]	22.1	22.1	22.9
	Dry Density, pcf	100.8	[illegible]	100.3	100.6
	Void Ratio	[illegible]	0.703	[illegible]	0.706
	Saturation, %	88.3	[illegible]	[illegible]	89.4
Before Shearing	Moisture Content after Saturation, %	[illegible]	25.6	[illegible]	25.7
	Saturation, %	[illegible]	[illegible]	[illegible]	[illegible]
	Moisture Content after Consolidation, %	25.0	24.1	24.4	24.0
	Void Ratio after Consolidation	[illegible]	[illegible]	0.658	[illegible]
Final Moisture Content, %		25.0	24.1	24.3	24.0
Minor Principal Stress, σ_3, tsf		[illegible]	1.00	[illegible]	2.00
Major Principal Stress, σ_1, tsf		1.79	[illegible]	[illegible]	[illegible]
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		[illegible]	[illegible]	[illegible]	[illegible]
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		[illegible]	2.45	[illegible]	[illegible]
Time to Failure, min.		[illegible]	[illegible]	[illegible]	[illegible]
Rate of Strain, %/min.		0.2	0.2	[illegible]	[illegible]
Specimen Height, in.		3.17	3.17	[illegible]	[illegible]
Specimen Diameter, in.		1.40	1.40	[illegible]	1.40



Remarks: REMOLDED AT 2% ABOVE OPTIMUM MOISTURE CONTENT STANDARD PROCTOR DENSITY

Project: JOHNSONVILLE S.P. BORROW AREA	
Feature ASH DIKE	
Boring No.	Sample No. CLASS [illegible]
Station	Offset
Date 8/27/69	Elev.

TRIAXIAL COMPRESSION TEST (R)



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
I CL	0	13	43	44	2.73	40.9	19.8	19.8	104.5
II CL	0	13	35	52	2.75	42.9	20.8	20.8	102.4

Plus No. 4 Specific Gravity, SSD

Plus No. 4 Absorption, %

Remarks:

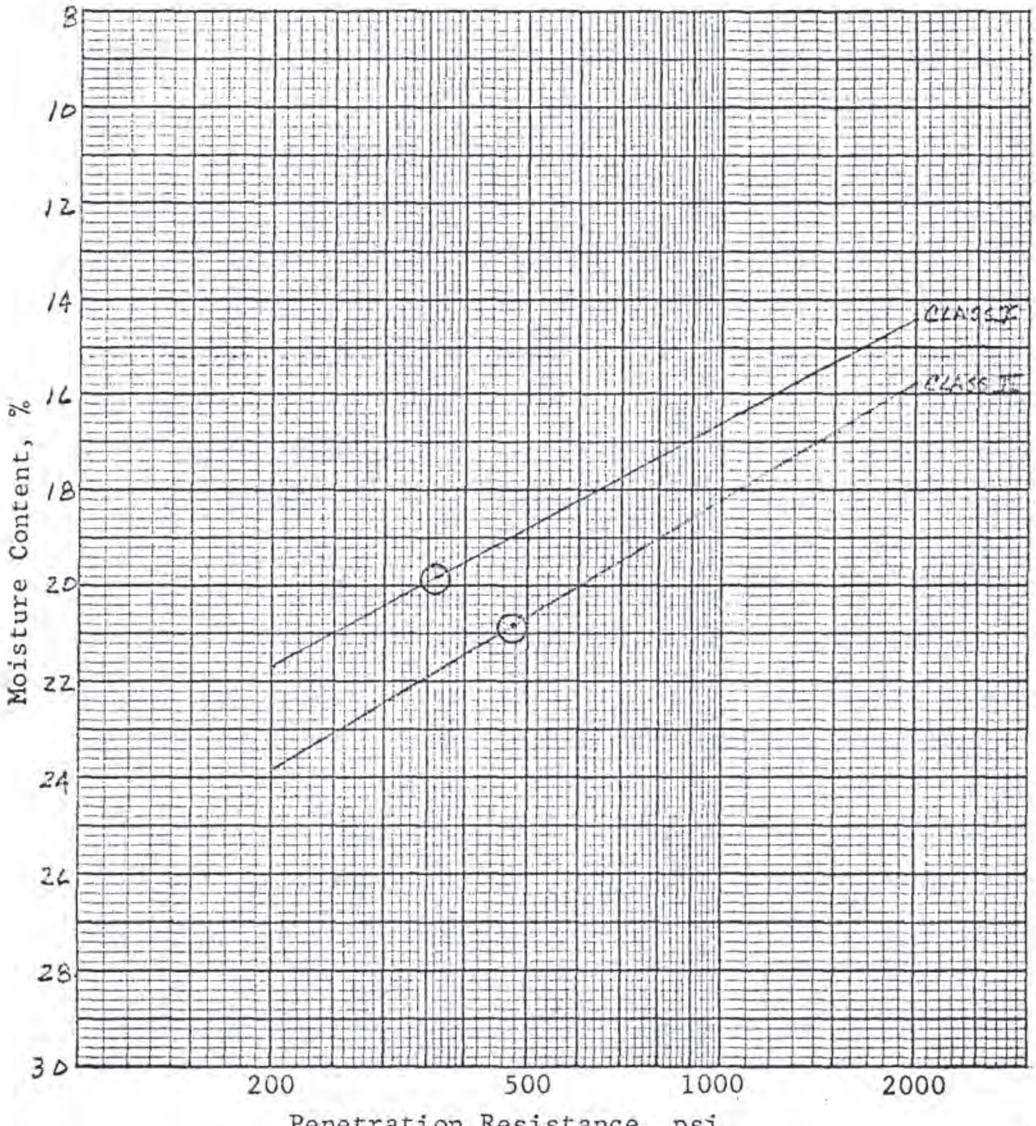
Project JOHNSONVILLE ASH DIKE

Feature BORROW AREA

ASTM Designation D698-66T

Date Tested 7-31-69

COMPACTION TEST (FAMILY OF CURVES)



Soil Class	Optimum Moisture, %	Maximum Density, pcf	Penetration Resistance, psi
I	19.8	104.5	360
II	20.8	102.4	475

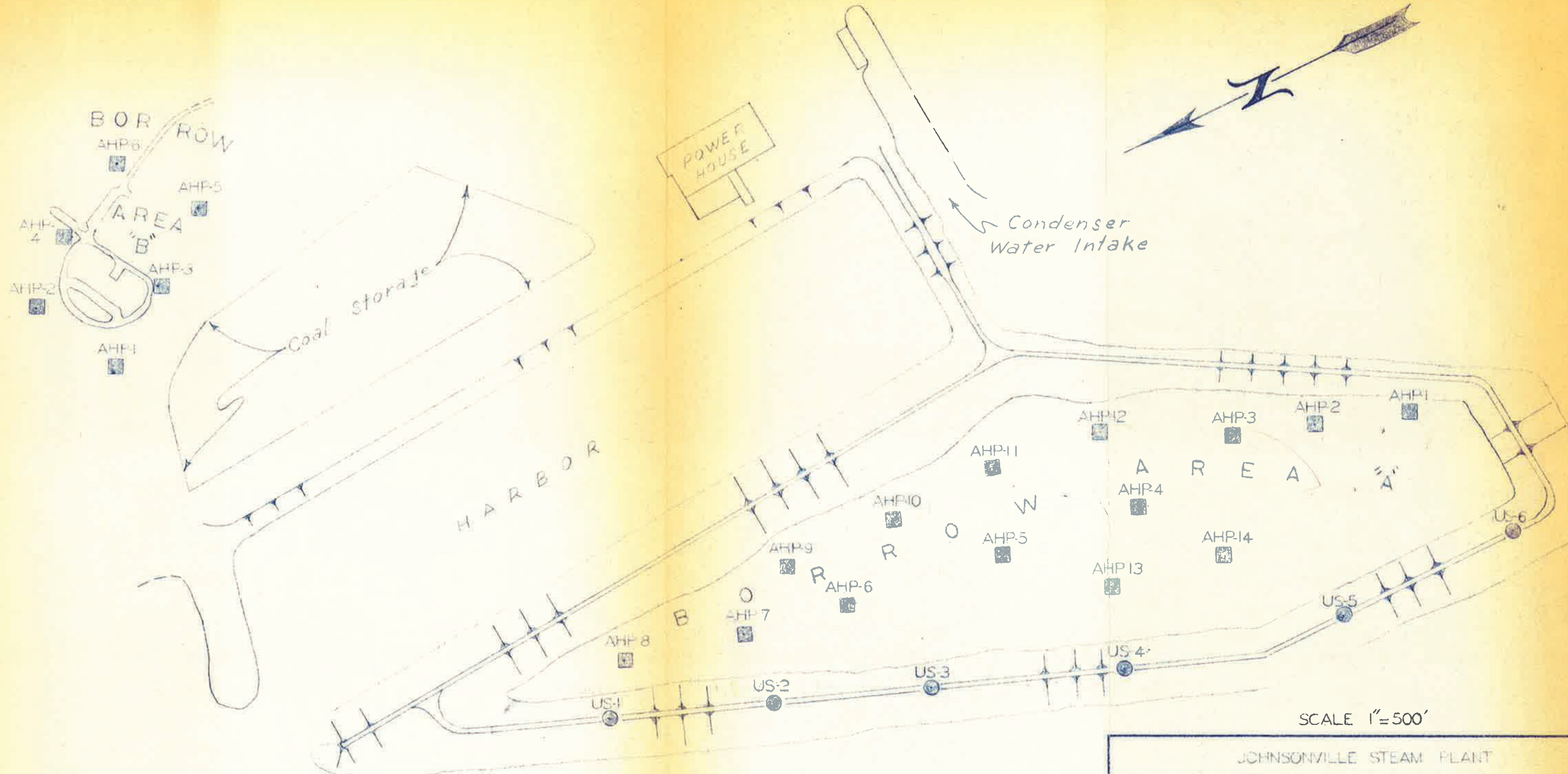
Remarks:

Denotes Optimum Moisture

Project	JOHNSONVILLE ASH DIKE
Feature	BORROW AREA
ASTM Designation	
Date Tested	7-31-69

MOISTURE-PENETRATION TEST

Soil Form 15

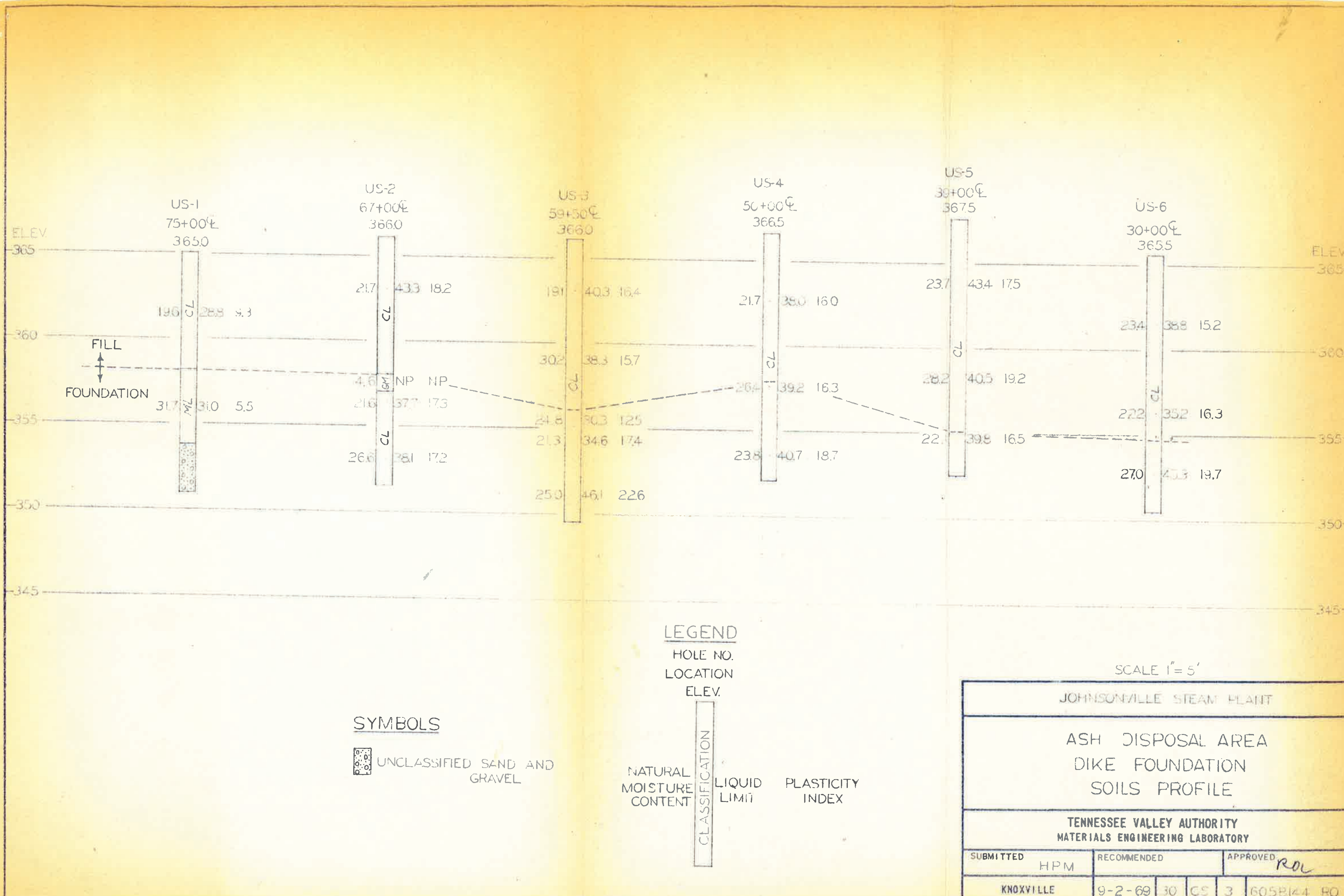


SYMBOLS

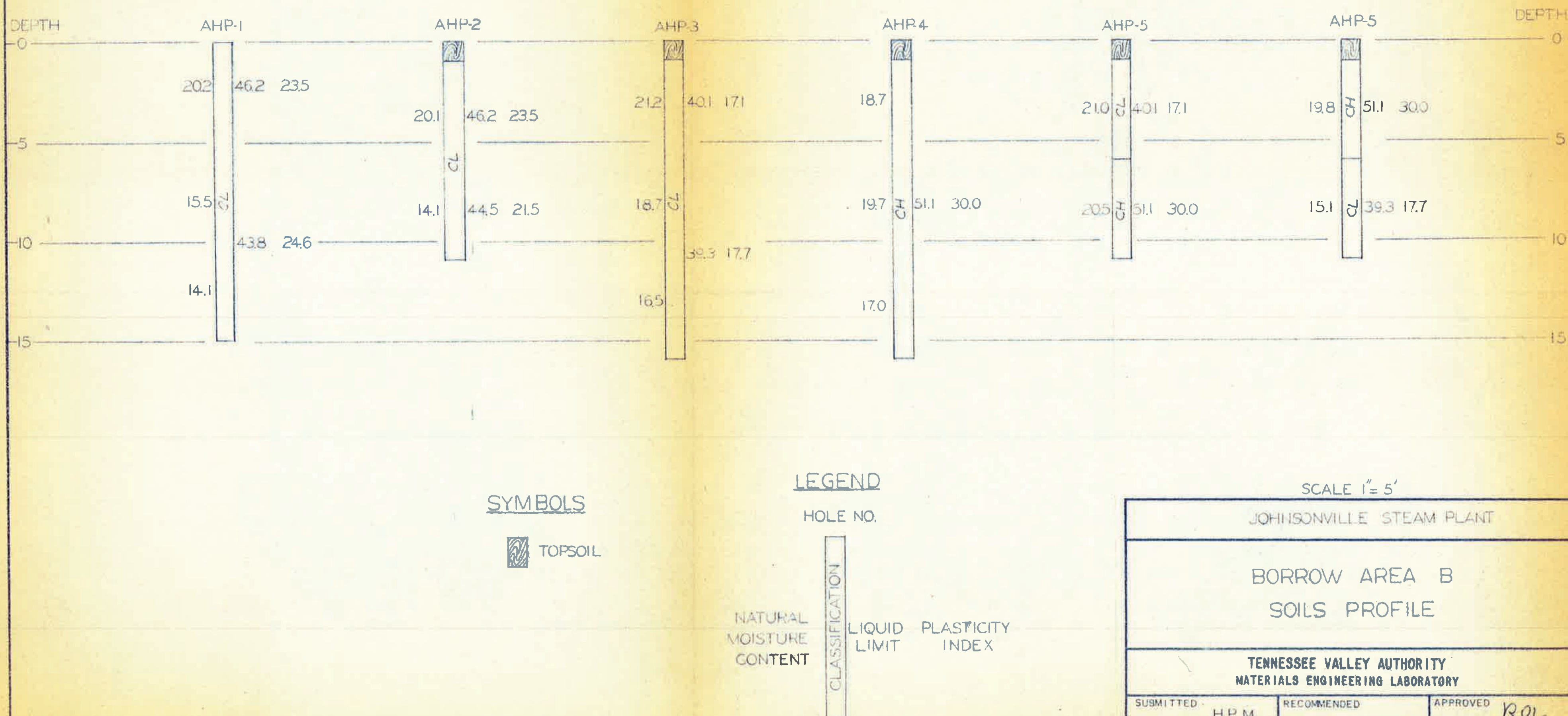
UNDISTURBED SAMPLING HOLES

AUGER HOLES

JOHNSONVILLE STEAM PLANT		
ASH DISPOSAL AREA PLAN OF SOILS INVESTIGATION		
TENNESSEE VALLEY AUTHORITY MATERIALS ENGINEERING LABORATORY		
SUBMITTED HPM	RECOMMENDED	APPROVED ROL
KNOXVILLE	9-2-69 30 CS	3 605B143 RO

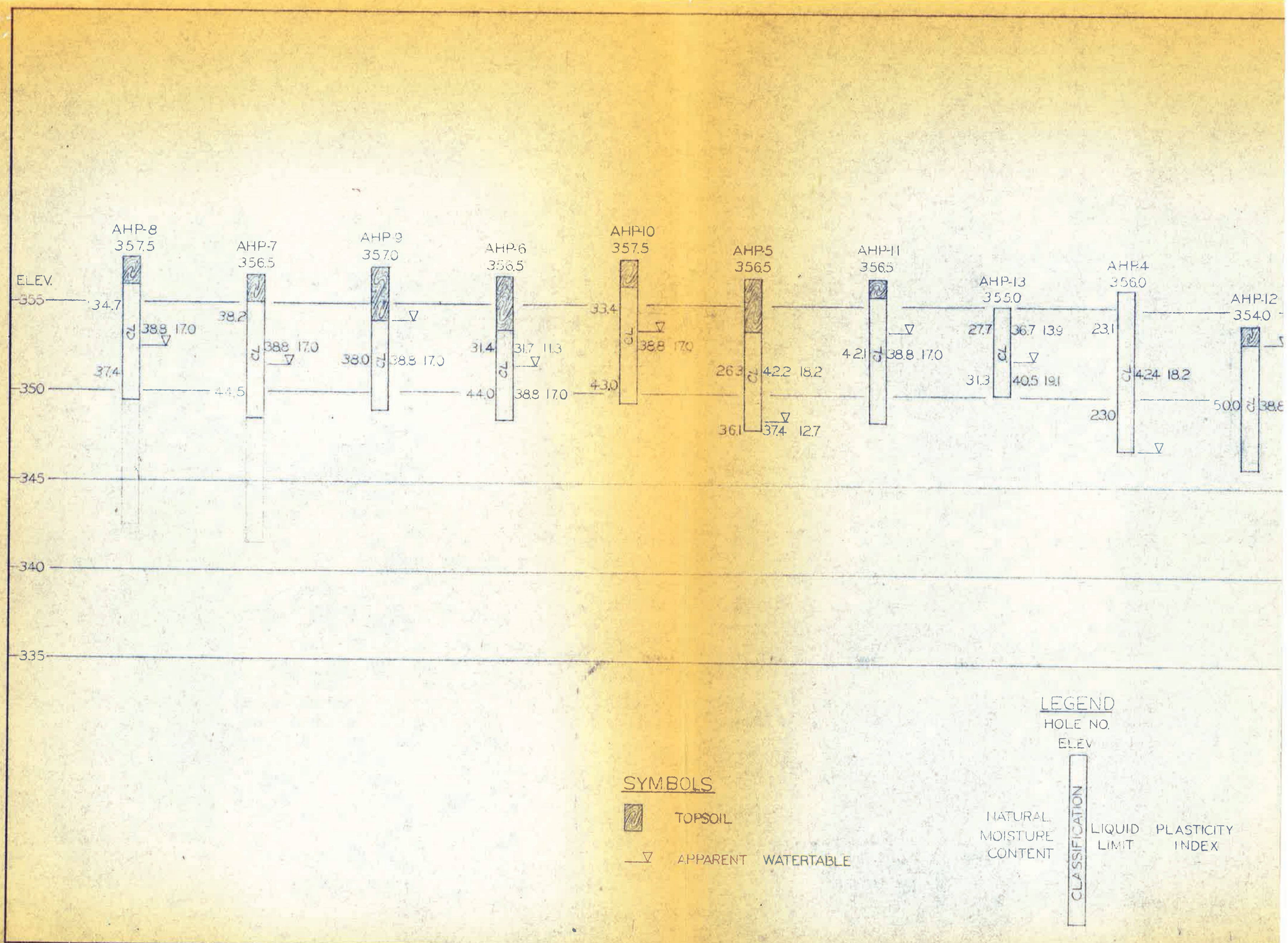


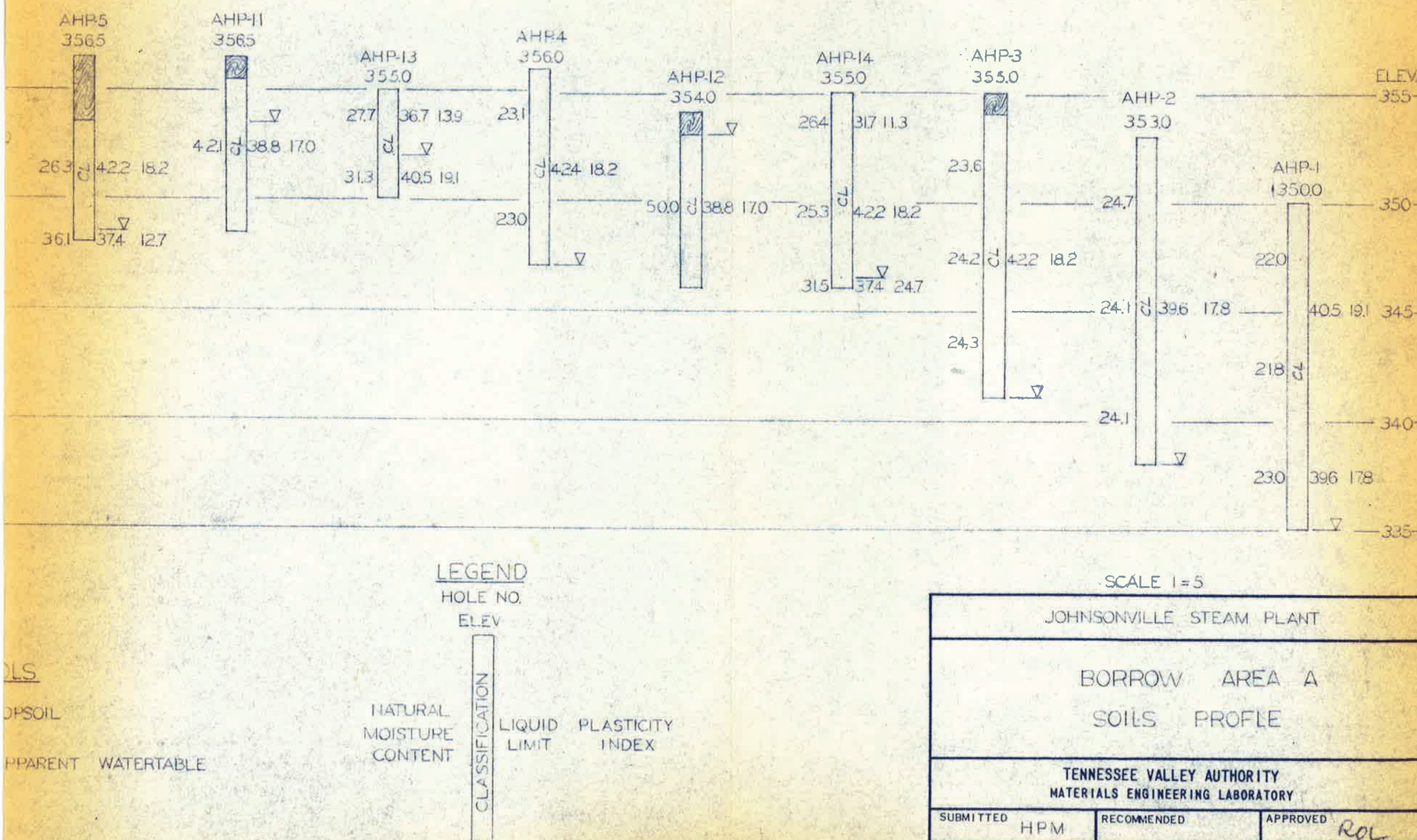
ELEV
365
360
355
350
345
FILL
FOUNDATION
US-1
75+00℄
365.0
US-2
67+00℄
366.0
US-3
59+50℄
366.0
US-4
50+00℄
366.5
US-5
30+00℄
367.5
US-6
30+00℄
365.5
CL
ML
GM
NP NP
LEGEND
HOLE NO.
LOCATION
ELEV.
NATURAL MOISTURE CONTENT
CLASSIFICATION
LIQUID LIMIT
PLASTICITY INDEX
SYMBOLS
UNCLASSIFIED SAND AND GRAVEL
SCALE 1" = 5'
JOHNSONVILLE STEAM PLANT
ASH DISPOSAL AREA
DIKE FOUNDATION
SOILS PROFILE
TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY
SUBMITTED HPM
RECOMMENDED
APPROVED ROL
KNOXVILLE
9-2-69
30
CS
3
605B144 RO



SCALE 1" = 5'

JOHNSONVILLE STEAM PLANT					
BORROW AREA B SOILS PROFILE					
TENNESSEE VALLEY AUTHORITY MATERIALS ENGINEERING LABORATORY					
SUBMITTED HPM	RECOMMENDED		APPROVED ROL		
KNOXVILLE	9-2-69	30	CS	3	605B146 RO


ELEV.
355
350
345
340
335
AHP-8
357.5
34.7
38.8 17.0
37.4
CL
AHP-7
356.5
38.2
38.8 17.0
44.5
CL
AHP-9
357.0
38.0
38.8 17.0
CL
AHP-6
356.5
31.4
31.7 11.3
44.0
38.8 17.0
CL
AHP-10
357.5
33.4
38.8 17.0
43.0
CL
AHP-5
356.5
26.3
42.2 18.2
36.1
37.4 12.7
CL
AHP-11
356.5
42.1
38.8 17.0
CL
AHP-13
355.0
27.7
36.7 13.9
31.3
40.5 19.1
CL
AHP-4
356.0
23.1
42.4 18.2
23.0
CL
AHP-12
354.0
50.0
38.8
CL
SYMBOLS
TOPSOIL
APPARENT WATERTABLE
LEGEND
HOLE NO.
ELEV
NATURAL MOISTURE CONTENT
CLASSIFICATION
LIQUID LIMIT
PLASTICITY INDEX



SCALE 1 = 5

JOHNSONVILLE STEAM PLANT					
BORROW AREA A SOILS PROFLE					
TENNESSEE VALLEY AUTHORITY MATERIALS ENGINEERING LABORATORY					
SUBMITTED HPM	RECOMMENDED		APPROVED ROL		
KNOXVILLE	9-2-69	30	CS	3	605FF145 RO

TVA 64 (OS-9-65)
UNITED STATES GOVERNMENT

CSB '77 1122 051

Memorandum

TENNESSEE VALLEY AUTHORITY

TO : G. L. Buchanan, Chief, Civil Engineering and Design Branch, W3C126 C-K (2)

FROM : Gene Farmer, Chief, Construction Services Branch, E6B39 C-K

DATE : November 22, 1977

SUBJECT: JOHNSONVILLE STEAM PLANT - ASH DISPOSAL AREA NO. 2 DIKE RAISING - SOIL EXPLORATION AND TESTING

We are transmitting herewith a report on a soil investigation program conducted by SME Laboratory.

This work was authorized May 16, 1977, (CDB 770517 004) and is presently listed under EN DES Soil Schedule No. 71.1.

Original Signed By
Gene Farmer

Gene Farmer

ROL:ASH
Attachments
cc (Attachments):
R. O. Lane, SME-K
H. H. Mull, E7B24 C-K (w/text only)
MEDS, E4B37 C-K

CDB '77 1123 002

11/23/77 - GLB:NCH
cc: W. M. Bivens, 5100 MIB-K
Roy H. Dunham, W11A9 C-K
xc: MEDS, E4B37 C-K

JOHNSONVILLE STEAM PLANT

ASH DISPOSAL AREA NO. 2 DIKE RAISING

SOIL EXPLORATION AND TESTING

EN DES SOILS SCHEDULE NO. 71.1

Sampling and in-situ testing of soils in the ash disposal area No. 2 dike raising at Johnsonville Steam Plant were conducted between August 17 and September 14, 1977. In the investigation, two trailer-mounted drill rigs, hollow-stem and solid-core augers, 2-inch o.d. split spoons, and a 5-inch-diameter tube sampler were used.

Foundation

As shown on drawing 604A860, 11 standard penetration and 3 undisturbed borings were drilled around the perimeter of the No. 2 ash disposal area. Borings were discontinued after penetrating into the foundation to a depth equivalent to half the embankment height. The water table within the existing dike was variable but generally established between el. 355 and el. 360. See drawings 604K861R1 and 604K862R0. However, a water level of 372 was found for boring SS-8 in a zone of clayey gravel, indicating possible percolation through the zone.

The profile determined within the existing dike is composed primarily of lean clay, CL, with layers of clayey sand, SC; silty sand, SM; and gravelly soils, G-CL, G-SC, G-SM, and GC; scattered throughout. Angular gravel contents as high as 66 percent with a fines content as low as 21 percent were determined in the clayey gravel, GC.

In boring SS-6, at el. 364, a layer of clean sand was encountered. Since this material had a fines content of only 11 percent, 6 additional borings were drilled to determine the extent of the sand stratum. See drawing 604K881R0. Gradation curves are included in the attachments for the sandy soils encountered in these 6 borings.

Overall, soil consistency of the cohesive fill is of medium to stiff range as indicated by penetration resistance. However, the sands present around borings SS-6 were found to be relatively loose with "N" values in the 4 to 6 range.

Foundation soils are primarily lean clays, CL. Over much of the dike area, topsoil marks the contact between fill and original ground. In-situ standard penetration tests reveal quite variable foundation consistency with soft zones established in borings 7, 8, and 9. Particularly, the weak zone between el. 343 and el. 357 in boring SS-8 may require special consideration. Over the remainder of the dike area, foundation soils are of medium to stiff consistency.

Undisturbed samples were obtained from borings 1, 7, and 8 for detailed testing. Strength determinations under triaxial compression unconsolidated-undrained and consolidated-undrained test conditions reveal a wide range of shear strengths. See table 1. Samples from borings 1 and 7 generally exhibit medium to medium-high shear strength under both Q and R test conditions. However, weak foundation soils in boring US-8 disclose essentially zero friction angle and low cohesion in the triaxial Q test. Under consolidated R test conditions, moderately high friction angles with low cohesion were indicated for these soils.

Bottom Ash

In-place density determinations were made around the perimeter of the existing dike in traffic-compacted bottom ash. Sand cone densities indicate a range of densities varying from 121.7 pcf to 125.3 pcf. The gradation of a composite ash sample classifies it as a gravelly poorly graded silty sand, G-SP-SM, according to the Unified Soil Classification System. After scalping particles larger than 3/4 inch, specimens were remolded for shear testing to an average density of 123.8 pcf. Test results are summarized in table ~~3~~ 2. Relatively high shear strength was determined under all test conditions. After completion of the shear tests, gradation testing disclosed little breakage of ash particles. See the attached plot. The well-graded and fairly dense ash had a coefficient of permeability of 1×10^{-5} cm/sec. All ash testing was performed on the largest size test specimens as allowed by equipment size. Triaxial specimens were 4 inches in diameter, direct shear specimens were 6 inches thick by 12 inches square, and the permeability specimen had a 6-inch diameter.

Borrow

As shown on drawings 604K886 and 604B887, two areas designated A and B were explored as potential sources of borrow soil. In area A, 37 auger borings were sunk to obtain samples and determine the quantity of suitable fill material available.

Drawing 604K882 indicates that in area A, along lines S12+00 and S14+00 cherty gravel, GC, dominates the profile. Lean clay, CL, and gravelly lean clay, G-CL, are also present but are scattered throughout. This portion of area A should not be considered a prime borrow source. South of S14+00, as shown on drawings 604K883 and 604K884, the profile typically consists of 7 to 15 feet of lean to medium clay, CL, which overlies clayey gravel, GC. Bedrock was not encountered to the depths drilled.

In area B (suitable lean clay, CL, or clayey sand, SC) borrow soils are available to depths of 3 to 10 feet.

Overall, area A could supply the 390,000 cubic yards of fill required for the dike construction. This area can probably be expanded to the south or southeast if necessary. Because of the clearing involved and the relatively shallow extent of suitable borrow, area B is considered a secondary borrow area.

Soils from borrow areas A and B were grouped according to their grain-size distribution and index properties and subjected to standard compaction testing. Gravelly soils, which contained over 40 percent gravel were not tested. Compaction characteristics limited soils to two classes of fine-grained and one class of gravelly borrow. These soils are equally distributed in both areas, having natural moisture contents within 2 percent of optimum and exhibiting similar plasticity.

The fine-grained borrow soils were tested for shear strength as requested. See table 2. The gravelly borrow class was not tested for shear strength since it is assumed to be as strong or stronger than the fine-grained soils.

Summary

This investigation has shown the existing Colbert ash dike and underlying foundation soils to consist primarily of the medium clay, CL, type. Interspersed throughout the dike and foundation are zones of gravelly clays, G-CL, clayey gravel, and occasionally within the dike soils, clayey sand, SC, and silty sand, SM.

A significant area of clayey gravel, GC, was established in boring SS-8 while semipervious to pervious sands were encountered in the vicinity of boring SS-6. Soil consistency in the dike is generally of medium to stiff range. Softer conditions exist in the foundation soils, particularly in borings SS-7, 8, and 9, and may require special attention.

The traffic-compacted ash is of relatively high density, and high shear strength under all shear test conditions.

Adequate quantities of lean to medium clay, CL, are available as borrow. Many of these clays contain chert gravel and will require close inspection to prevent use of soils with excessively high gravel contents.

Recommended design values are as follows:

		Triaxial Q		Triaxial R	
	γ_w pcf	ϕ deg	c tsf	ϕ deg	c tsf
New dike	125	7	0.8	16	.05
Existing dike	125	19	0.7	20	.35
Foundation	120	1	0.3	19	0.7
Bottom ash	134	40	1.8	42	1.3

Table 1

JOHNSONVILLE STEAM PLANT

ASH DIKE NO. 2

SUMMARY OF LABORATORY TEST DATA

EXISTING DIKE AND FOUNDATION

Elevation	Soil Symbol	Natural Moisture		Std. Penetr.	Grain-Size Analysis					Atterb. Limits		Dry Dens.	Void Ratio	Triaxial Q Undisturbed		Natural Moisture Triaxial R		Saturated Triaxial R Apparent		Saturated Triaxial R Effective	
		%	% Sat.		Gravel %	Sand %	Silt %	Clay %	D_{10} mm	Liq. Limit %	Plastic. Index %	pcf		ϕ deg.	c tsf	ϕ deg.	c tsf	ϕ deg.	c tsf	ϕ deg.	c tsf
Boring No. US-1, S-10+00, W-33+08, Surface Elevation 378.9																					
377.4-375.2	CL	20.3	95.0	20	0	6	54	40	--	43.6	23.6	107.3	.582	10.5	2.11			19.6	0.68	30.0	0.00
374.4-372.4	CL	21.6	96.1	18	0	12	54	34	--	38.2	16.6	105.1	.610								
371.4-369.9	CL	20.1	92.8	22	0	7	53	40	--	40.5	17.7	106.8	.590	10.5	2.23			22.0	1.30	29.5	0.12
368.4-366.9	CL	24.8	90.4	14	0	12	48	40	--	42.3	18.7	97.4	.750	5.1	0.60	17.0	0.70				
365.5-363.4	CL	22.7	96.6	10	0	11	45	44	--	42.4	20.8	103.4	.636								
362.9-360.5	CL	23.7	96.9	16	0	11	49	40	--	41.0	17.5	101.4	.657	3.1	1.06	17.5	0.78				
359.9-358.6	ML	25.6	94.3	14	0	7	53	40	--	43.0	16.4	97.4	.737								
Boring No. US-7, N-14+00, W-17+53, Surface Elevation 378.1																					
376.6-374.2	CL	17.7	81.3	13	10	19	47	24	--	30.1	11.2	105.5	.580								
373.6-372.3	CL	17.9	81.4	7	8	15	53	24	--	34.8	13.3	104.6	.582	19.1	0.65						
370.6-369.2	G-SM-SC	16.7	75.0	7	19	45	25	11	.0043	24.8	6.4	106.2	.610								
367.6-365.2	G-SM-SC	17.2	82.7	9	24	29	32	15	--	21.9	5.3	107.6	.561								
364.6-363.6	SM	22.0	81.1	7	9	48	33	10	.0053	NP	NP	96.0	.716								
Boring No. US-8, N-4+00, W-16+90, Surface Elevation 377.4																					
358.4-356.6	CL	28.1	97.9	4	0	7	37	56	--	40.3	18.1	95.4	.780	1.1	0.36	20.0	0.25				
354.4-352.4	G-SM	19.4		2	22	50	14	14	--	--	--	--									
351.4-350.4	CL	28.5	100.0	4	5	19	37	39	--	37.6	16.9	96.8	.760								
345.4-344.4	CL	27.6	98.0	3	2	14	50	34	--	40.1	16.6	95.8	.761	0.5	0.29	20.5	0.38				
342.4-340.3	MH	35.2	83.2	10	0	2	38	60	--	50.8	21.9	78.0	1.121								
339.4-337.8	CL	28.9	96.4	7	0	1	54	45	--	37.4	16.3	92.7	.799	0.0	0.25	25.0	0.15				

Table 2

JOHNSONVILLE STEAM PLANT

ASH DIKE NO. 2

BOTTOM ASH

SUMMARY OF LABORATORY TEST DATA

BORROW SOIL CLASSES

Class	I
Symbol	G-SW-SM
Mechanical and Hydrometer Analysis	
Gravel, percent	34
Sand, percent	57
Silt, percent	9
Atterberg Limits	
Liquid limit, percent	NP
Plastic limit, percent	NP
Plasticity index, percent	NP
Shear Strength at	
Triaxial Q: ø degrees	40.0
c tsf	2.00
Triaxial Q: ø degrees	39.0
c tsf	2.00
Triaxial R: ø degrees	42.0
c tsf	1.50
Direct Shear S: ø degrees	43.5
c tsf	0.72
Direct Shear S: ø degrees	45.5
c tsf	0.55
Coefficient of Permeability, cm/sec	1.04×10^{-5}

Table 3

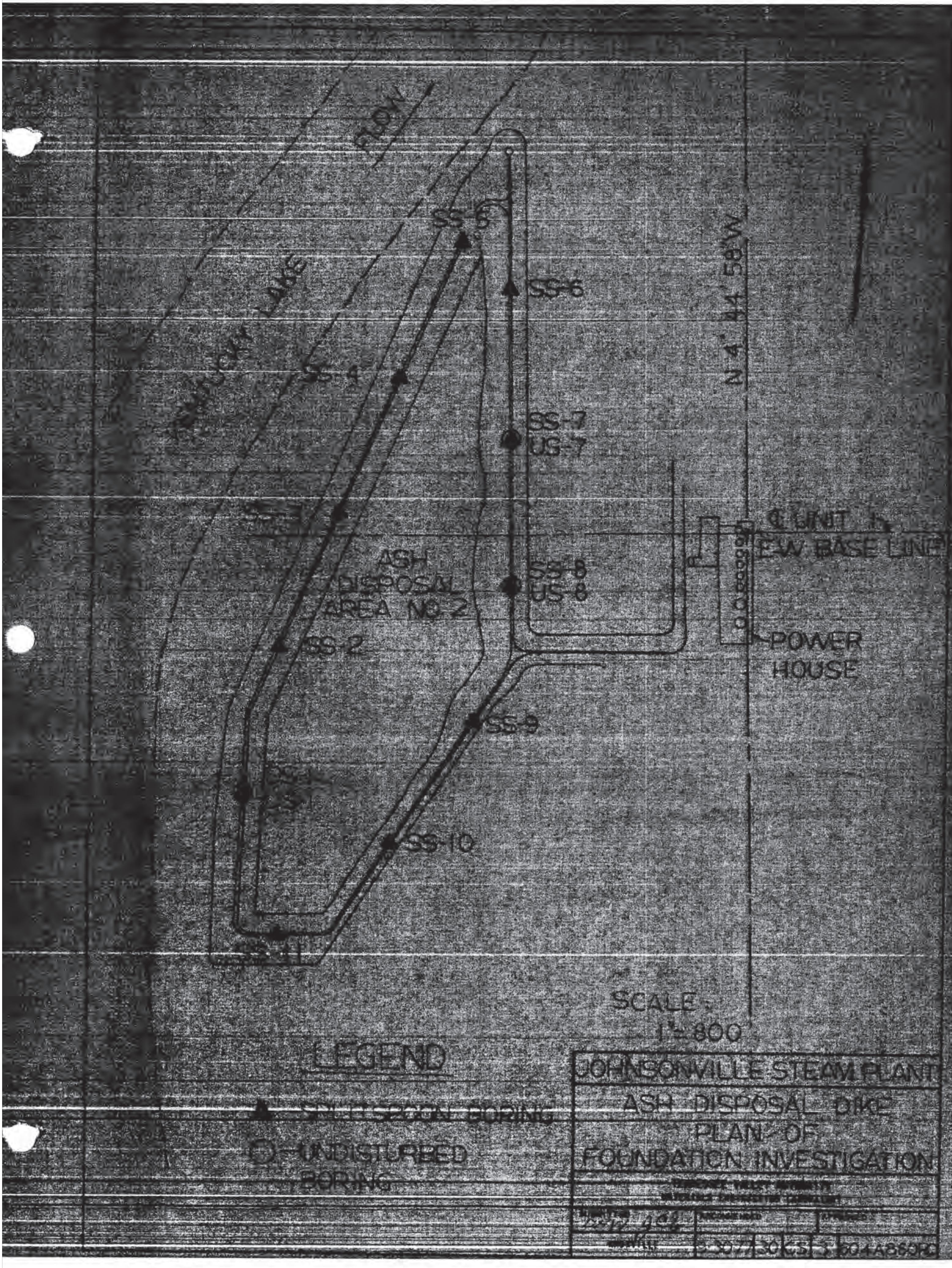
JOHNSONVILLE STEAM PLANT

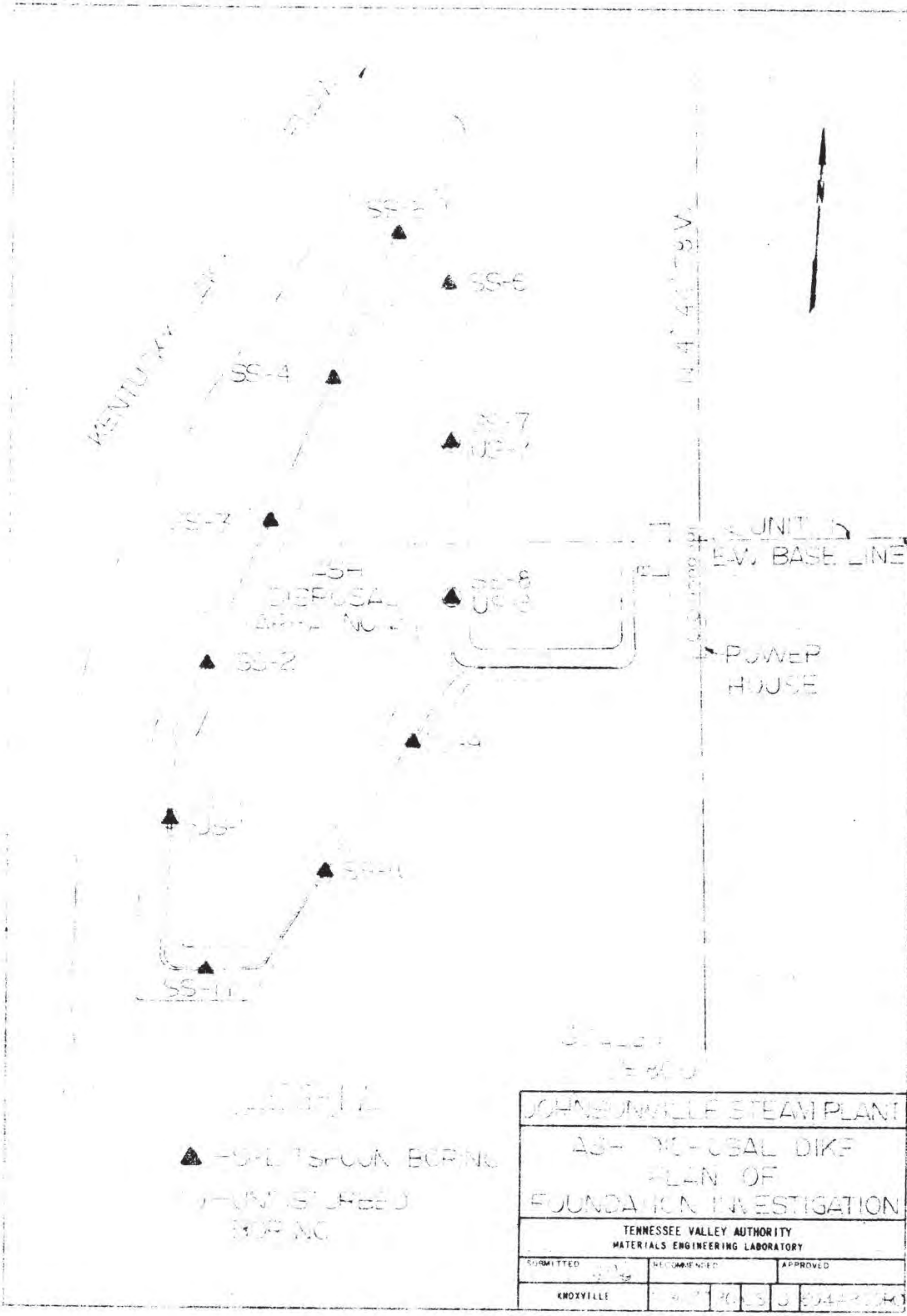
BORROW AREAS A & B

SUMMARY OF LABORATORY TEST DATA

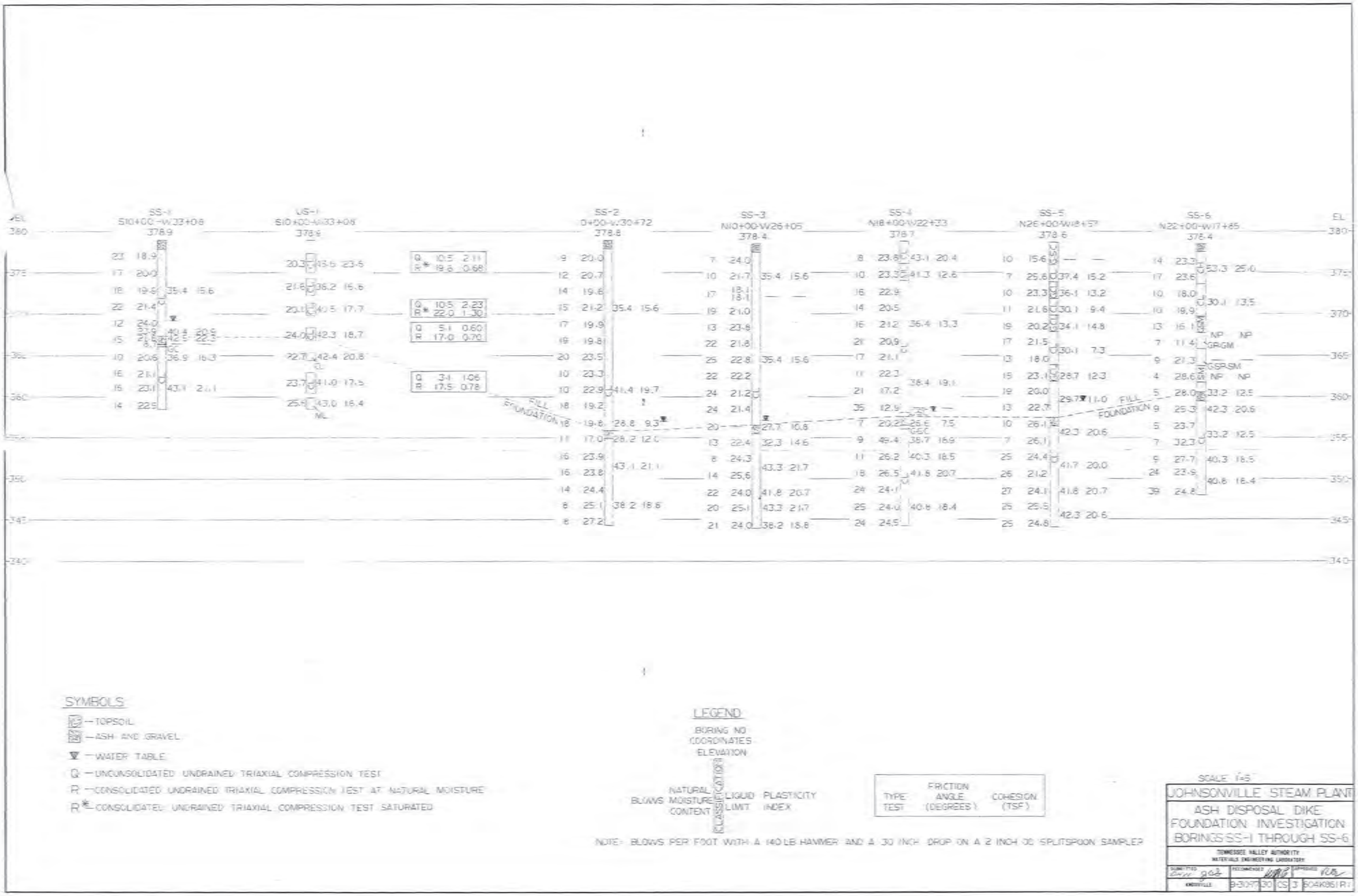
BORROW SOIL CLASSES

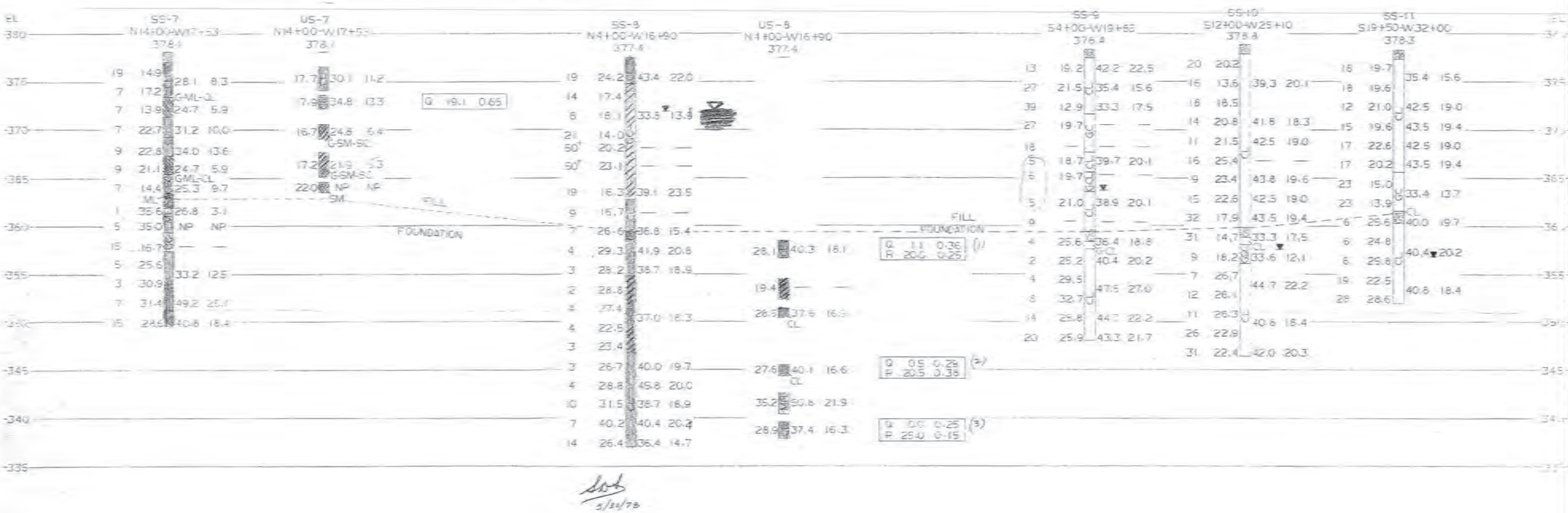
Class	I	II
Symbol	CL	CL
Mechanical and Hydrometer Analysis		
Gravel, percent	0	0
Sand, percent	21	11
Silt, percent	42	47
Clay, percent	37	42
Atterberg Limits		
Liquid limit, percent	42.1	46.7
Plastic limit, percent	18.5	18.5
Plasticity index, percent	23.6	28.2
Shrinkage limit, percent	--	--
Standard Proctor Compaction		
Optimum moisture, percent	16.9	18.0
Maximum density, pcf	109.2	106.8
Penetration resistance, psi	790	765
Shear strength at 3 percent wet of optimum moisture and at 95 percent of standard maximum dry density		
Triaxial Q: ϕ degrees	6.0	7.5
c tsf	1.05	0.82
Shear strength at 3 percent dry of optimum moisture and at 95 percent of standard maximum dry density		
Triaxial Q: ϕ degrees	32.0	30.0
c tsf	1.30	0.75
Triaxial R: ϕ degrees	16.5	18.0
c tsf	0.06	0.05


FLOW
KENTUCKY LAKE
SS-5
SS-6
SS-4
SS-7
UG-7
SS-3
ASH
DISPOSAL
AREA NO 2
SS-8
US-8
SS-2
SS-9
SS-10
SS-11
N 4° 44' 58" W
℄ UNIT 1
E-W BASE LINE
POWER
HOUSE
SCALE
1" = 800
LEGEND
SPLIT SPOON BORING
UNDISTURBED
BORING
JOHNSONVILLE STEAM PLANT
ASH DISPOSAL DIKE
PLAN OF
FOUNDATION INVESTIGATION



SS-6
SS-4
SS-2
E-W BASE LINE
POWER
HOUSE
JOHNSONVILLE STEAM PLANT
PLAN OF
TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY
SUBMITTED
RECOMMENDED
APPROVED
KNOXVILLE


EL
SS-1
S10+00-W33+08
378.9
US-1
S10+00-W33+08
378.9
SS-2
0+00-W30+72
378.8
SS-3
N10+00-W26+05
378.4
SS-4
N18+00-W22+33
378.7
SS-5
N26+00-W18+57
378.6
SS-6
N22+00-W17+85
378.4
FILL
FOUNDATION
SYMBOLS
—TOPSOIL
—ASH AND GRAVEL
—WATER TABLE
Q —UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
R —CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST AT NATURAL MOISTURE
R* CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST SATURATED
LEGEND
BORING NO
COORDINATES
ELEVATION
BLOWS
NATURAL MOISTURE CONTENT
CLASSIFICATION
LIQUID LIMIT
PLASTICITY INDEX
TYPE TEST
FRICTION ANGLE (DEGREES)
COHESION (TSF)
NOTE: BLOWS PER FOOT WITH A 140 LB HAMMER AND A 30 INCH DROP ON A 2 INCH OD SPLITSPOON SAMPLER
SCALE 1=5
JOHNSONVILLE STEAM PLANT
ASH DISPOSAL DIKE
FOUNDATION INVESTIGATION
BORINGS SS-1 THROUGH SS-6
TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY
KNOXVILLE
9-30-71 30 CS 3 604K861 R1



SYMBOLS

- TOPSOIL
- ASH AND GRAVEL
- ▼ — WATER TABLE
- Q — UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
- R — CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST AT NATURAL MOISTURE

LEGEND

BORING NO.
COORDINATES
ELEVATION

BLOWS | NATURAL MOISTURE CONTENT | CLASSIFICATION | LIQUID LIMIT | PLASTICITY INDEX

TYPE TEST	FRICTION ANGLE (DEGREES)	COHESION (TSF)

NOTE: BLOWS PER FOOT WITH A 140 LB HAMMER AND A 30 INCH DROP ON A 2 INCH OD SPLITSPOON SAMPLER

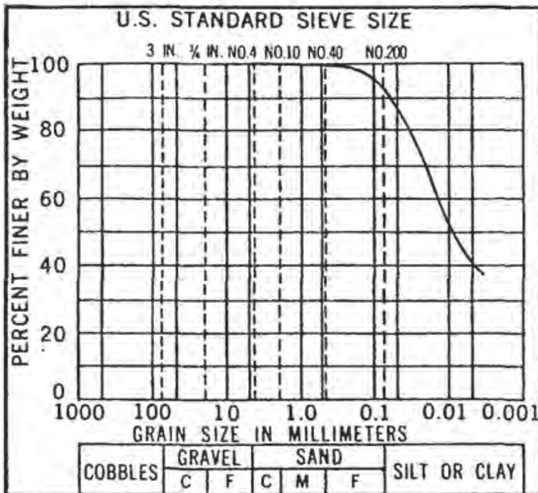
SCALE: 1=5'

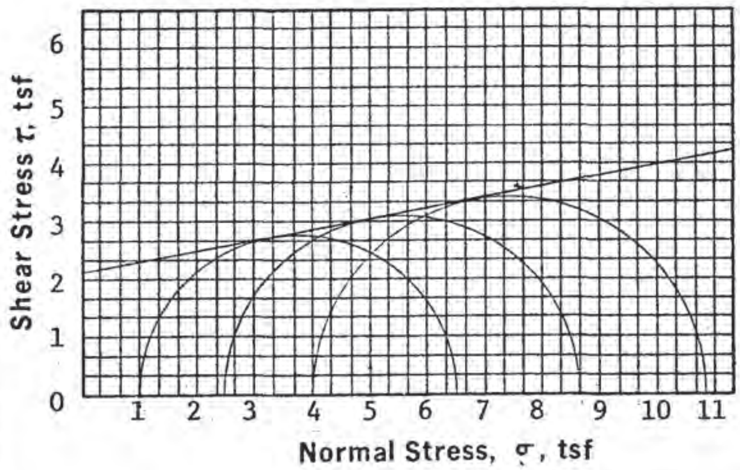
JOHNSONVILLE STEAM PLANT
ASH DISPOSAL DIKE
FOUNDATION INVESTIGATION
BORINGS SS-7 THROUGH SS-11

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED gol | RECOMMENDED WAE | APPROVED RO

KNOXVILLE | 9-30-77 | 30 | CS | 3 | 504K862RO

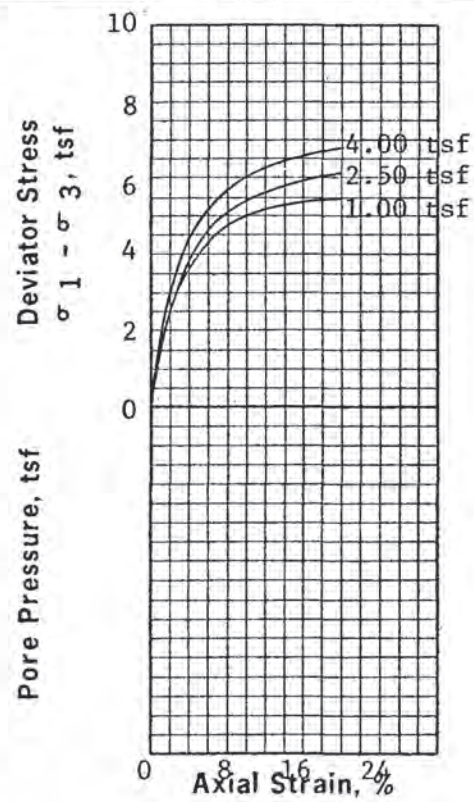




Type of Specimen	Undisturbed
Classification	CL
LL. 43.6	**G** 2.72
PI. 23.6	**D_{10}** --

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	10.5	.19	2.11
Effective	--	--	--

Specimen Number		1	2	3	4
Initial	Moisture Content, %	19.4	19.3	19.8	
	Dry Density, pcf	106.9	109.3	108.2	
	Void Ratio	.588	.553	.570	
	Saturation, %	90.0	94.9	94.3	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		19.3	19.3	19.7	
Minor Principal Stress, σ_3, tsf		1.00	2.50	4.00	
Major Principal Stress, σ_1, tsf		6.49	8.62	10.81	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		19	20	20	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	

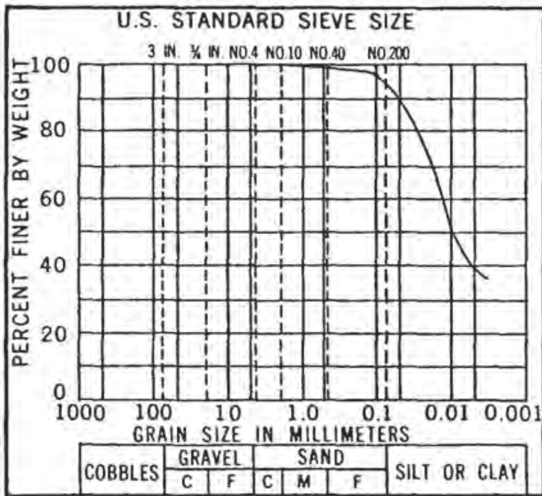


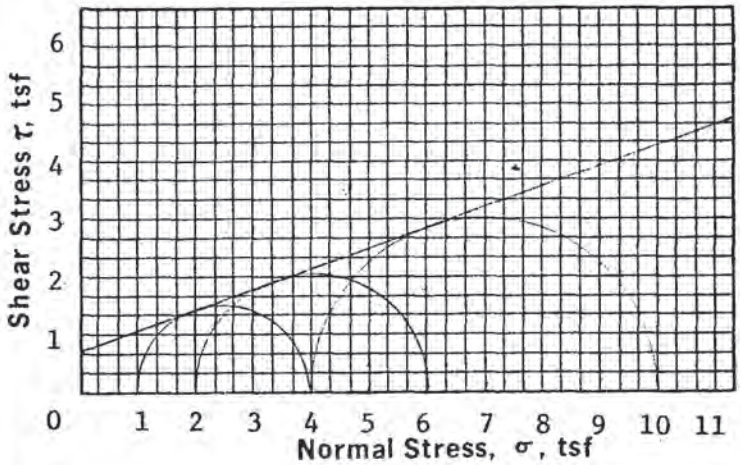
Remarks:

Project: Johnsonville Steam Plant	
Feature Ash Dike 2	
Boring No. US-1	**Sample No.** 1
Station S-10+00	**Range** W-33+08
Date 9-26-77	**Elev.**377.4-375.9

TRIAXIAL COMPRESSION TEST (Q)

TVA 10195 (CONST-6-77) Tested by: GMD & RW Reviewed by: JCS

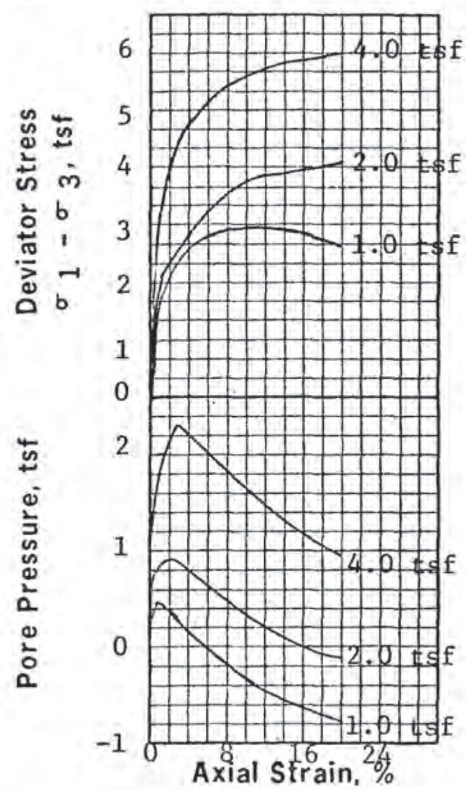




Type of Specimen	Undisturbed
Classification	CL
LL. 43.6	G 2.72
PI. 23.6	D_{10} --

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	19.6	.36	0.68
Effective	30.0	.58	0.00

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	20.4	20.9	20.7	
	Dry Density, pcf	107.9	105.6	107.5	
	Void Ratio	.573	.607	.580	
	Saturation, %	96.9	93.8	97.1	
Before Shearing	Moisture Content after Saturation, %	21.1	22.3	21.3	
	Saturation, %	100.0	100.0	100.0	
	Moisture Content after Consolidation, %	18.9	20.5	18.8	
	Void Ratio after Consolidation	.538	.556	.510	
Final Moisture Content ,%		18.9	20.5	18.8	
Minor Principal Stress, σ 3, tsf		1.00	2.00	4.00	
Major Principal Stress, σ 1, tsf		3.97	6.06	10.00	
Effective Minor Principal Stress, $\bar{\sigma}$ 3, tsf		1.42	2.08	3.01	
Effective Major Principal Stress, $\bar{\sigma}$ 1, tsf		4.32	6.14	9.01	
Time to Failure, min.		60	97	100	
Rate of strain, %/min.		0.20	0.20	0.20	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	

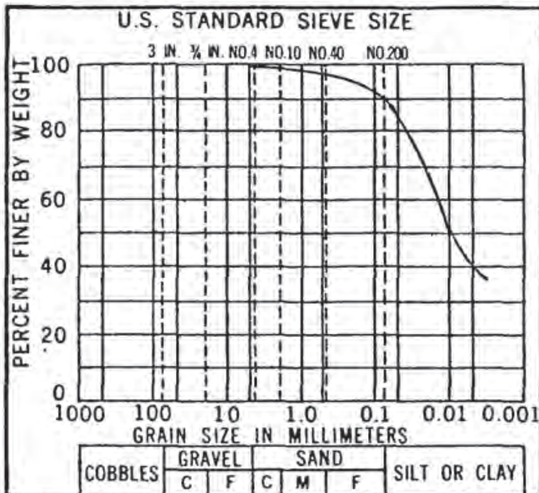


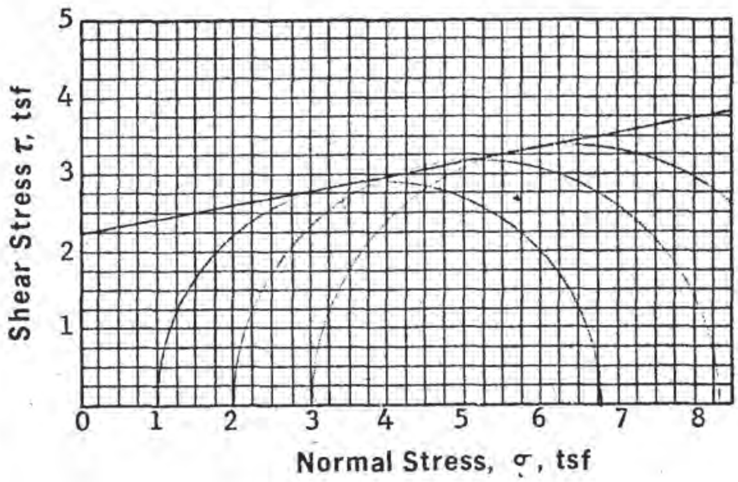
Remarks:

Project: Johnsonville Steam Plant	
Feature Ash Dike 2	
Boring No. US-1	Sample No. 1
Station S-10+00	Range W-33+08
Date 9-23-77	Elev. 375.9-375.4

TRIAXIAL COMPRESSION TEST (R)

TVA 10195 (CONST-6-77) Tested by: E.L. Reviewed by: JCL

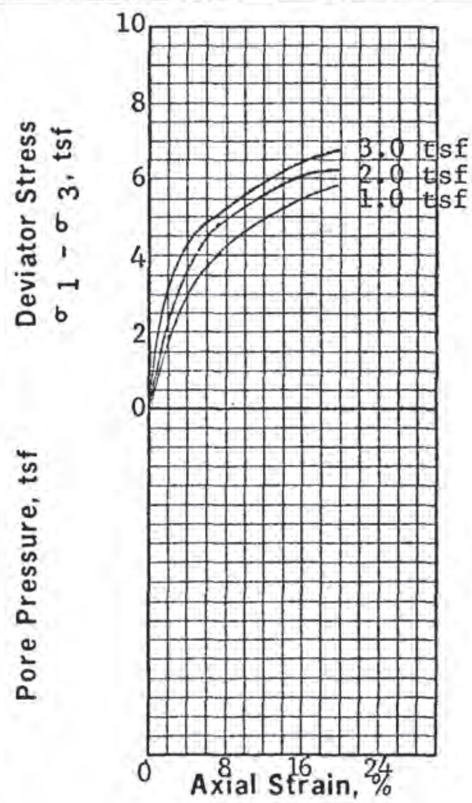




Type of Specimen	Undisturbed		
Classification	CL		
LL.	40.5	**G**	2.72
PI.	17.7	**D_{10}**	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	10.5	.19	2.23
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	19.8	19.6	19.3	
	Dry Density, pcf	106.8	107.5	107.9	
	Void Ratio	.590	.579	.574	
	Saturation, %	91.2	92.1	91.2	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
	Final Moisture Content ,%	19.7	19.5	19.2	
	Minor Principal Stress, σ_3, tsf	1.00	2.00	3.00	
	Major Principal Stress, σ_1, tsf	6.78	8.33	9.69	
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	--	--	--	
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	--	--	--	
	Time to Failure, min.	20	18	20	
	Rate of strain, %/min.	1.0	1.0	1.0	
	Specimen Height, in.	3.15	3.15	3.15	
	Specimen Diameter, in.	1.40	1.40	1.40	

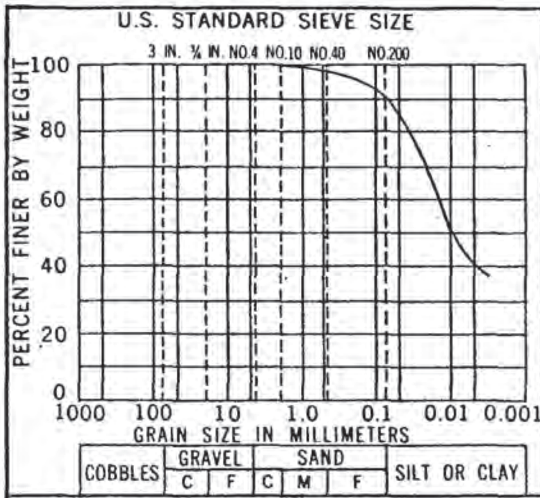


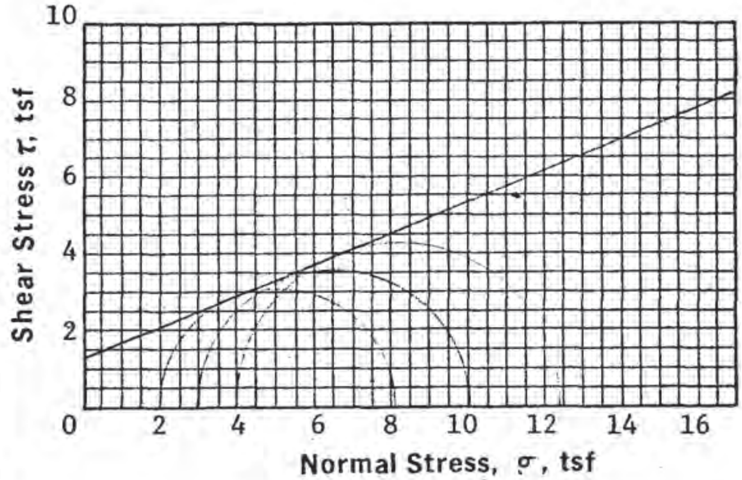
Remarks:

Project:	Johnsonville S. P.		
Feature	Ash Dike 2		
Boring No.	US-1	**Sample No.**	3
Station	S-10+00	**Range**	W-33+08
Date	7-19-77	**Elev.**	370.9-370.4

TRIAXIAL COMPRESSION TEST (Q)

TVA 10195 (CONST-6-77) Tested by: CEC Reviewed by: JCS

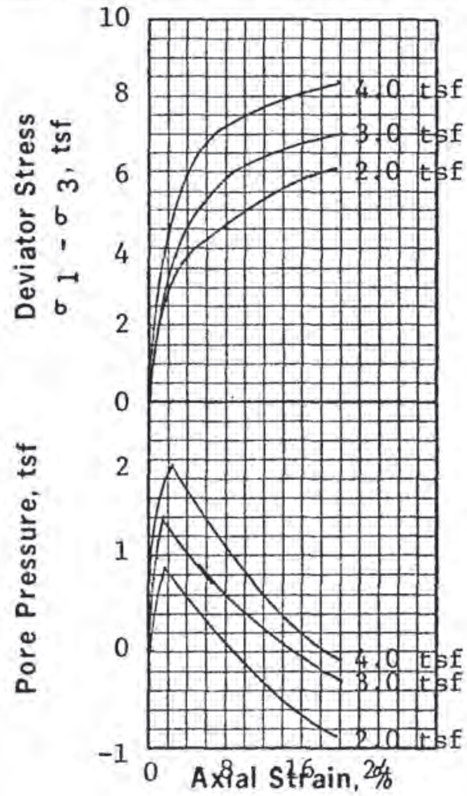




Type of Specimen	Undisturbed		
Classification	CL		
LL.	40.5	G	2.72
PI.	17.7	D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	22.0	.40	1.30
Effective	29.5	.57	0.12

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	20.4	20.4	20.4	
Initial	Dry Density, pcf	106.2	106.4	106.3	
Initial	Void Ratio	.600	.596	.597	
Initial	Saturation, %	92.6	93.3	92.8	
Before Shearing	Moisture Content after Saturation, %	22.0	21.9	22.0	
Before Shearing	Saturation, %	100	100	100	
Before Shearing	Moisture Content after Consolidation, %	20.6	20.4	20.9	
Before Shearing	Void Ratio after Consolidation	.539	.489	.571	
	Final Moisture Content ,%	20.6	20.4	20.9	
	Minor Principal Stress, σ_3, tsf	2.00	3.00	4.00	
	Major Principal Stress, σ_1, tsf	8.13	10.03	12.40	
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	2.89	3.29	4.09	
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	9.02	10.32	12.49	
	Time to Failure, min.	97	97	104	
	Rate of strain, %/min.	0.20	0.20	0.20	
	Specimen Height, in.	3.15	3.15	3.15	
	Specimen Diameter, in.	1.40	1.40	1.40	

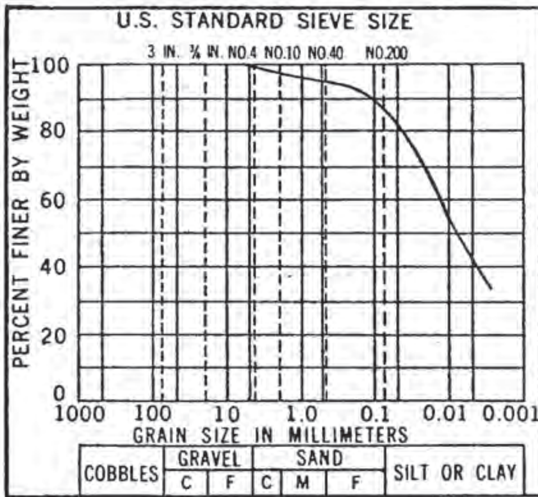


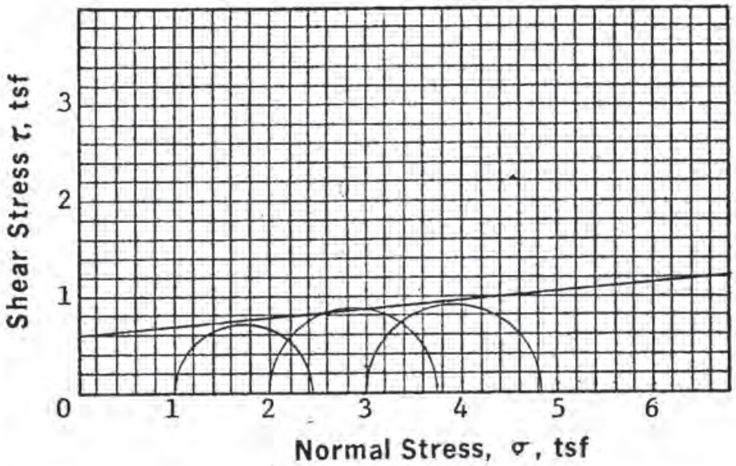
Remarks:

Project:	Johnsonville Steam Plant		
Feature	Ash Dike 2		
Boring No.	US-1	Sample No.	3
Station	S-10+00	Range	W-33+08
Date	9-23-77	Elev.	370.4-369.9

TRIAXIAL COMPRESSION TEST (R)

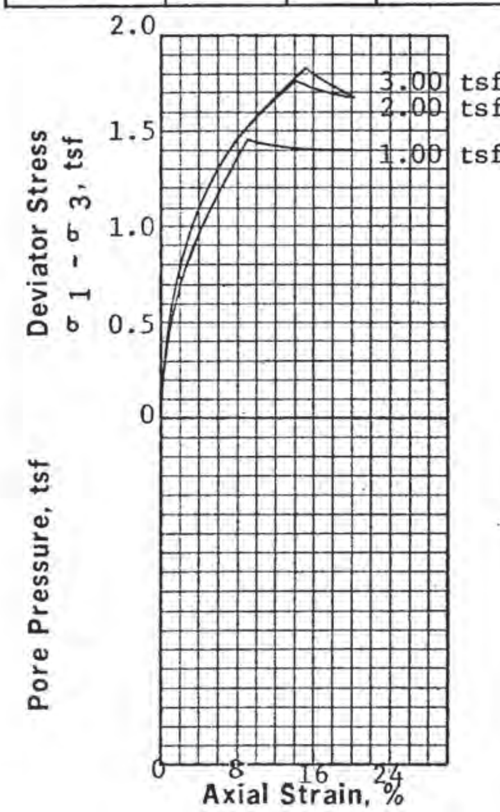
TVA 10195 (CONST-6-77) Tested by: OEC Reviewed by: JCS





Type of Specimen	Undisturbed
Classification	CL
LL. 42.3	G 2.73
PI. 18.7	D_{10} --

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	5.1	.09	0.60
Effective	--	--	--



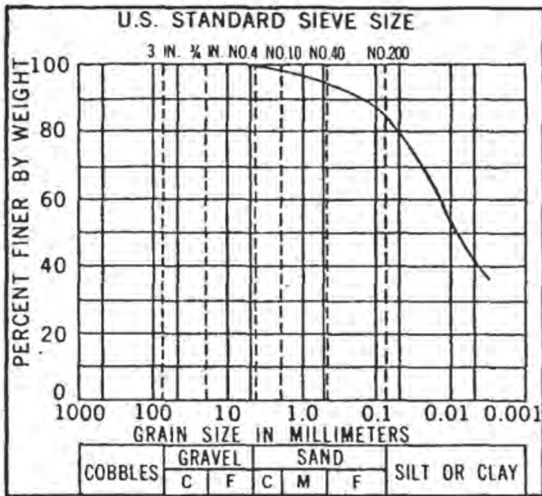
	Specimen Number	1	2	3	4
Initial	Moisture Content, %	24.3	23.8	24.5	
	Dry Density, pcf	97.5	99.2	98.0	
	Void Ratio	.748	.718	.739	
	Saturation, %	88.6	90.3	90.3	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		24.0	23.6	24.1	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		2.45	3.77	4.82	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		9	14	15	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	

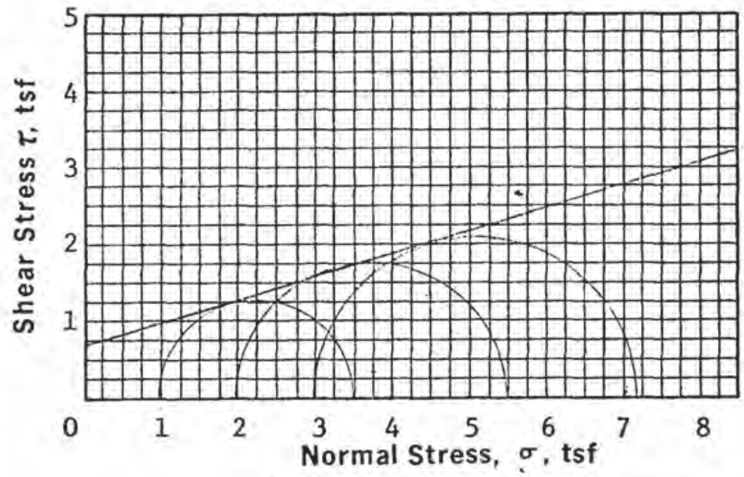
Remarks:

Project: Johnsonville Steam Plant	
Feature Ash Dike 2	
Boring No. US-1	Sample No. 4
Station S-10+00	Range W-33+-8
Date 9-25-77	Elev. 367.9-367.4

TRIAXIAL COMPRESSION TEST (Q)

TVA 10195 (CONST-6-77) Tested by: GMD & PLR Reviewed by: JCS

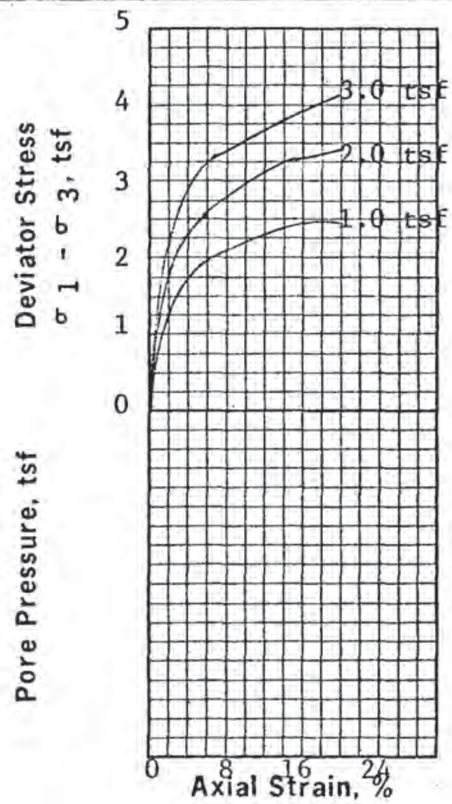




Type of Specimen	Undisturbed
Classification	CL
LL. 42.3	**G** 2.73
PI. 18.7	**D_{10}** --

Shear Strength	**ø Deg.**	**Tan ø**	**C, tsf**
Apparent	17.0	.31	0.70
Effective	--	--	--

	Specimen Number	**1**	**2**	**3**	**4**
Initial	**Moisture Content, %**	25.3	25.8	26.7	
	Dry Density, pcf	97.6	96.4	94.3	
	Void Ratio	.746	.768	.807	
	Saturation, %	92.7	91.7	90.4	
Before Shearing	**Moisture Content after Saturation, %**	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	24.3	23.5	23.1	
	Void Ratio after Consolidation	.742	.728	.727	
	Final Moisture Content ,%	24.3	23.5	23.1	
	Minor Principal Stress, σ 3, tsf	1.00	2.00	3.00	
	Major Principal Stress, σ 1, tsf	3.47	5.46	7.17	
	Effective Minor Principal Stress, $\bar{\sigma}$ 3, tsf	--	--	--	
	Effective Major Principal Stress, $\bar{\sigma}$ 1, tsf	--	--	--	
	Time to Failure, min.	90	100	100	
	Rate of strain, %/min.	0.2	0.2	0.2	
	Specimen Height, in.	3.15	3.15	3.15	
	Specimen Diameter, in.	1.40	1.40	1.40	

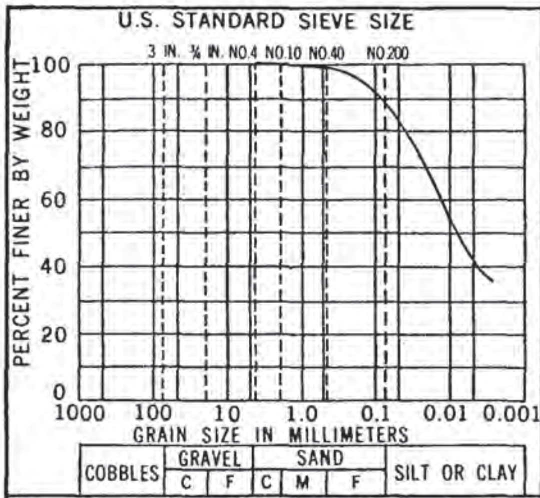


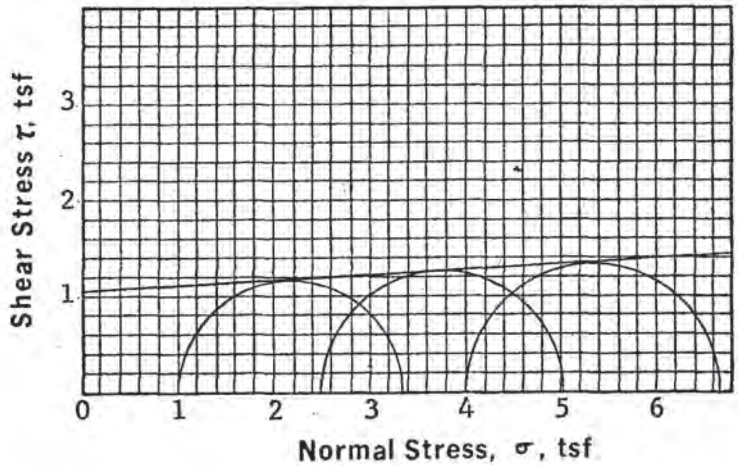
Remarks:

Project: Johnsonville Steam Plant	
Feature Ash Dike 2	
Boring No. US-1	**Sample No.** 4
Station S-10+00	**Range** W-33+08
Date 7-21-77	**Elev** 367.4-366.9

TRIAXIAL COMPRESSION TEST(R)

 Tested by: CEC Reviewed by: JCS

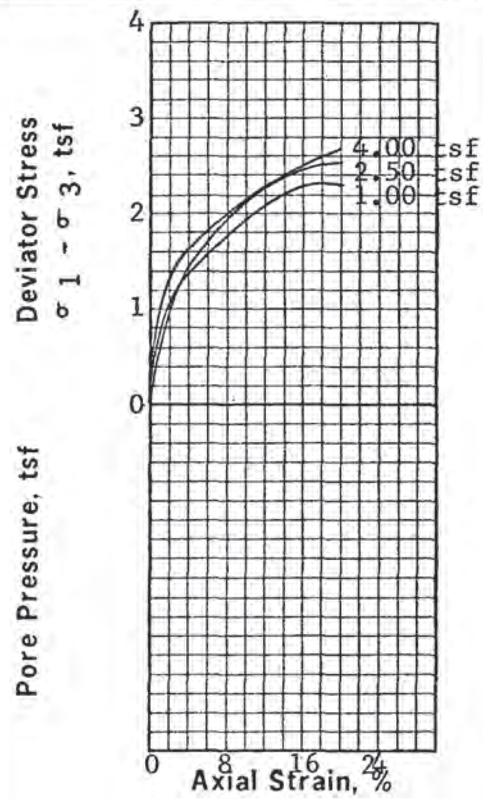




Type of Specimen	Undisturbed		
Classification	CL		
LL. 41.0		G	2.69
PI. 17.5		D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	3.1	.05	1.06
Effective	--	--	--

Specimen Number		1	2	3	4
Initial	Moisture Content, %	23.4	23.8	22.4	
	Dry Density, pcf	102.5	101.7	103.9	
	Void Ratio	.639	.651	.617	
	Saturation, %	98.4	98.4	97.7	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		23.3	23.7	22.3	
Minor Principal Stress, σ_3, tsf		1.00	2.50	4.00	
Major Principal Stress, σ_1, tsf		3.34	5.03	6.69	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		18	19	20	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	

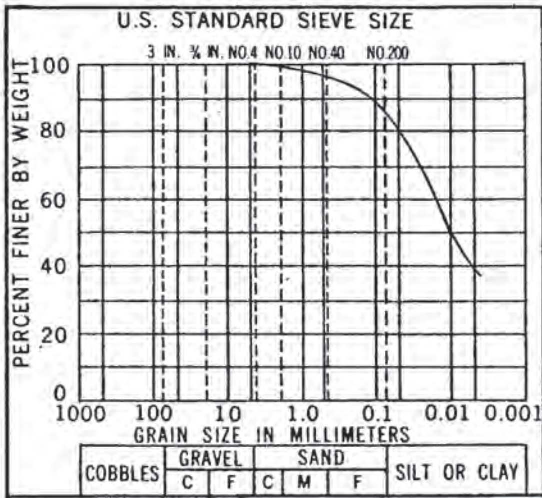


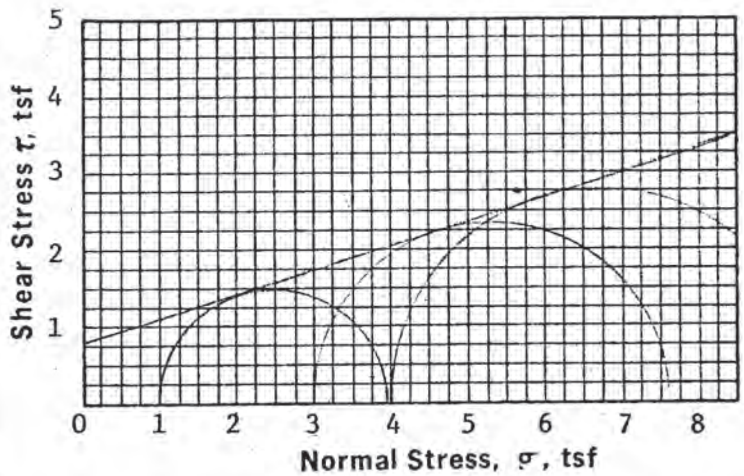
Remarks:

Project: Johnsonville S. P.	
Feature Ash Dike 2	
Boring No. US-1	Sample No. 6
Station S-10+00	Range W-33+08
Date 9-20-77	Elev. 362.4-361.9

TRIAXIAL COMPRESSION TEST (Q)

TVA 10195 (CONST-6-77) Tested by: RW Reviewed by: JGS

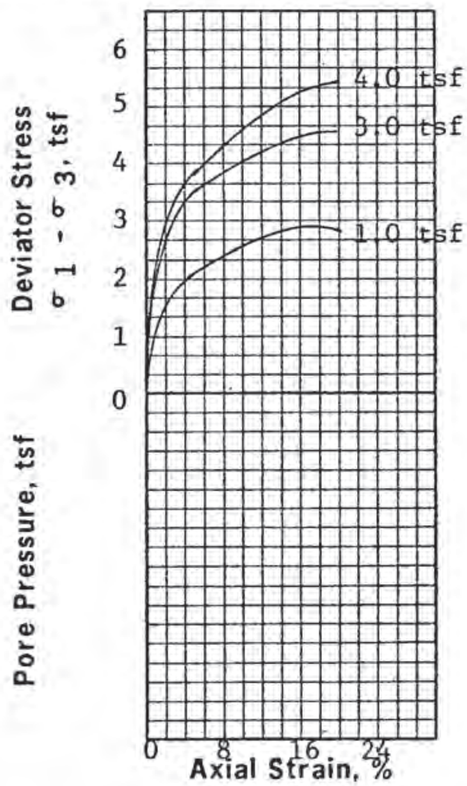




Type of Specimen	Undisturbed
Classification	CL
LL. 41.0	G 2.69
PI. 17.5	D_{10} --

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	17.5	.32	0.78
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	25.0	24.6	24.5	
	Dry Density, pcf	99.2	99.7	99.7	
	Void Ratio	.693	.685	.684	
	Saturation, %	97.0	96.8	96.3	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	24.4	22.8	22.3	
	Void Ratio after Consolidation	.663	.606	.625	
	Final Moisture Content ,%	24.4	22.8	22.3	
	Minor Principal Stress, σ_3, tsf	1.00	3.00	4.00	
	Major Principal Stress, σ_1, tsf	3.96	7.62	9.47	
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	--	--	--	
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	--	--	--	
	Time to Failure, min.	90	100	96	
	Rate of strain, %/min.	0.20	0.20	0.20	
	Specimen Height, in.	3.15	3.15	3.15	
	Specimen Diameter, in.	1.40	1.40	1.40	

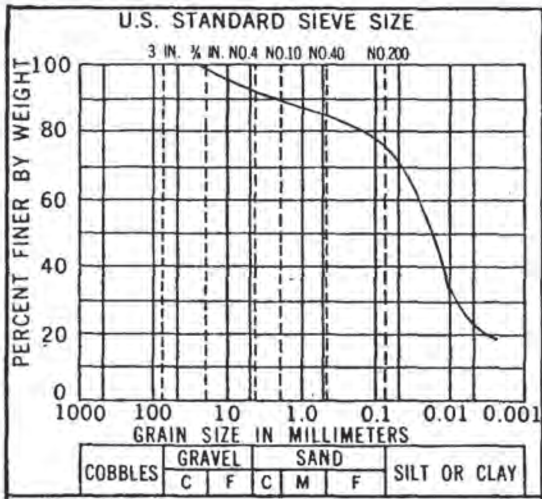


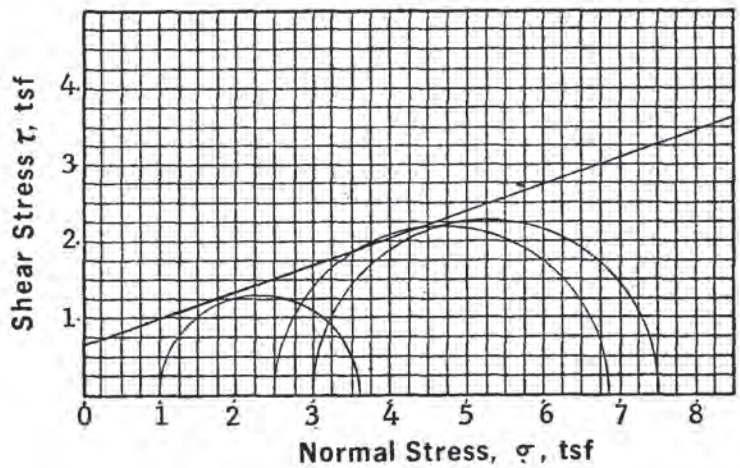
Remarks:

Project: Johnsonville Steam Plant	
Feature Ash Dike 2	
Boring No. US-1	Sample No. 6
Station S-10+00	Range W-33+08
Date 9-23-77	Elev. 361.9-361.5

TRIAXIAL COMPRESSION TEST (R)

TVA 10195 (CONST-6-77) Tested by: CEC Reviewed by: JCS



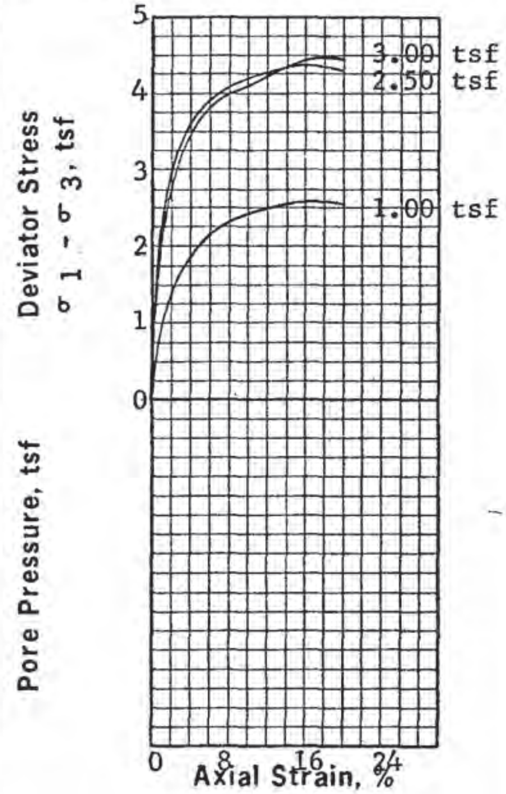


Type of Specimen	Undisturbed
Classification	CL

LL.	34.8	**G**	2.65
PI.	13.3	**D_{10}**	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	19.1	.35	0.65
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	18.4	16.9	15.5	
	Dry Density, pcf	103.4	103.3	107.3	
	Void Ratio	.600	.601	.542	
	Saturation, %	81.2	74.6	75.9	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
	Final Moisture Content ,%	18.3	16.9	15.5	
	Minor Principal Stress, σ_3, tsf	1.00	2.50	3.00	
	Major Principal Stress, σ_1, tsf	3.60	6.88	7.48	
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	--	--	--	
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	--	--	--	
	Time to Failure, min.	19	16	19	
	Rate of strain, %/min.	1.00	1.00	1.00	
	Specimen Height, in.	3.15	3.15	3.15	
	Specimen Diameter, in.	1.40	1.40	1.40	

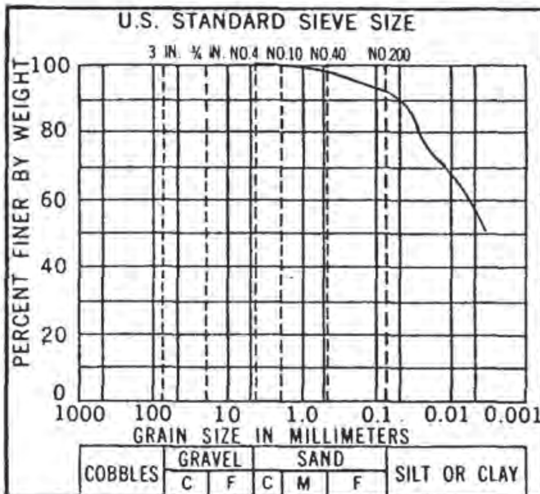


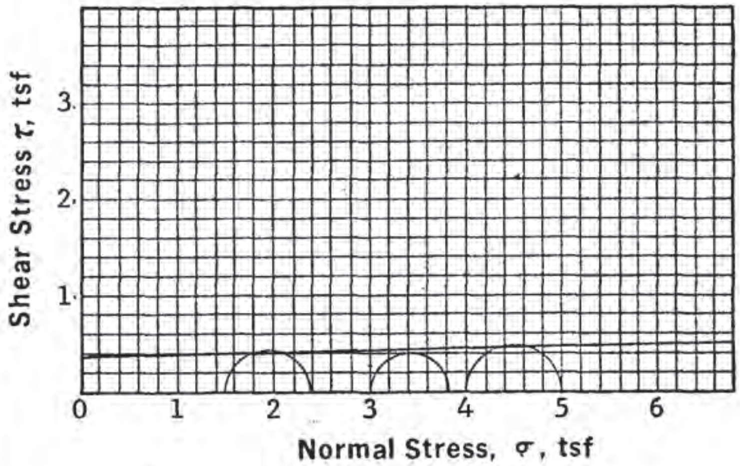
Remarks: Specimen nonuniform in moisture and density.

Project: Johnsonville S. P.	
Feature Ash Dike 2	
Boring No. US-7	**Sample No.** 2
Station N-14+00	**Range** W-17+53
Date 9-21-77	**Elev.** 373.6-373.1

TRIAXIAL COMPRESSION TEST (Q)

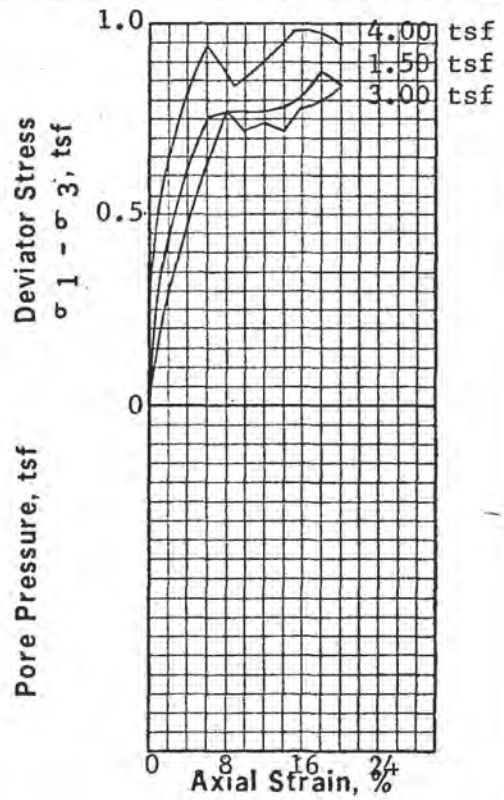
TVA 10195 (CONST-6-77) Tested by: RW Reviewed by: JCS





Type of Specimen	Undisturbed
Classification	CL
LL. 40.3	**G** 2.72
PI. 18.1	**D_{10}** --

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	1.1	.02	0.36
Effective	--	--	--



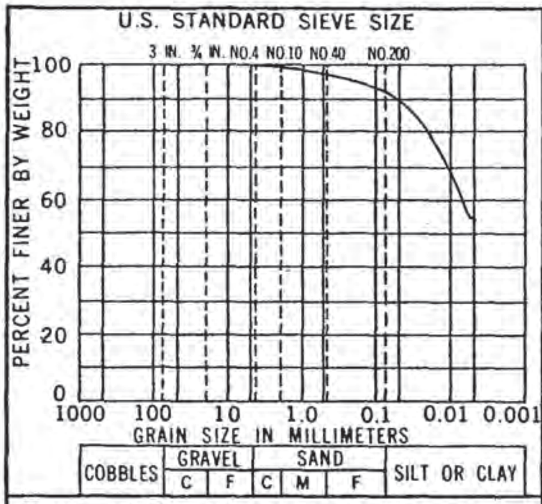
	Specimen Number	1	2	3	4
Initial	Moisture Content, %	27.0	27.2	27.7	
Initial	Dry Density, pcf	97.4	96.5	96.8	
Initial	Void Ratio	.744	.760	.754	
Initial	Saturation, %	98.9	97.4	99.9	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
Before Shearing	Saturation, %	--	--	--	
Before Shearing	Moisture Content after Consolidation, %	--	--	--	
Before Shearing	Void Ratio after Consolidation	--	--	--	
	Final Moisture Content ,%	26.6	26.9	27.4	
	Minor Principal Stress, σ_3, tsf	1.50	3.00	4.00	
	Major Principal Stress, σ_1, tsf	2.37	3.84	4.99	
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	--	--	--	
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	--	--	--	
	Time to Failure, min.	18	20	17	
	Rate of strain, %/min.	1.00	1.00	1.00	
	Specimen Height, in.	3.15	3.15	3.15	
	Specimen Diameter, in.	1.40	1.40	1.40	

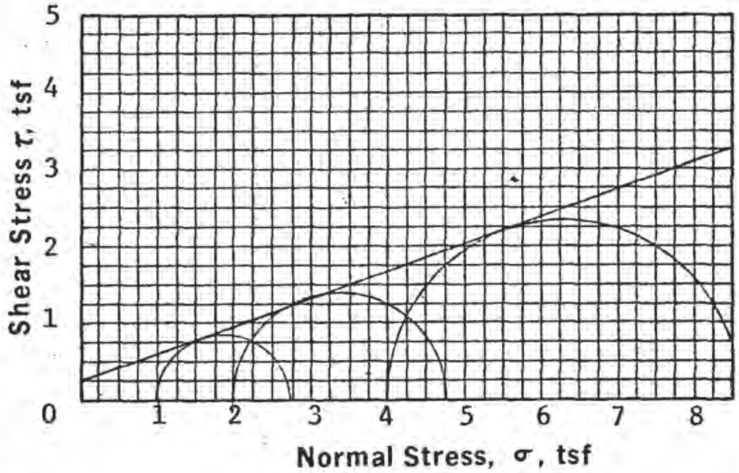
Remarks:

Project: Johnsonville S. P.	
Feature Ash Dike 2	
Boring No. US-8	**Sample No.** 1
Station N-4+00	**Range** W-16+90
Date 9-23-77	**Elev.** 358.0-357.5

TRIAXIAL COMPRESSION TEST (Q)

 Tested by: GMD & RLY Reviewed by: J. C.

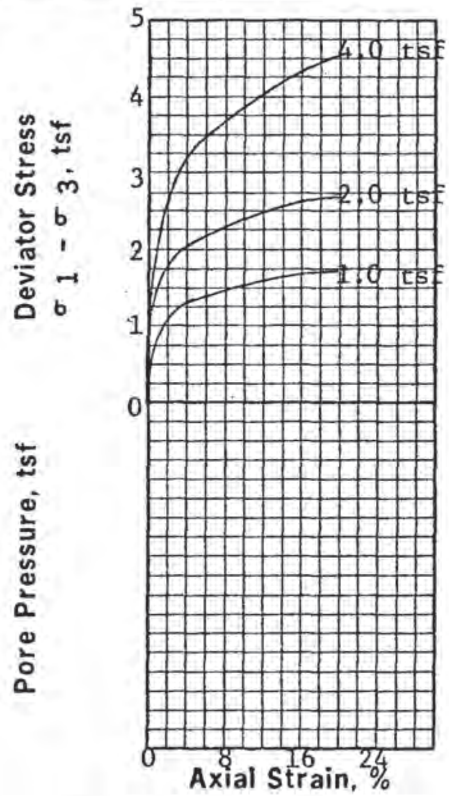




Type of Specimen	Undisturbed		
Classification	CL		
LL. 40.3		**G** 2.72	
PI. 18.1		D_{10} --	

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	20.0	.36	0.25
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	28.1	28.7	27.7	
	Dry Density, pcf	94.4	94.0	95.8	
	Void Ratio	.798	.807	.773	
	Saturation, %	95.7	96.8	97.5	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	25.2	25.0	23.0	
	Void Ratio after Consolidation	.788	.763	.712	
	Final Moisture Content ,%	25.2	25.0	23.0	
	Minor Principal Stress, σ_3, tsf	1.00	2.00	4.00	
	Major Principal Stress, σ_1, tsf	2.75	4.75	8.55	
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	--	--	--	
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	--	--	--	
	Time to Failure, min.	100	100	96	
	Rate of strain, %/min.	0.20	0.20	0.20	
	Specimen Height, in.	3.15	3.15	3.15	
	Specimen Diameter, in.	1.40	1.40	1.40	

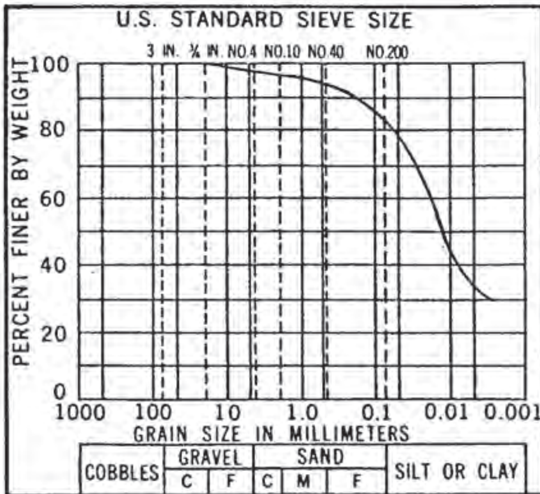


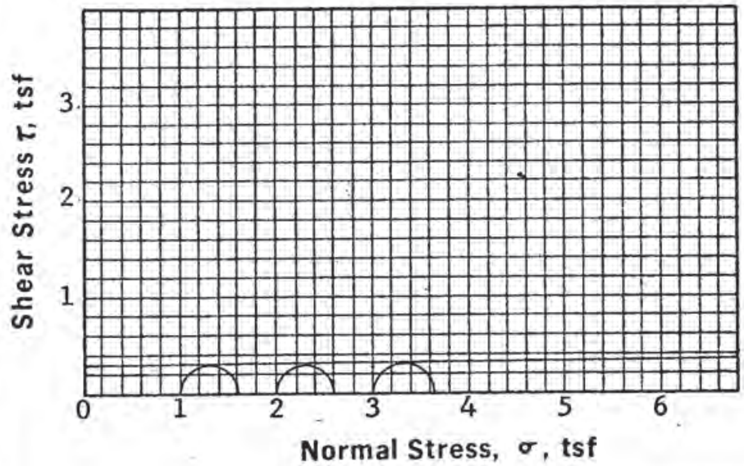
Remarks:

Project: Johnsonville Steam Plant	
Feature Ash Dike 2	
Boring No. US-8	**Sample No.** 1
Station N. 4+00	Range W.16+90
Date 7-23-77	**Elev.** 357.5-357.0

TRIAXIAL COMPRESSION TEST (R)

 Tested by: CEC Reviewed by: JCS

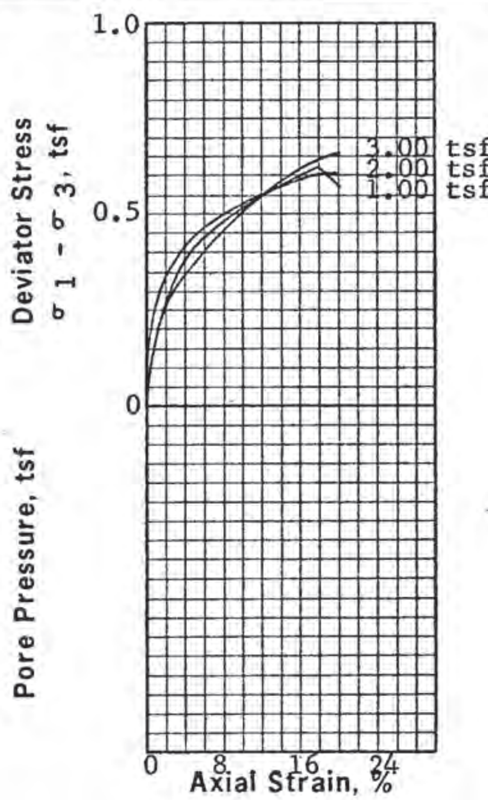




Type of Specimen	Undisturbed		
Classification	CL		
LL.	40.1	G	2.70
PI.	16.6	D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	0.5	.01	0.29
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	27.7	27.5	28.1	
	Dry Density, pcf	96.5	97.1	96.1	
	Void Ratio	.747	.737	.754	
	Saturation, %	100.0	100.0	100.0	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
	Final Moisture Content ,%	27.4	27.3	27.7	
	Minor Principal Stress, σ 3, tsf	1.00	2.00	3.00	
	Major Principal Stress, σ 1, tsf	1.62	2.61	3.66	
	Effective Minor Principal Stress, $\bar{\sigma}$ 3, tsf	--	--	--	
	Effective Major Principal Stress, $\bar{\sigma}$ 1, tsf	--	--	--	
	Time to Failure, min.	17	18	19	
	Rate of strain, %/min.	1.00	1.00	1.00	
	Specimen Height, in.	3.15	3.15	3.15	
	Specimen Diameter, in.	1.40	1.40	1.40	



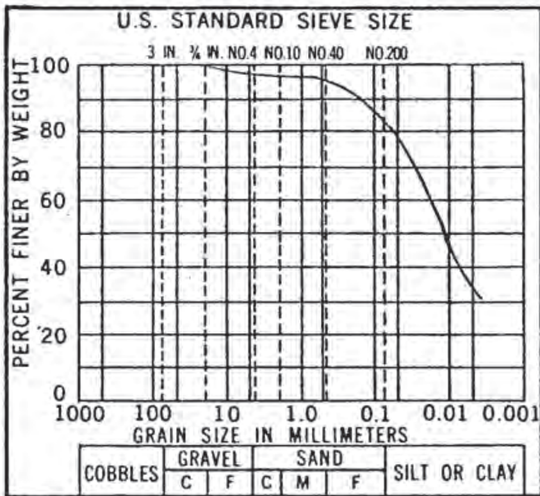
Remarks:

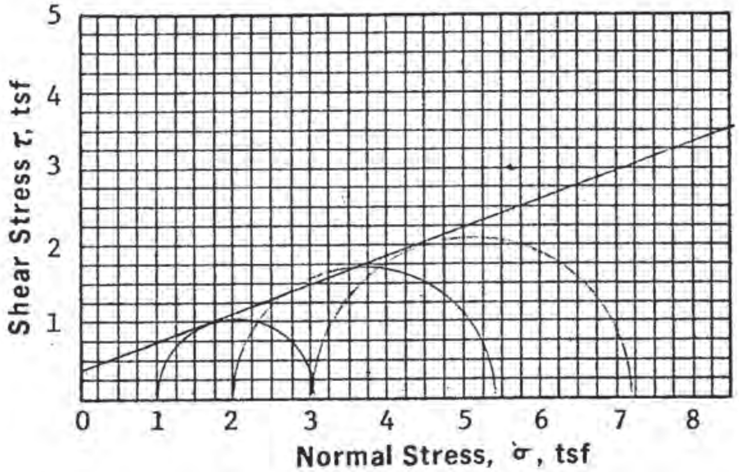
Project:	Johnsonville S.P.		
Feature	Ash Dike 2		
Boring No.	US-8	Sample No.	4
Station	N-4+00	Range	W-16+90
Date	9-21-77	Elev.	345.4-344.9

TRIAXIAL COMPRESSION TEST (Q)

TVA 10195 (CONST-6-77) Tested by: RW Reviewed by: JCB

ATTACHMENT 2
CONST-QCP 5.3

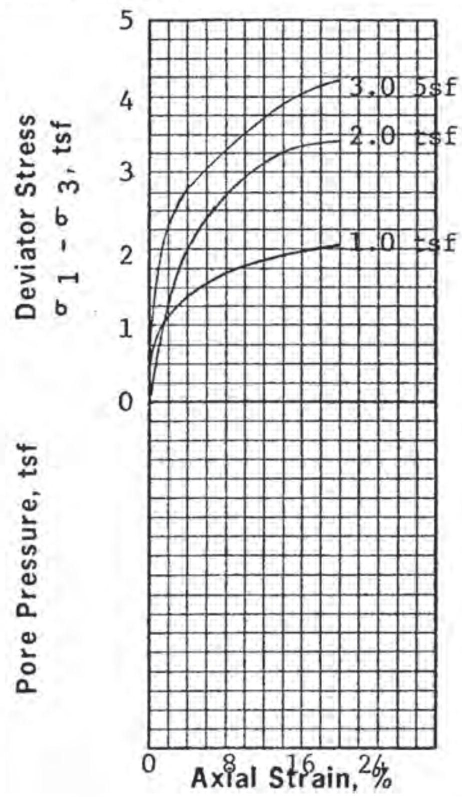




Type of Specimen	Undisturbed
Classification	CL
LL. 40.1	G 2.70
PI. 16.6	D_{10} --

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	20.5	.37	0.38
Effective	--	--	--

Specimen Number		1	2	3	4
Initial	Moisture Content, %	28.6	26.7	27.8	
	Dry Density, pcf	93.9	97.2	95.9	
	Void Ratio	.795	.734	.757	
	Saturation, %	97.0	98.1	99.0	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	26.7	24.0	23.8	
	Void Ratio after Consolidation	.717	.621	.651	
Final Moisture Content ,%		26.7	24.0	23.8	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		3.07	5.41	7.19	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		99	99	99	
Rate of strain, %/min.		0.20	0.20	0.20	
Specimen Height, in.		3.15	3.15	3.15	
Specimen Diameter, in.		1.40	1.40	1.40	

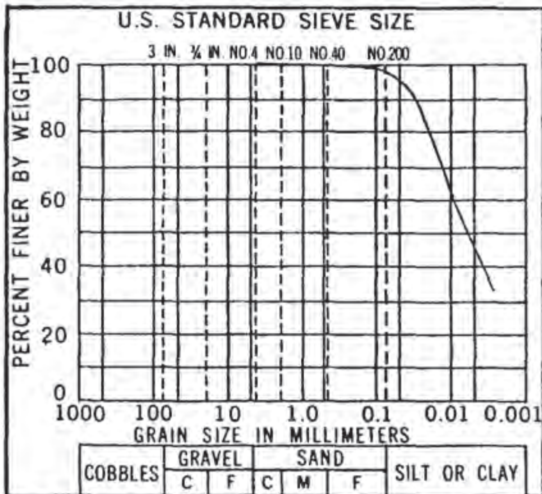


Remarks:

Project:	Johnsonville Steam Plant
Feature	Ash Dike 2
Boring No. US-8	Sample No. 4
Station N. 4+00	Range W-16+90
Date 9-24-77	Elev. 344.9-344.4

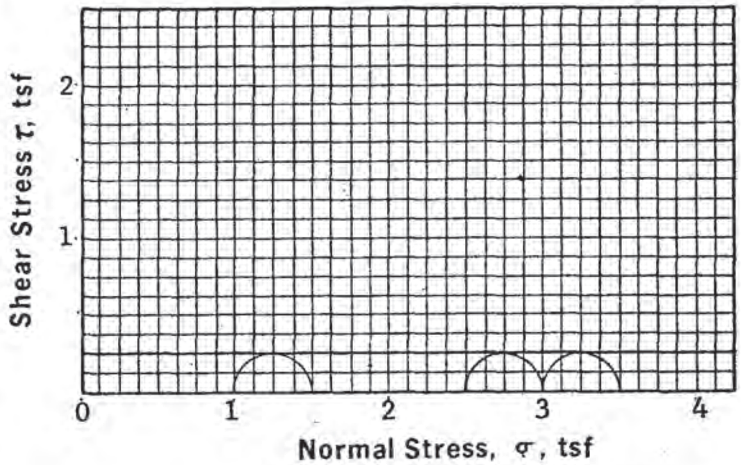
TRIAXIAL COMPRESSION TEST (R)

TVA 10195 (CONST-6-77) Tested by: E.L. Reviewed by: JCS



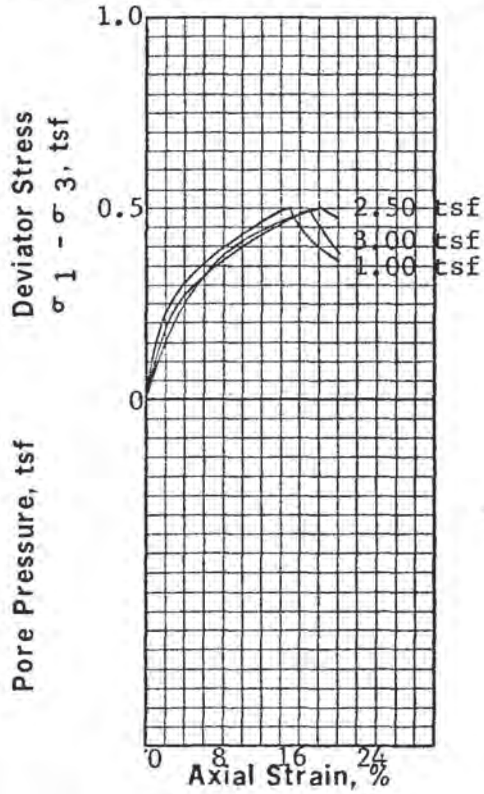
Type of Specimen	Undisturbed
Classification	CL

LL.	37.4	G	2.67
PI.	16.3	D_{10}	--



Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	0.0	.00	0.25
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	29.5	30.4	29.6	
Initial	Dry Density, pcf	90.8	89.7	91.4	
Initial	Void Ratio	.835	.859	.824	
Initial	Saturation, %	94.2	94.4	95.7	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
Before Shearing	Saturation, %	--	--	--	
Before Shearing	Moisture Content after Consolidation, %	--	--	--	
Before Shearing	Void Ratio after Consolidation	--	--	--	
	Final Moisture Content ,%	29.1	30.2	29.3	
	Minor Principal Stress, σ_3, tsf	1.00	2.50	3.00	
	Major Principal Stress, σ_1, tsf	1.50	3.00	3.49	
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	--	--	--	
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	--	--	--	
	Time to Failure, min.	15	18	17	
	Rate of strain, %/min.	1.00	1.00	1.00	
	Specimen Height, in.	3.15	3.15	3.15	
	Specimen Diameter, in.	1.40	1.40	1.40	



Remarks:

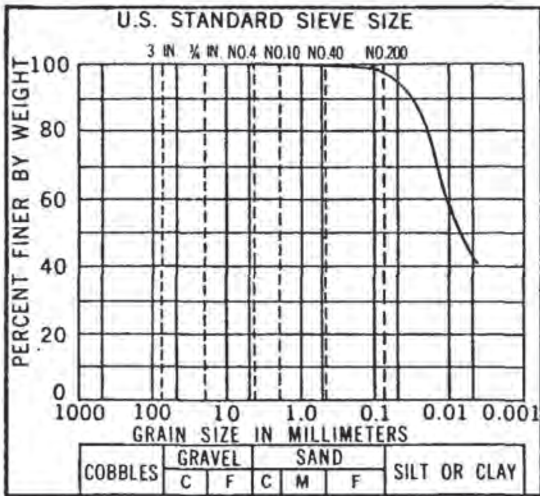
Project: Johnsonville S. P.	
Feature Ash Dike 2	
Boring No. US-8	Sample No. 6
Station N-4+00	Range W-16+90
Date 9-23-77	Elev. 338.9-338.4

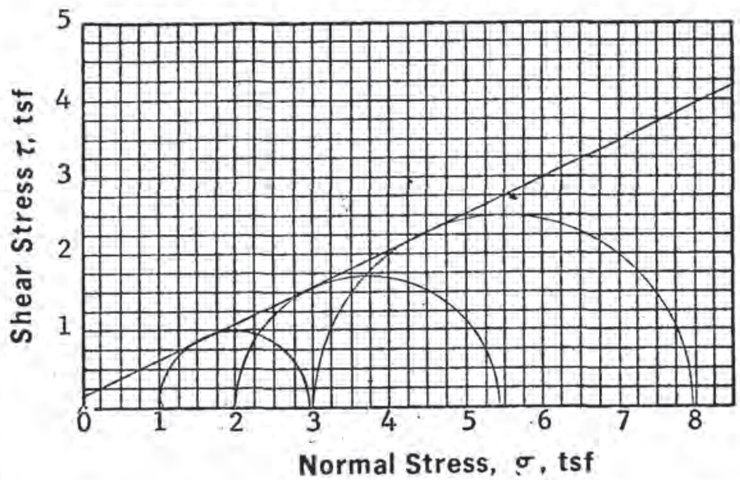
TRIAXIAL COMPRESSION TEST (Q)

TVA 10195 (CONST-6-77)

Tested by: RLY

Reviewed by: [illegible]

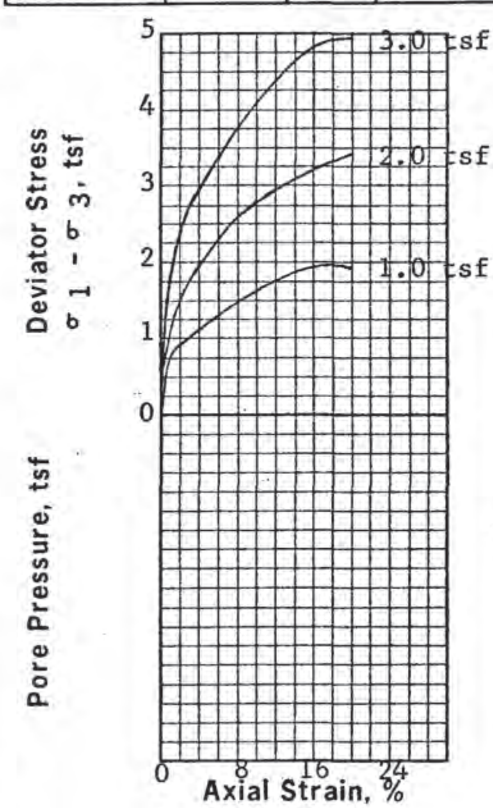




Type of Specimen	Undisturbed		
Classification	CL		
LL.	37.4	G	2.67
PI.	16.3	D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	25.0	.47	0.15
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	27.7	28.2	27.5	
	Dry Density, pcf	95.9	95.3	96.5	
	Void Ratio	.738	.749	.723	
	Saturation, %	100.0	100.0	100.0	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	25.0	23.6	22.5	
	Void Ratio after Consolidation	.664	.672	.630	
	Final Moisture Content ,%	25.0	23.6	22.5	
	Minor Principal Stress, σ_3, tsf	1.00	2.00	3.00	
	Major Principal Stress, σ_1, tsf	2.94	5.42	7.98	
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	--	--	--	
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	--	--	--	
	Time to Failure, min.	90	99	91	
	Rate of strain, %/min.	0.20	0.20	0.20	
	Specimen Height, in.	3.15	3.15	3.15	
	Specimen Diameter, in.	1.40	1.40	1.40	

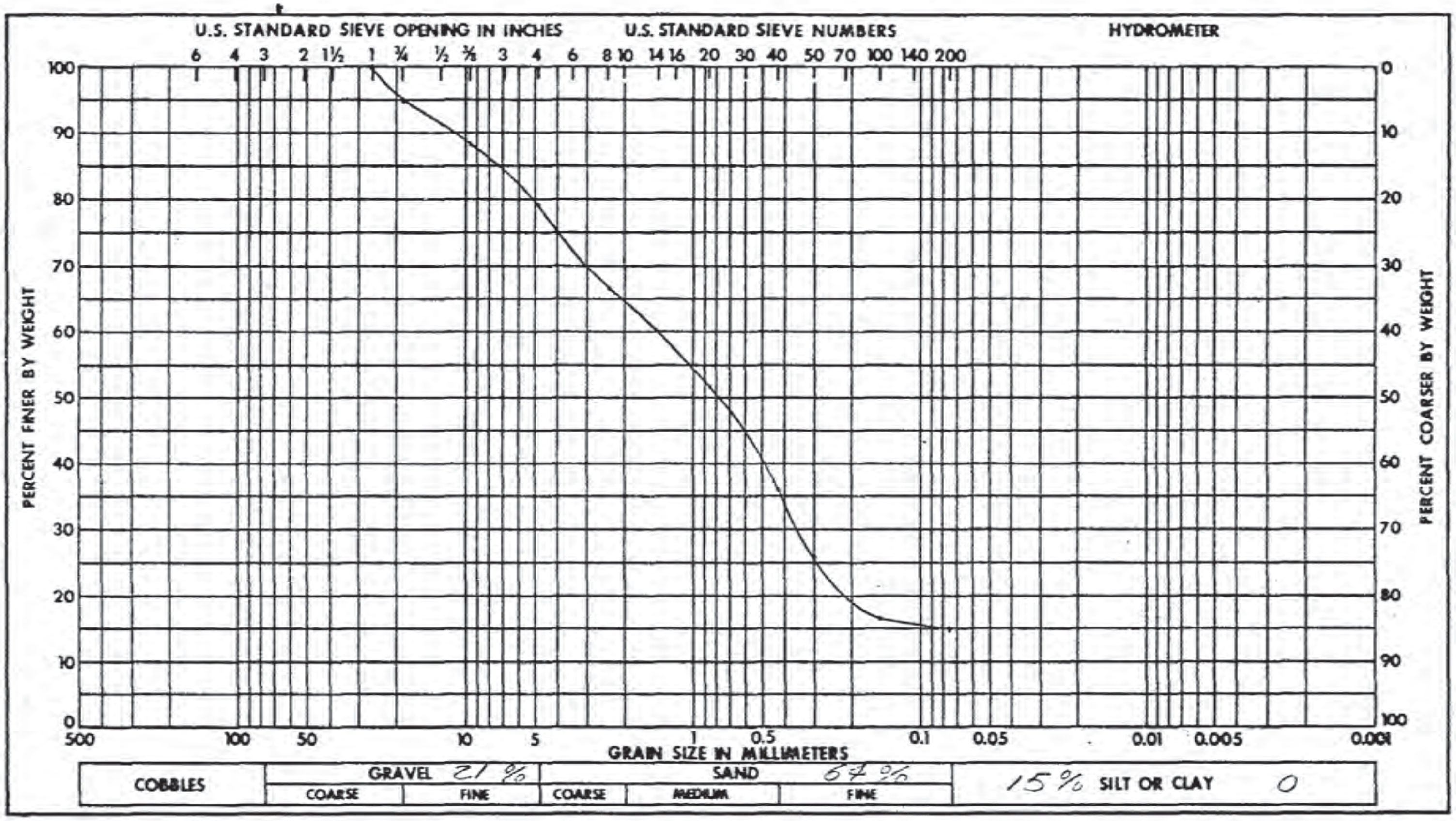


Remarks:

Project:	Johnsonville Steam Plant		
Feature	Ash Dike 2		
Boring No.	US-8	Sample No.	6
Station	N 4+00	Range	W 16+90
Date	9-29-77	Elev.	338.4-338.0

TRIAXIAL COMPRESSION TEST (R)

TVA 10195 (CONST-6-77) Tested by: E.L. Reviewed by: JCS



Soil Symbol	G-SM	**Liquid Limit, %**	NP
Moisture Content, %	10.9	**Plastic Limit, %**	NP
Specific Gravity		**Plasticity Index, %**	NP
		Shrinkage Limit, %	

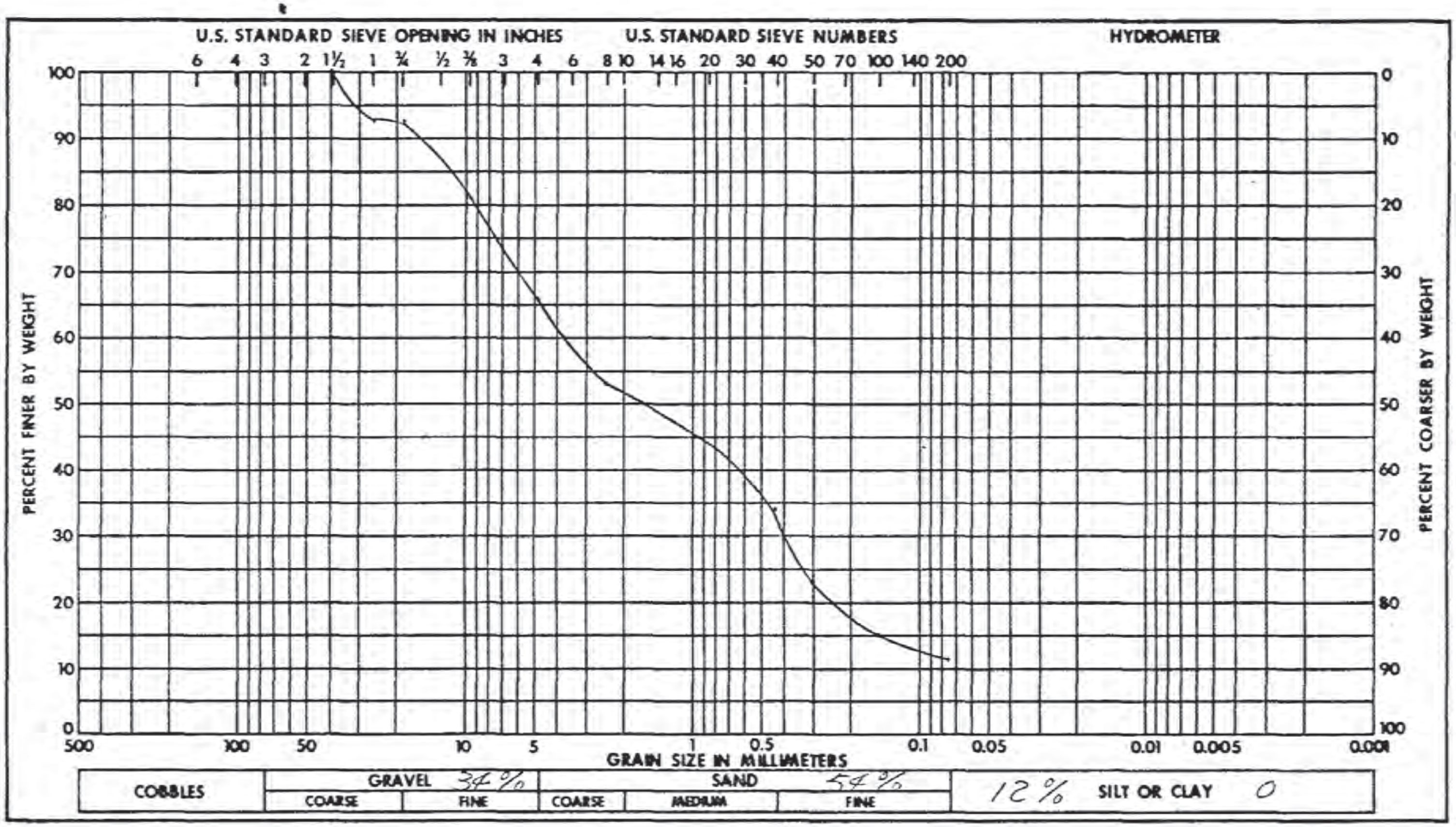
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6A	**Sample No.** 1A
Station	Range
Date 11-2-77	**Elevation** 367.9-366.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ______ Reviewed by: ______



Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	11.9	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

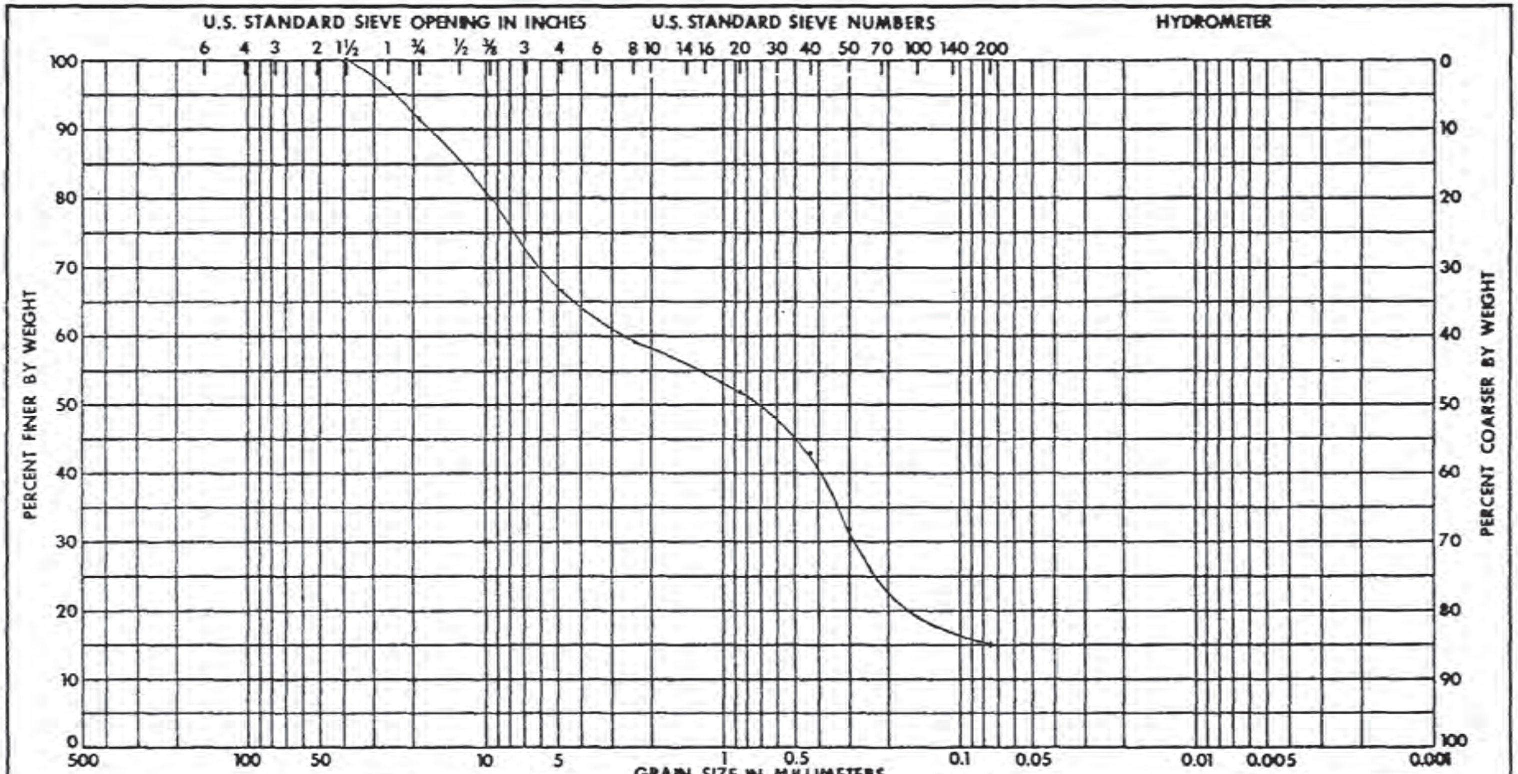
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6A	Sample No. 2A
Station	Range
Date 11-2-77	Elevation 365.9-364.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ____________ Reviewed by: ____________



COBBLES	GRAVEL 33%		SAND 52%			15% SILT OR CLAY 0%
	COARSE	FINE	COARSE	MEDIUM	FINE	

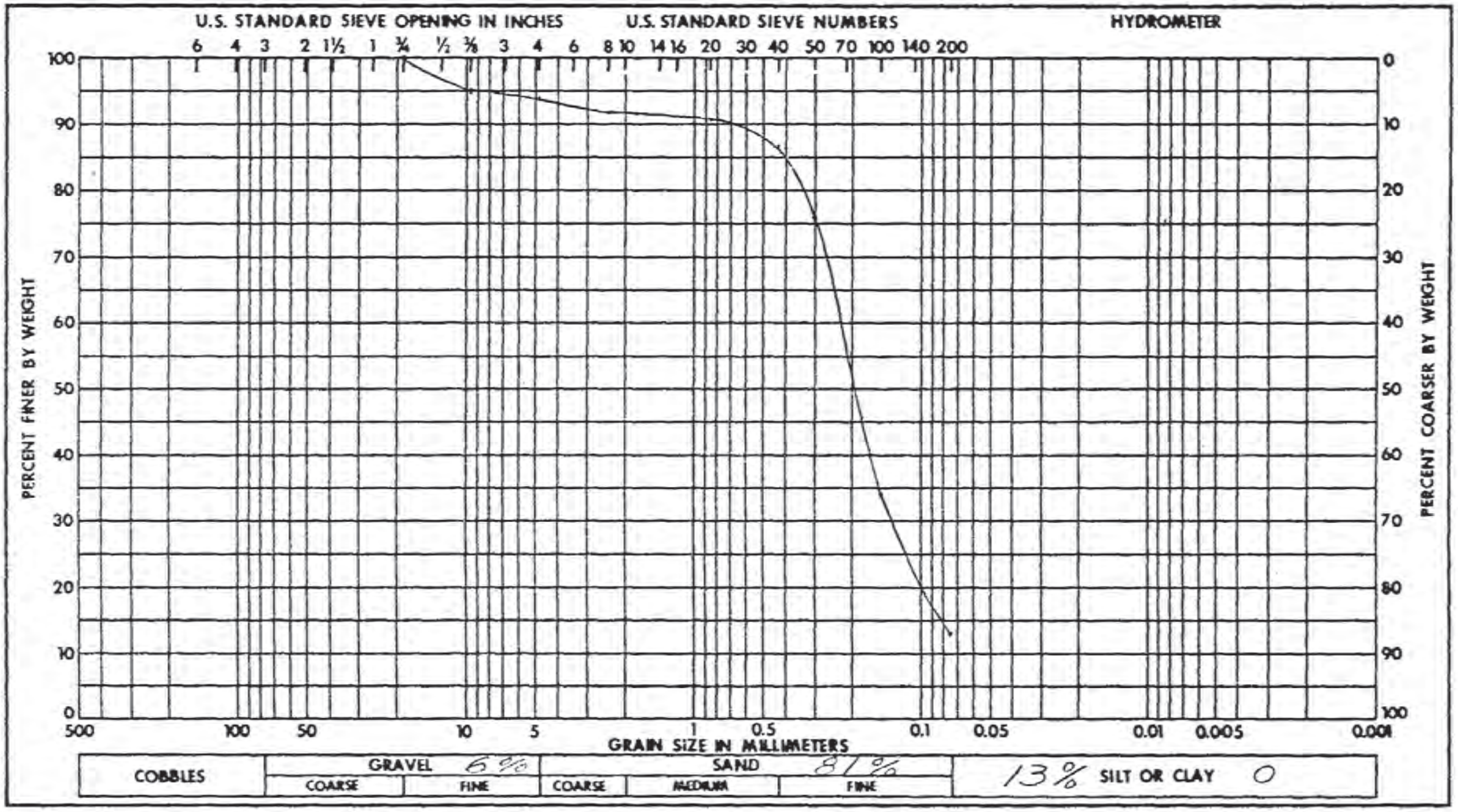
Soil Symbol	GSM	Liquid Limit, %	NP
Moisture Content, %	20.0	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6A	Sample No. 3A
Station	Range
Date 11-2-77	Elevation 363.9-362.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77) Tested by: ______ Reviewed by: ______



Soil Symbol	SM	Liquid Limit, %	NP
Moisture Content, %	31.4	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:

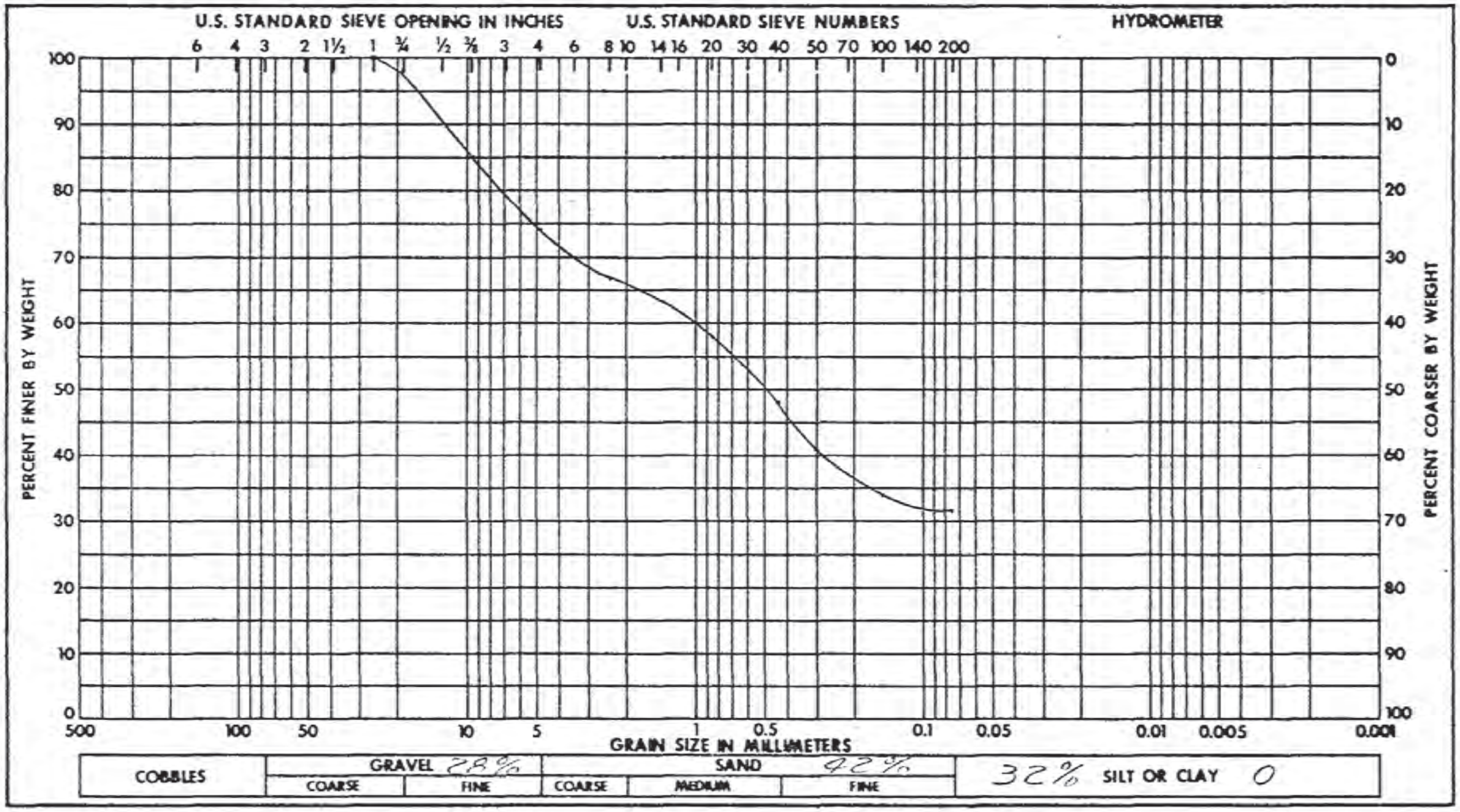
Project Johnsonville S. P.	
Feature	
Boring No. SS-6A	Sample No. 4A
Station	Range
Date 11-2-77	Elevation 361.9-360.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ______ Reviewed by: ______

ATTACHMENT 6
CONST-QCP 5.3



Soil Symbol	GSM	Liquid Limit, %	NP
Moisture Content, %	14.9	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

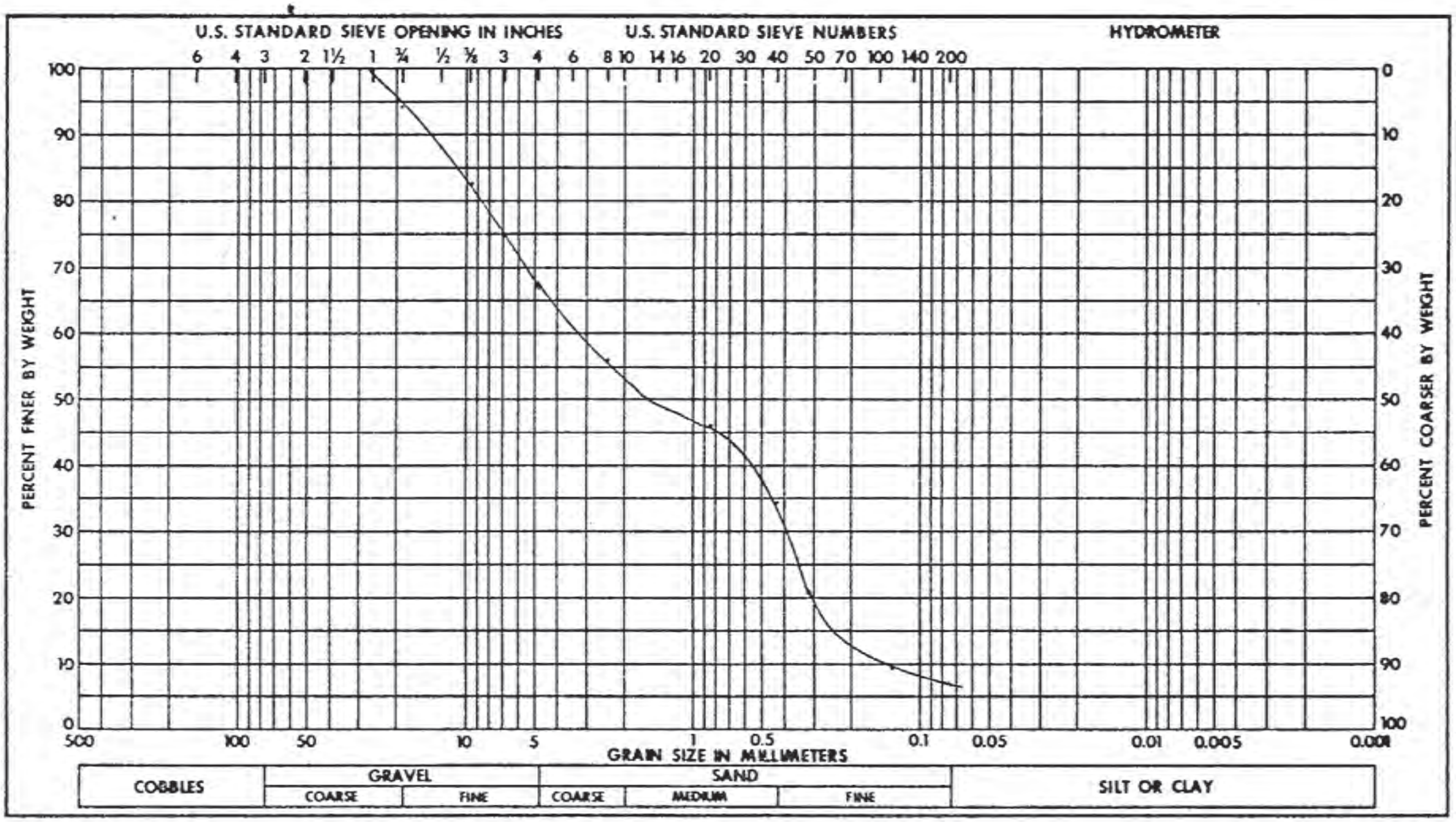
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6B	Sample No. 1A
Station	Range
Date 11-2-77	Elevation 367.9-366.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ______ Reviewed by: ______



Soil Symbol	G-SP-SM	Liquid Limit, %	NP
Moisture Content, %		Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:

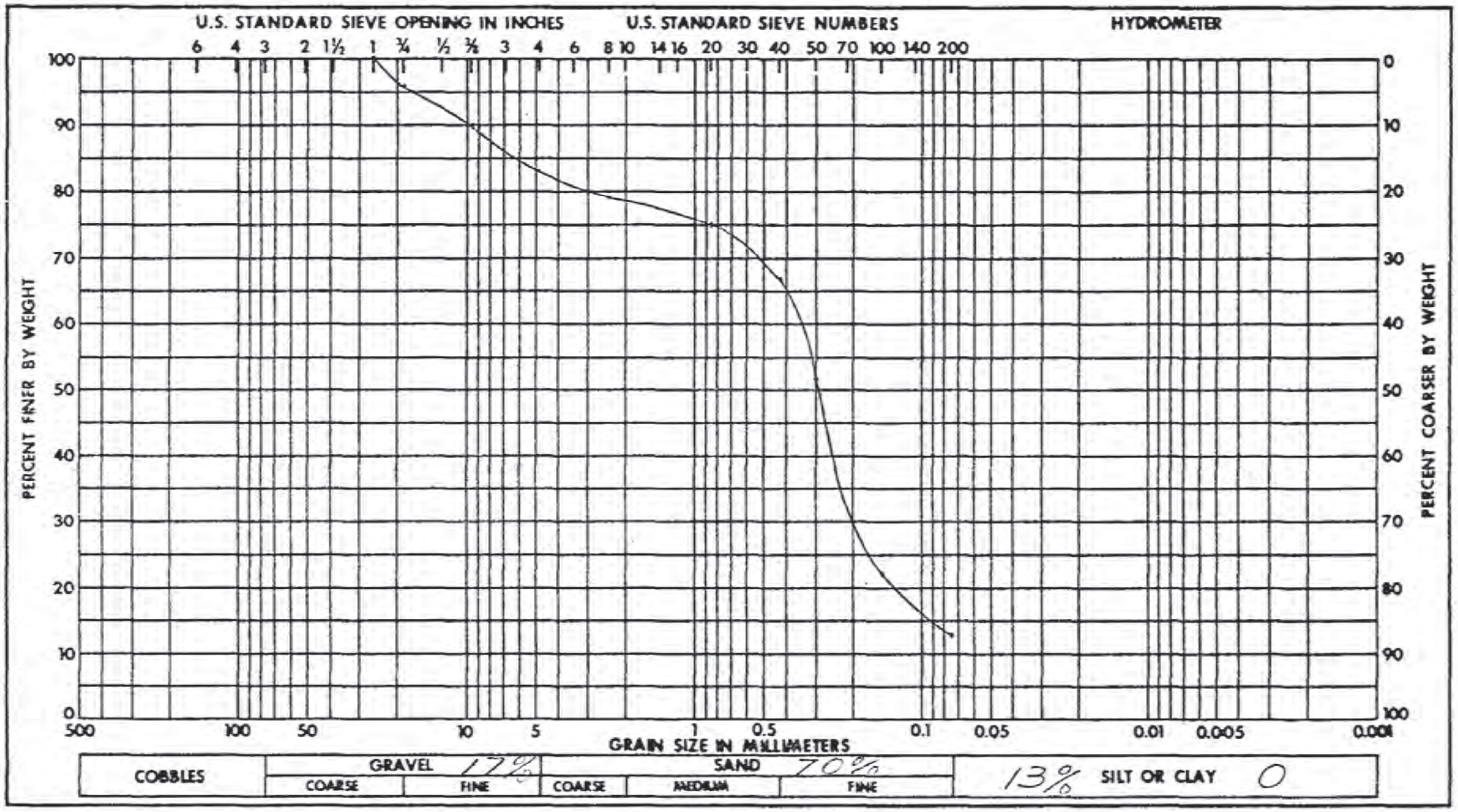
Cu.=22.0
Cc=.31

Project Johnsonville S.P.	
Feature	
Boring No. SS-6B	Sample No. 2A
Station	Range
Date 10-4-77	Elevation 365.9-364.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ____________ Reviewed by: ____________



Soil Symbol	GSM	Liquid Limit, %	NP
Moisture Content, %	26.0	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

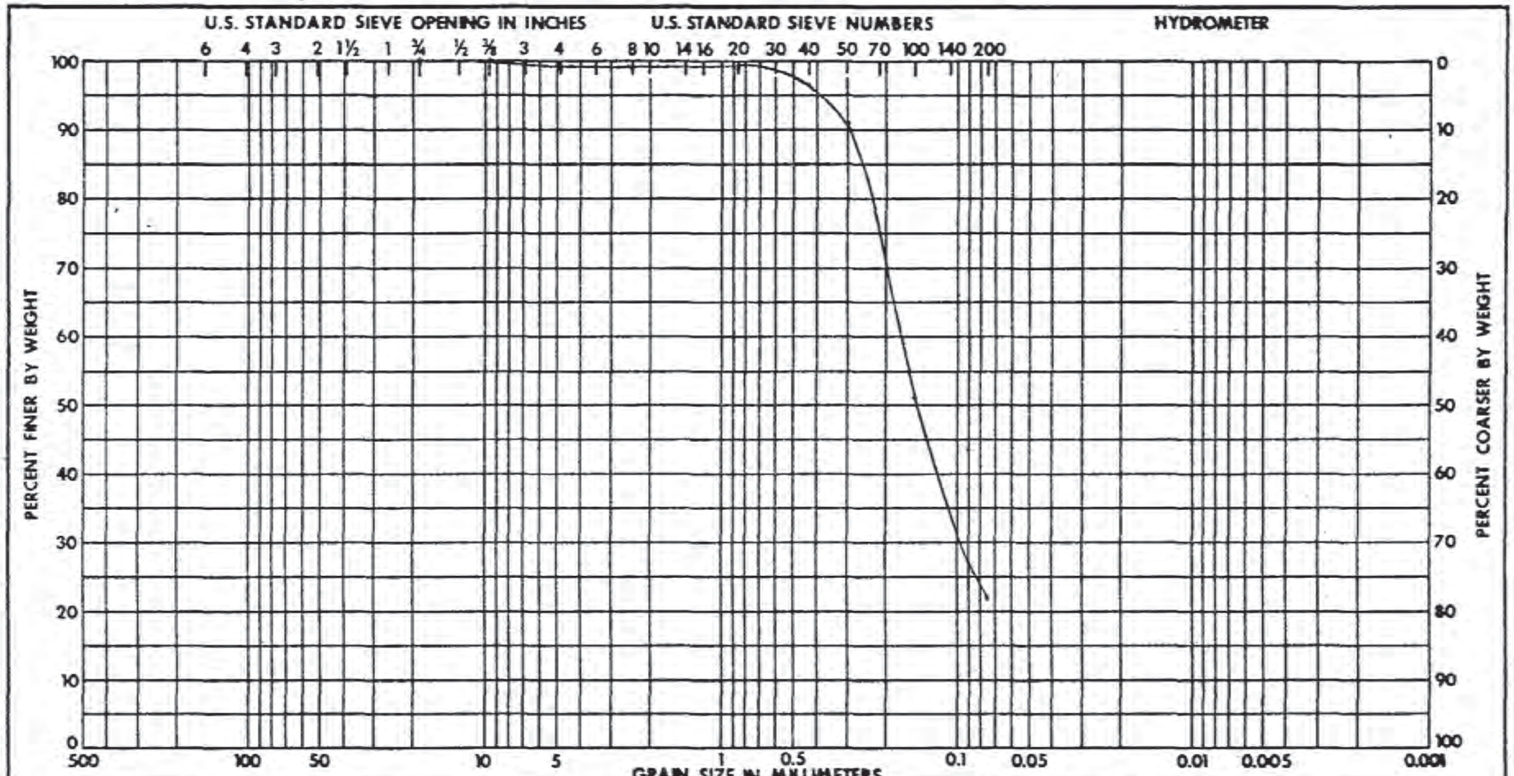
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6B	Sample No. 3A
Station	Range
Date 11-2-77	Elevation 363.9-362.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ____________ Reviewed by: ____________



COBBLES	GRAVEL 1%		SAND 77%			22% SILT OR CLAY 0
	COARSE	FINE	COARSE	MEDIUM	FINE	

Soil Symbol	SM	Liquid Limit, %	NP
Moisture Content, %	32.6	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

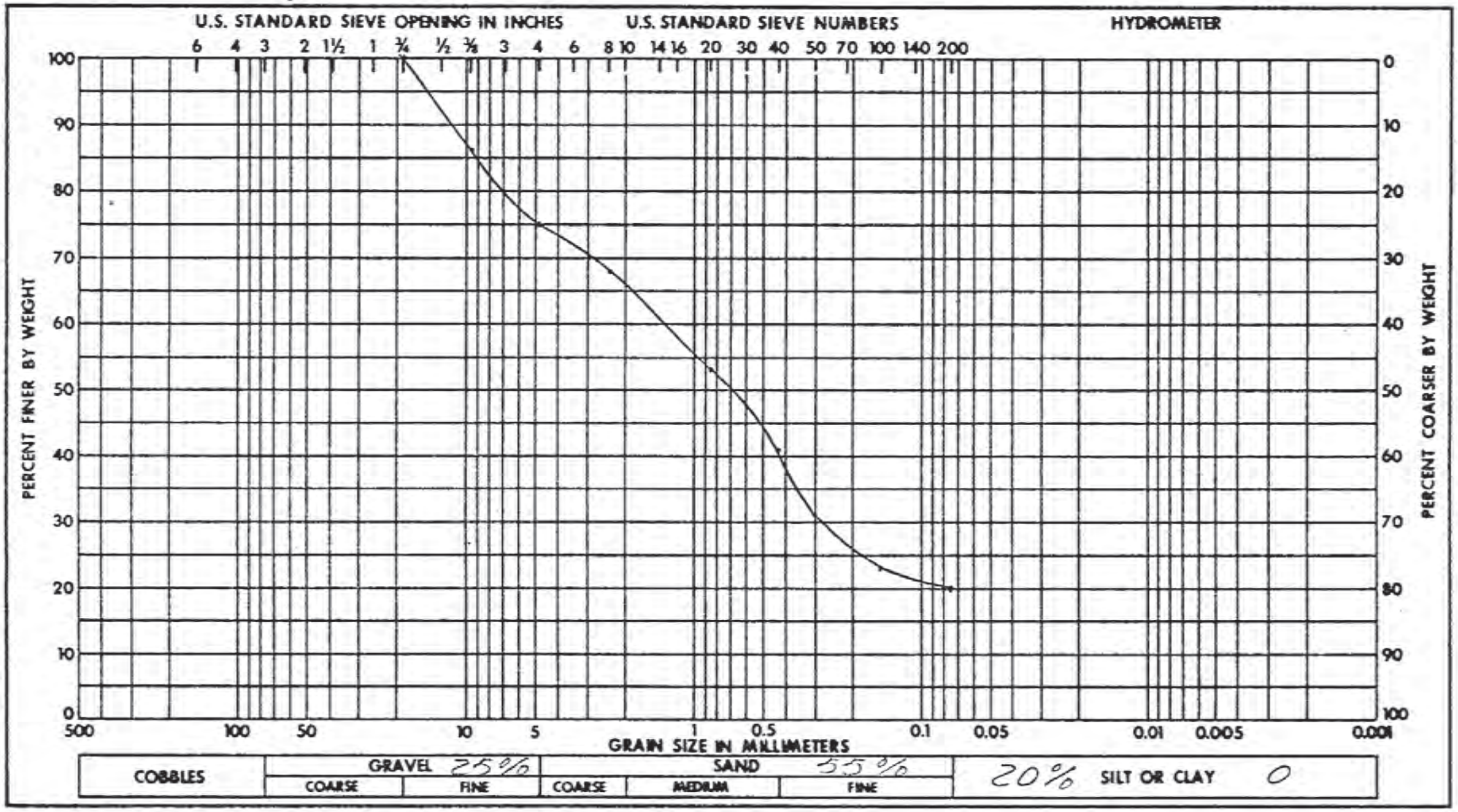
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6B	Sample No. 4A
Station	Range
Date 11-2-77	Elevation 361.9-360.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ________ Reviewed by: ________



Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	10.8	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

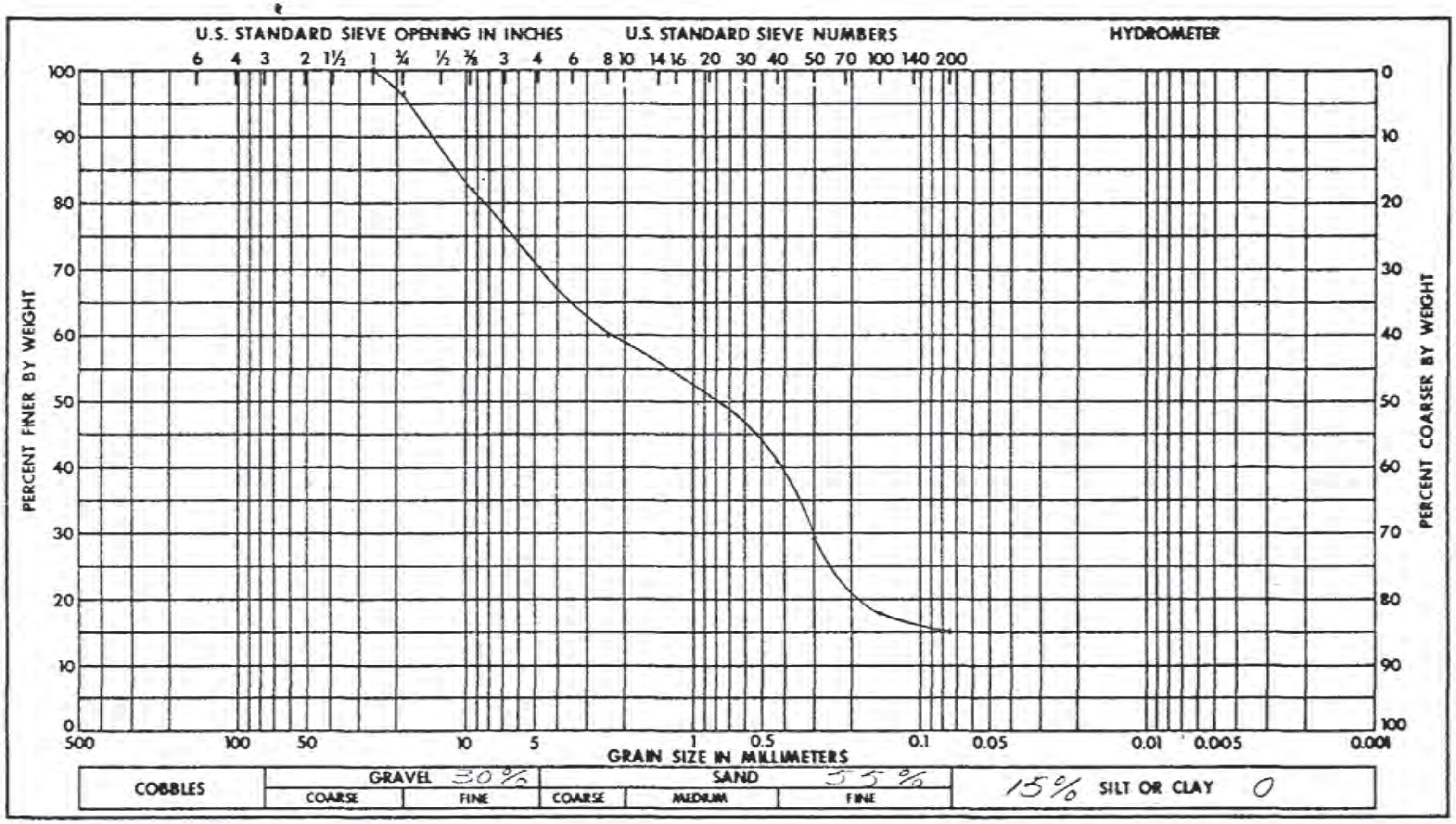
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6C	Sample No. 1A
Station	Range
Date 11-2-77	Elevation 367.9-366.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ____________ Reviewed by: ____________



Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	15.7	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

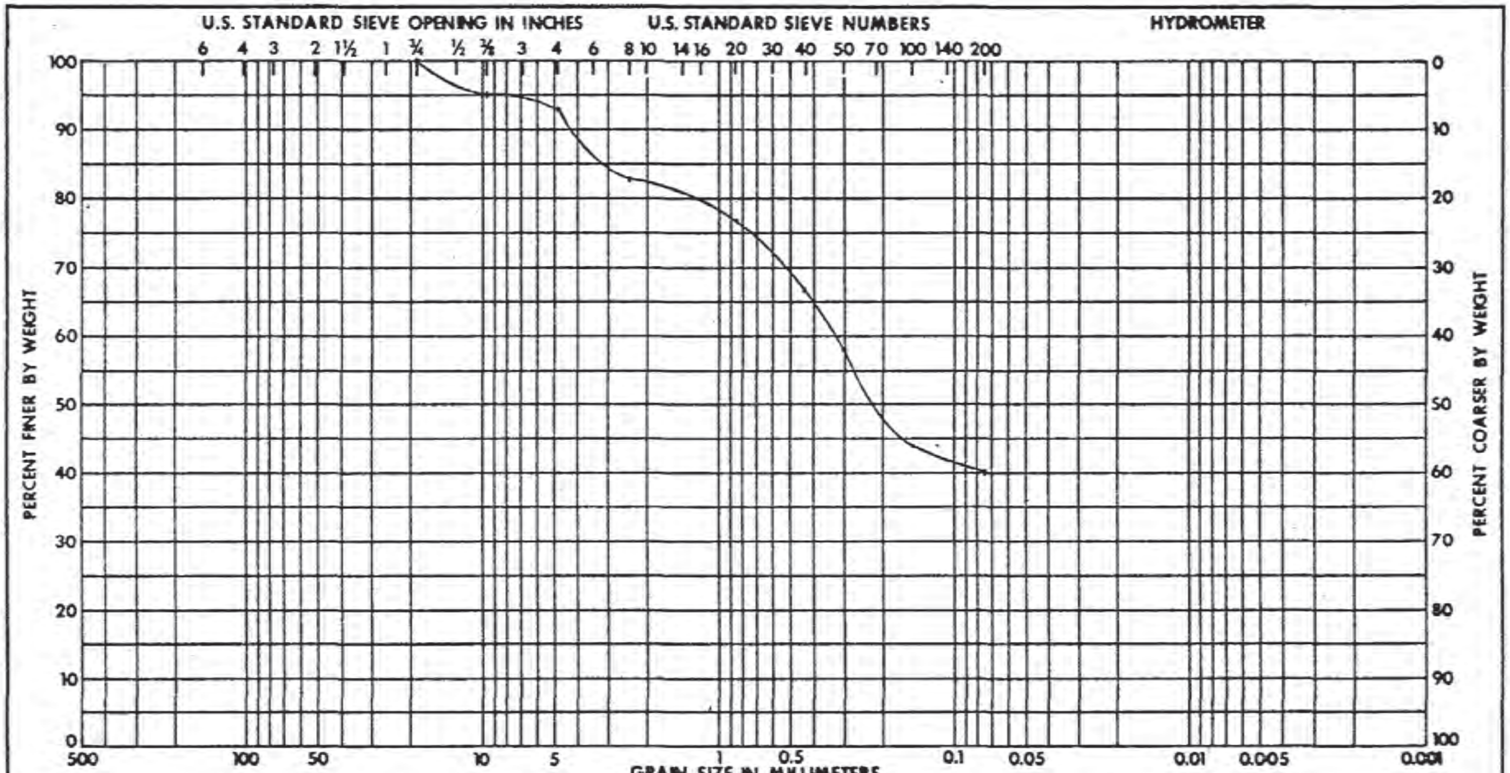
Remarks:

Project Johnsonville S. P	
Feature	
Boring No. SS-6C	Sample No. 2A
Station	Range
Date 11-2-77	Elevation 365.9-364.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ____________ Reviewed by: ____________



COBBLES	GRAVEL 7%		SAND 53%			40% SILT OR CLAY 0
	COARSE	FINE	COARSE	MEDIUM	FINE	

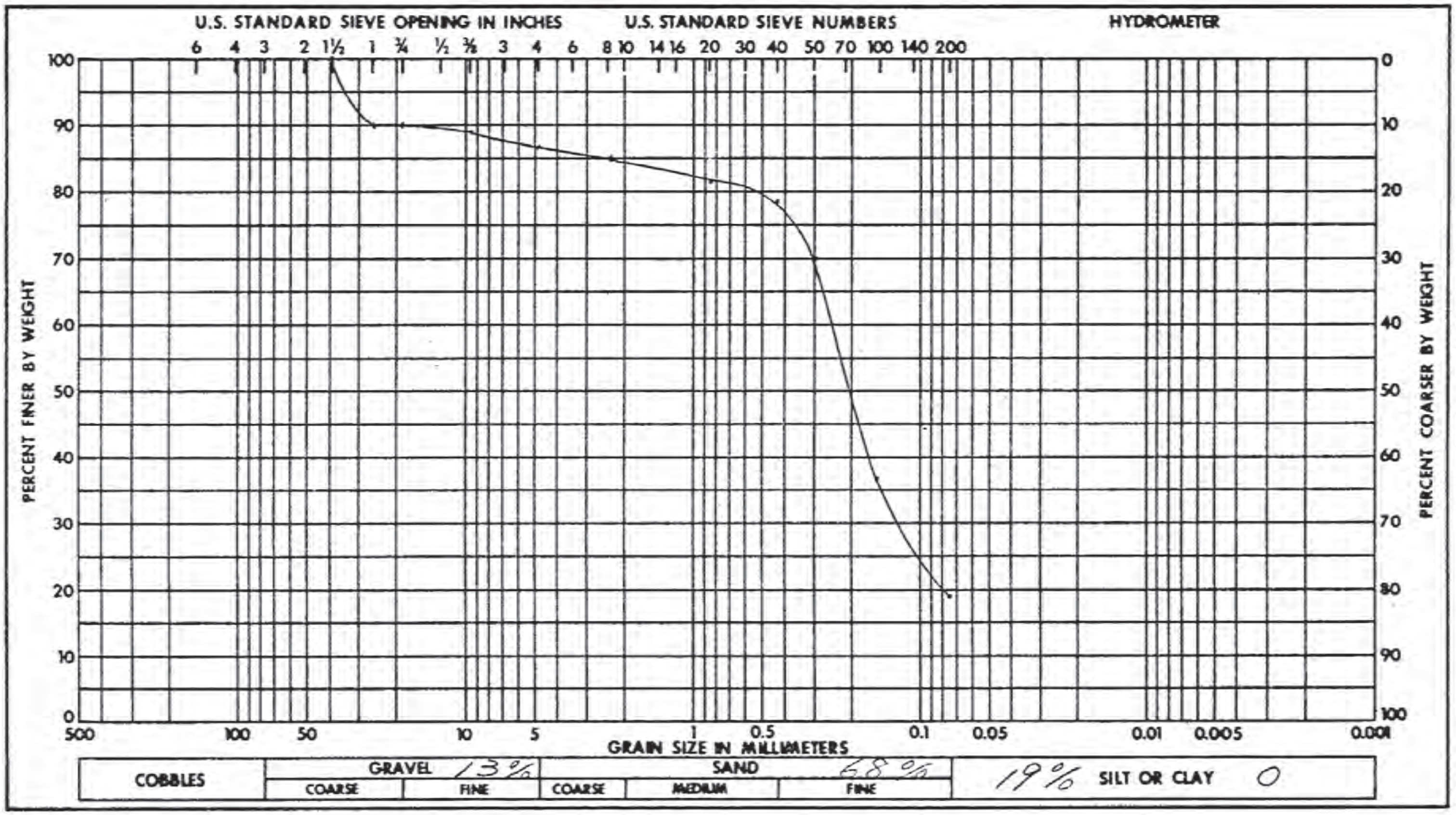
Soil Symbol	SM	Liquid Limit, %	NP
Moisture Content, %	23.0	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6C	Sample No. 3A
Station	Range
Date 11-2-77	Elevation 363.9-362.9

GRAIN SIZE ANALYSIS

Tested by: ____________ Reviewed by: ____________



Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	26.9	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

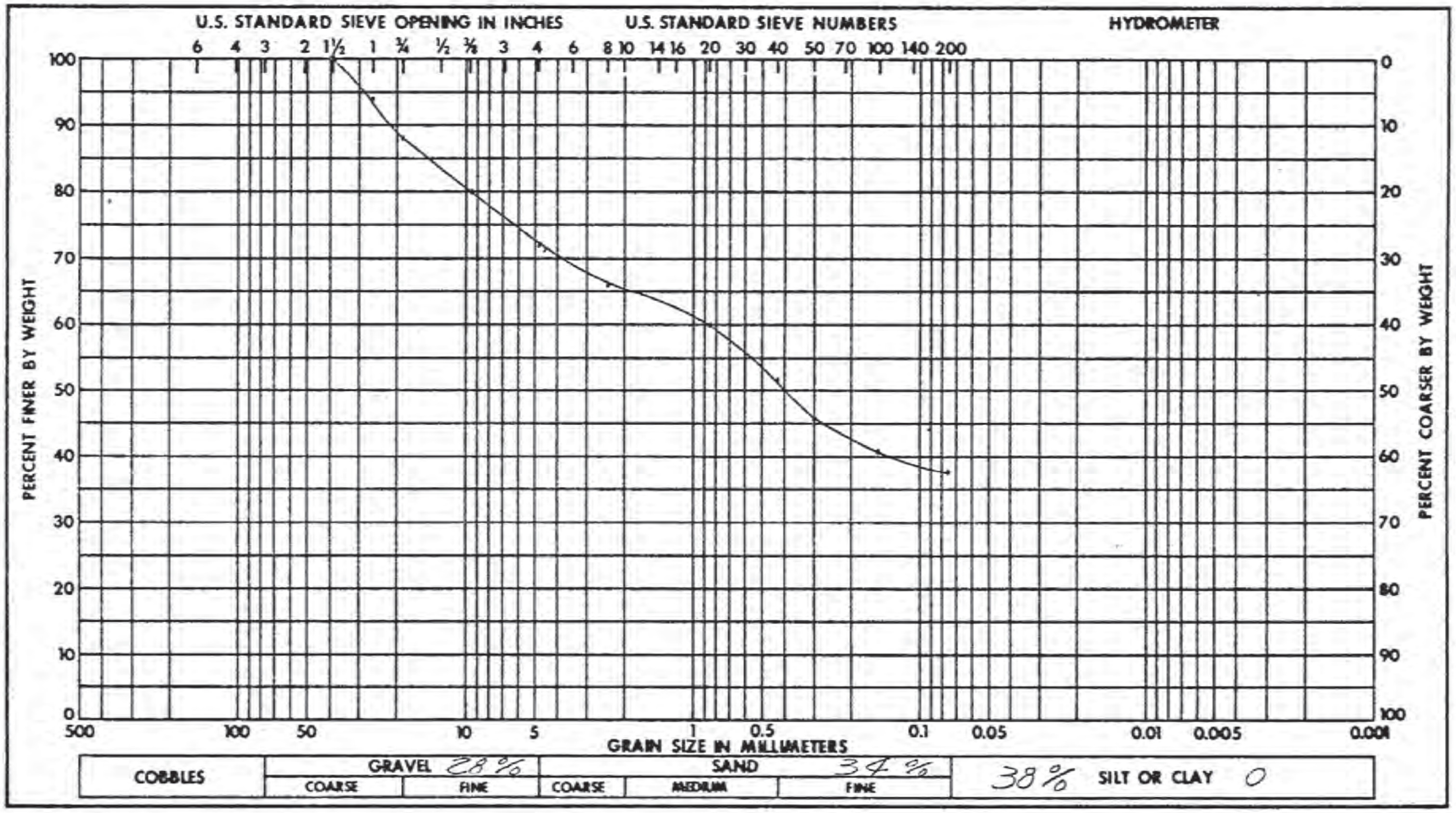
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6C	Sample No. 4A
Station	Range
Date 11-2-77	Elevation 361.9-360.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ____________ Reviewed by: ____________



Soil Symbol	GSM	Liquid Limit, %	NP
Moisture Content, %	15.8	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:

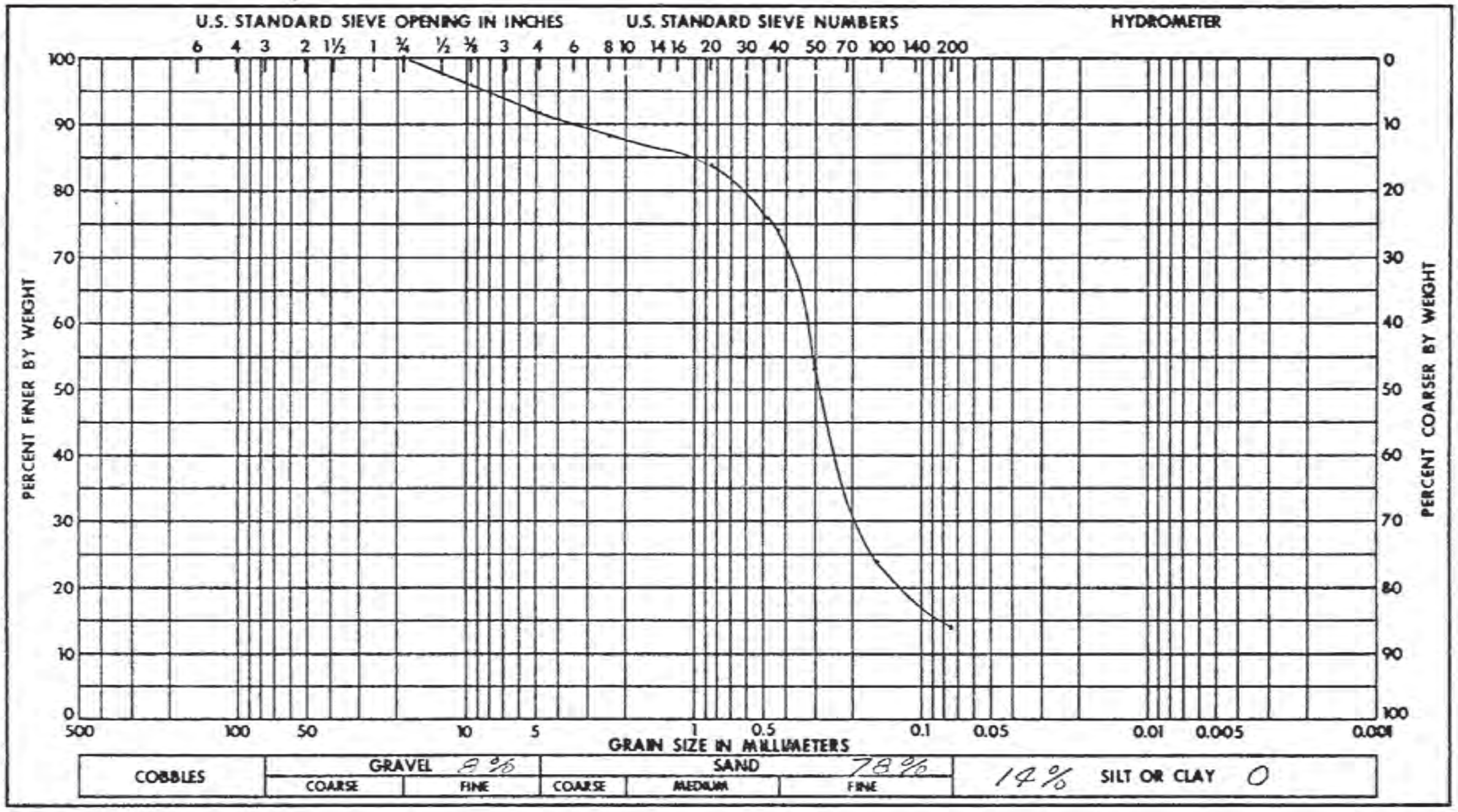
Project Johnsonville S. P.	
Feature	
Boring No. SS-6D	**Sample No.** 1A
Station	Range
Date 11-2-77	**Elevation** 367.9-366.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ______________ Reviewed by: ______________

ATTACHMENT 6
CONST-QCP 5.3



Soil Symbol	SM	Liquid Limit, %	NP
Moisture Content, %	27.0	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

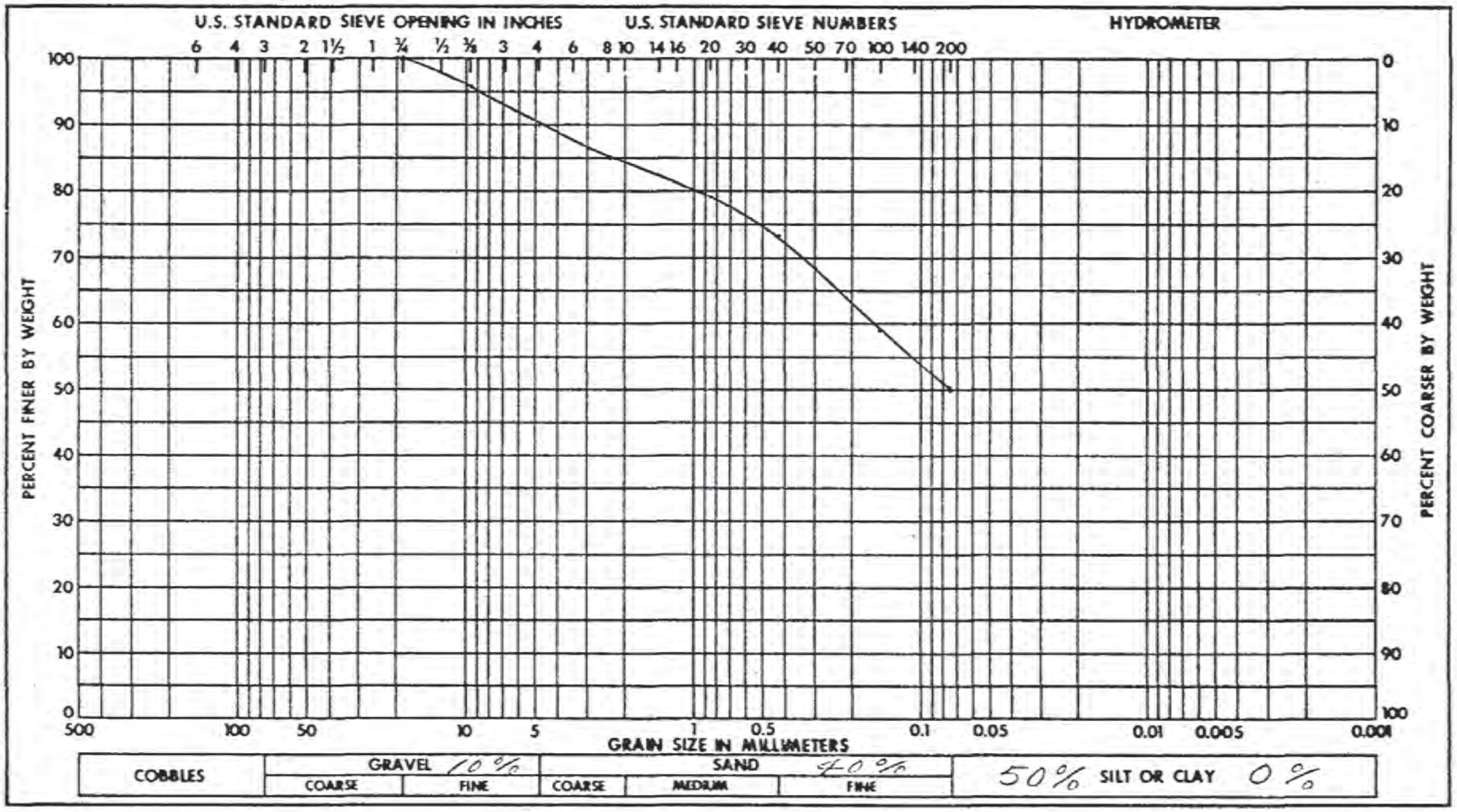
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6D	Sample No. 3A
Station	Range
Date 11-2-77	Elevation 363.9-362.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ____________ Reviewed by: ____________



Soil Symbol	ML	Liquid Limit, %	NP
Moisture Content, %	27.0	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

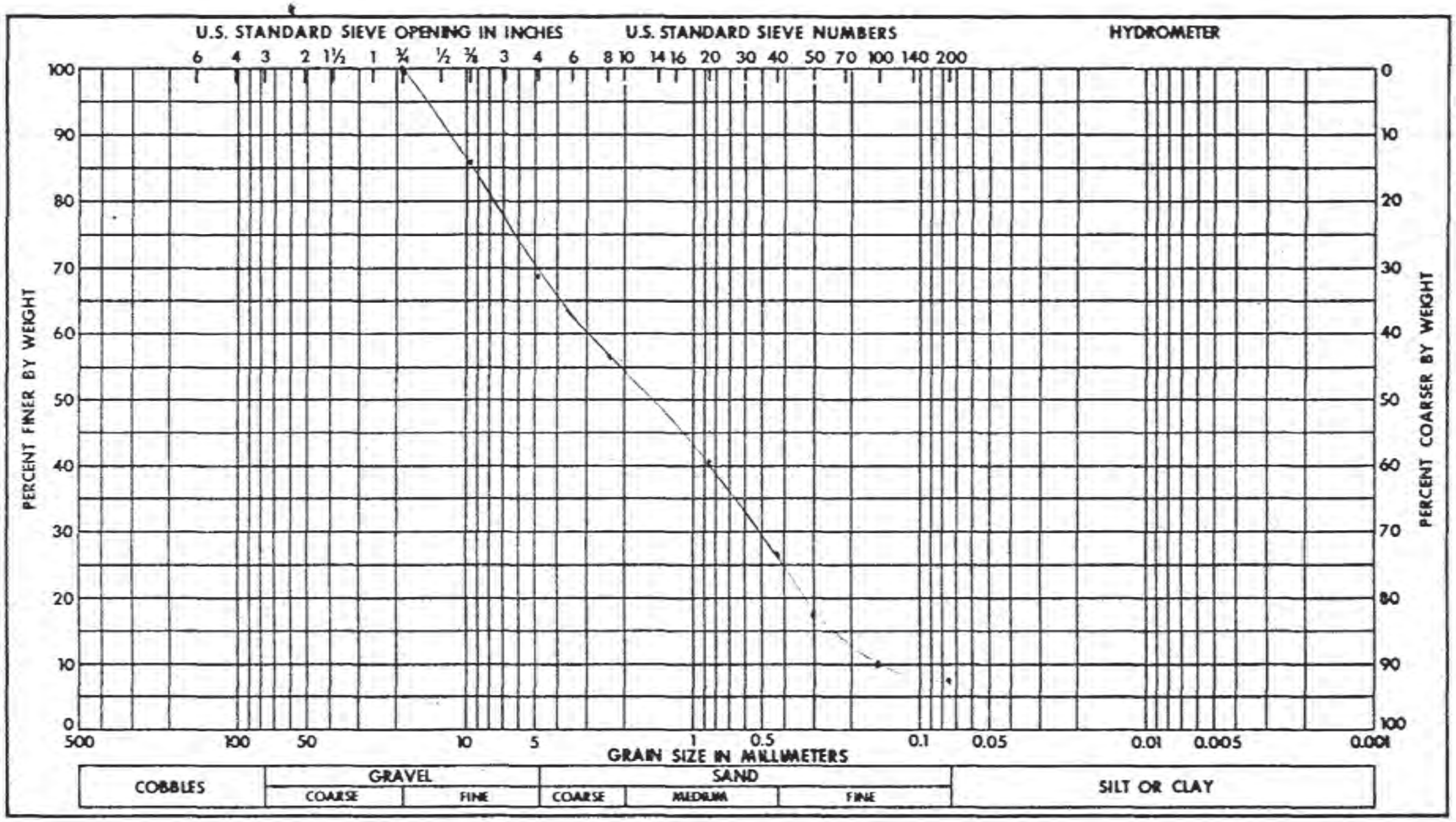
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6D	Sample No. 4A
Station	Range
Date 11-2-77	Elevation 361.9-360.9

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ______ Reviewed by: ______



Soil Symbol	G-SP-SM	**Liquid Limit, %**	NP
Moisture Content, %		**Plastic Limit, %**	NP
Specific Gravity		**Plasticity Index, %**	NP
		Shrinkage Limit, %	

Remarks:

$C_u = 17.6$

$C_c = .51$

Project Johnsonville S. P.

Feature

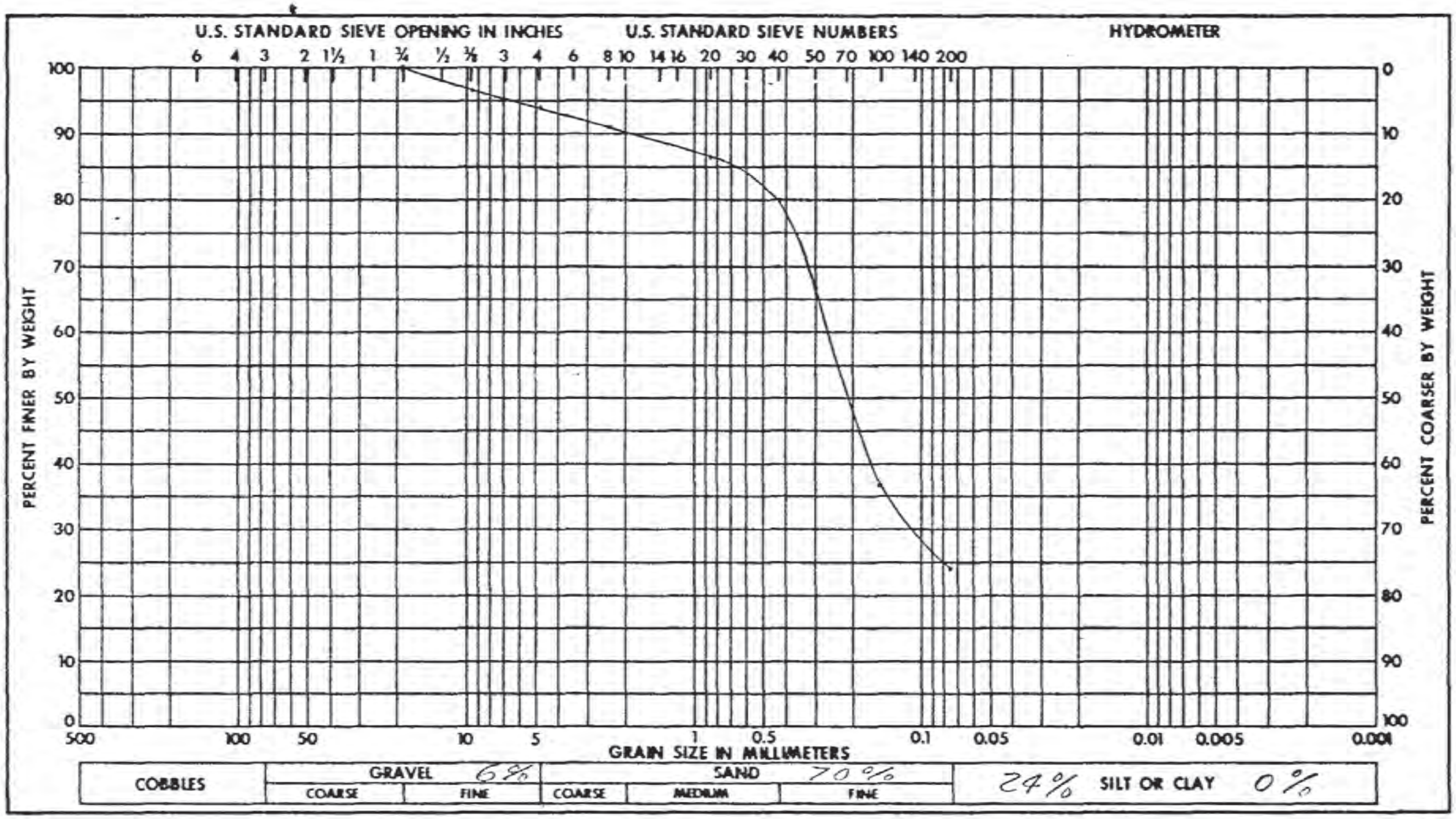
Boring No. 556E **Sample No.** 2A

Station Range

Date 10-4-77 **Elevation** 365.4-364.4

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77) Tested by: ______ Reviewed by: ______



Soil Symbol	SM	Liquid Limit, %	NP
Moisture Content, %	24.7	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

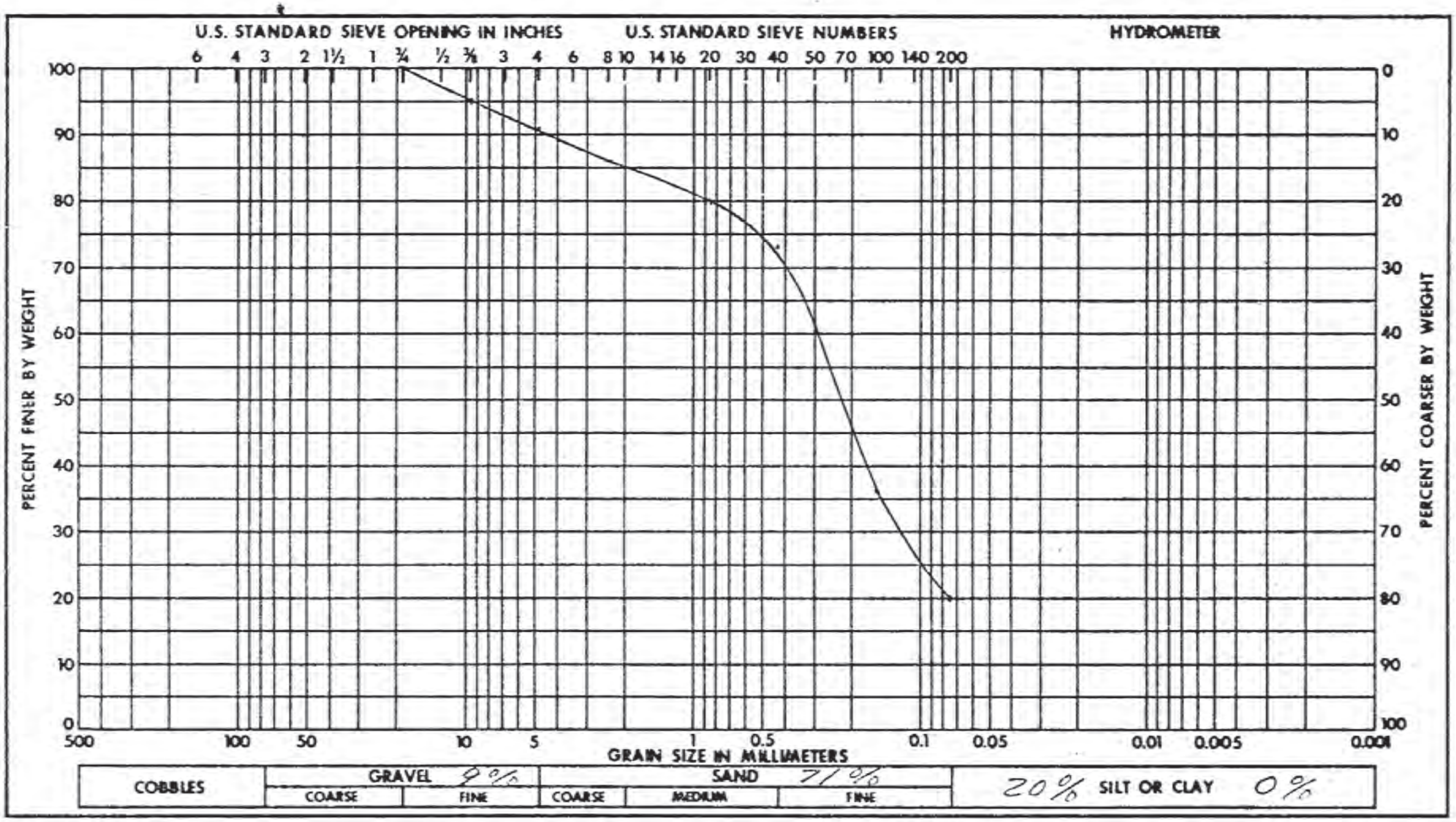
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6E	Sample No. 3A
Station	Range
Date 11-2-77	Elevation 363.4-362.4

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ____________ Reviewed by: ____________



Soil Symbol	SM	Liquid Limit, %	NP
Moisture Content, %	24.0	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

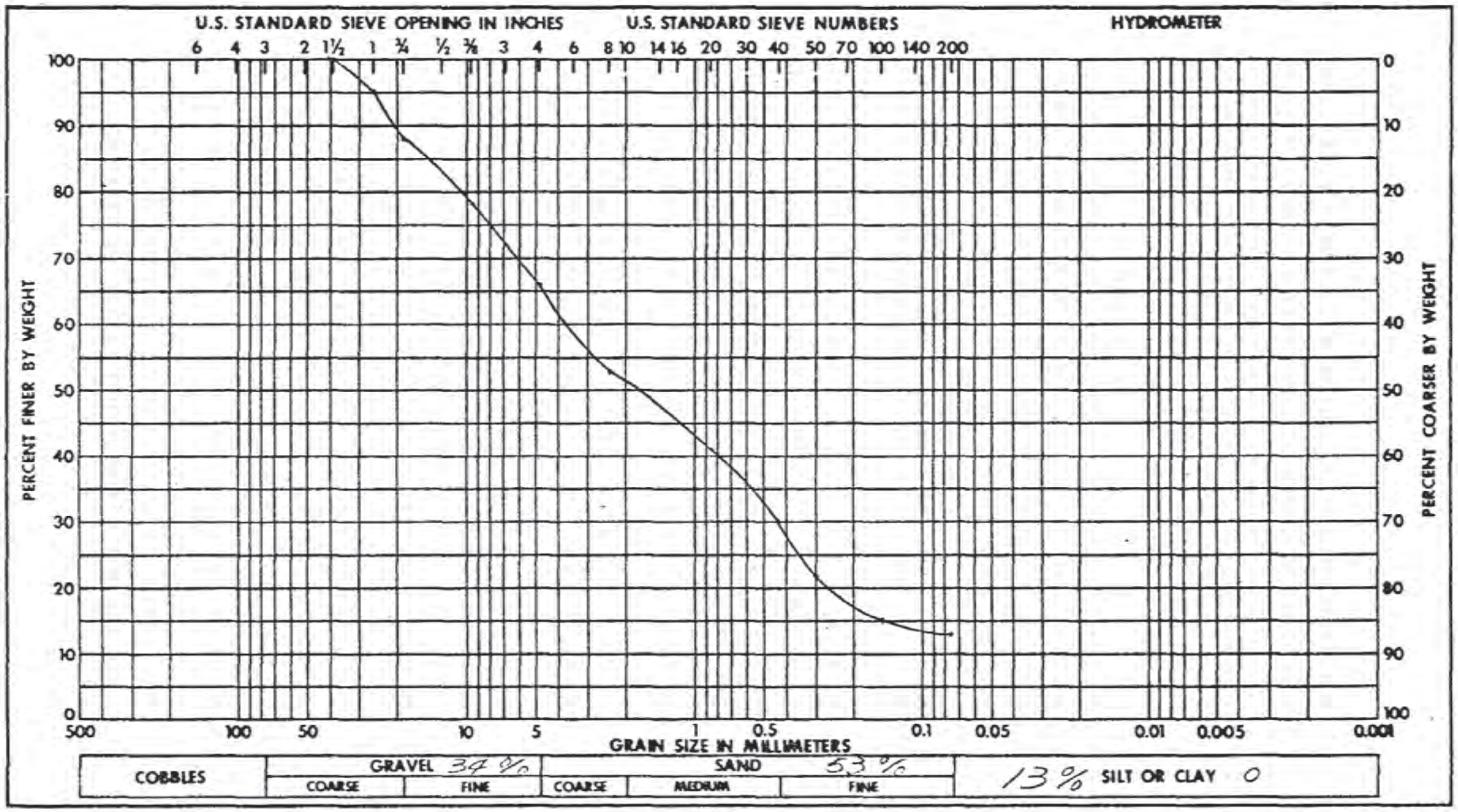
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6E	Sample No. 4A
Station	Range
Date 11-2-77	Elevation 3614-3608

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ______ Reviewed by: ______



Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	8.95	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

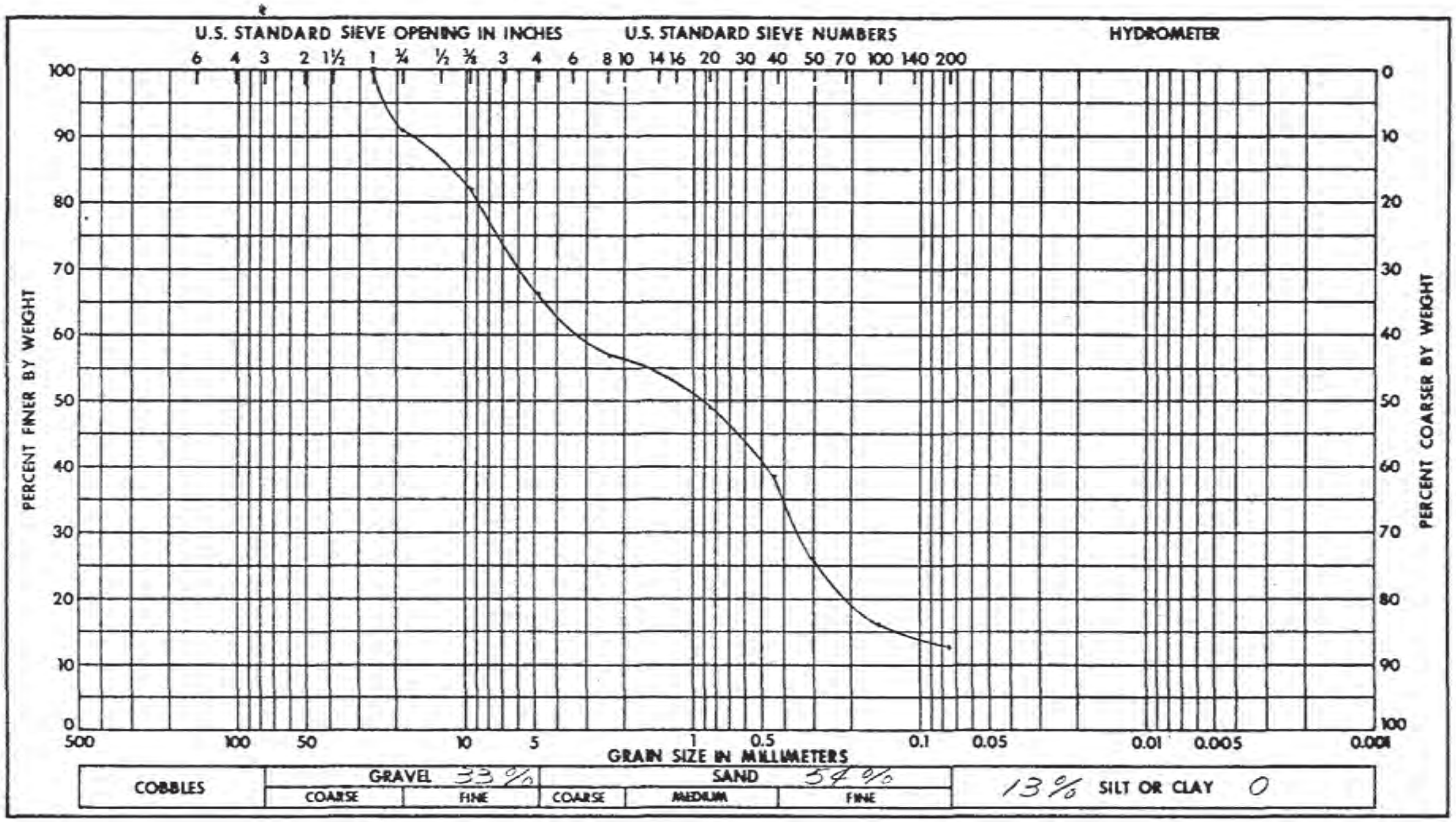
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6F	Sample No. 1A
Station	Range
Date 11-2-77	Elevation 368.3-367.3

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ______ Reviewed by: ______



Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	14.1	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

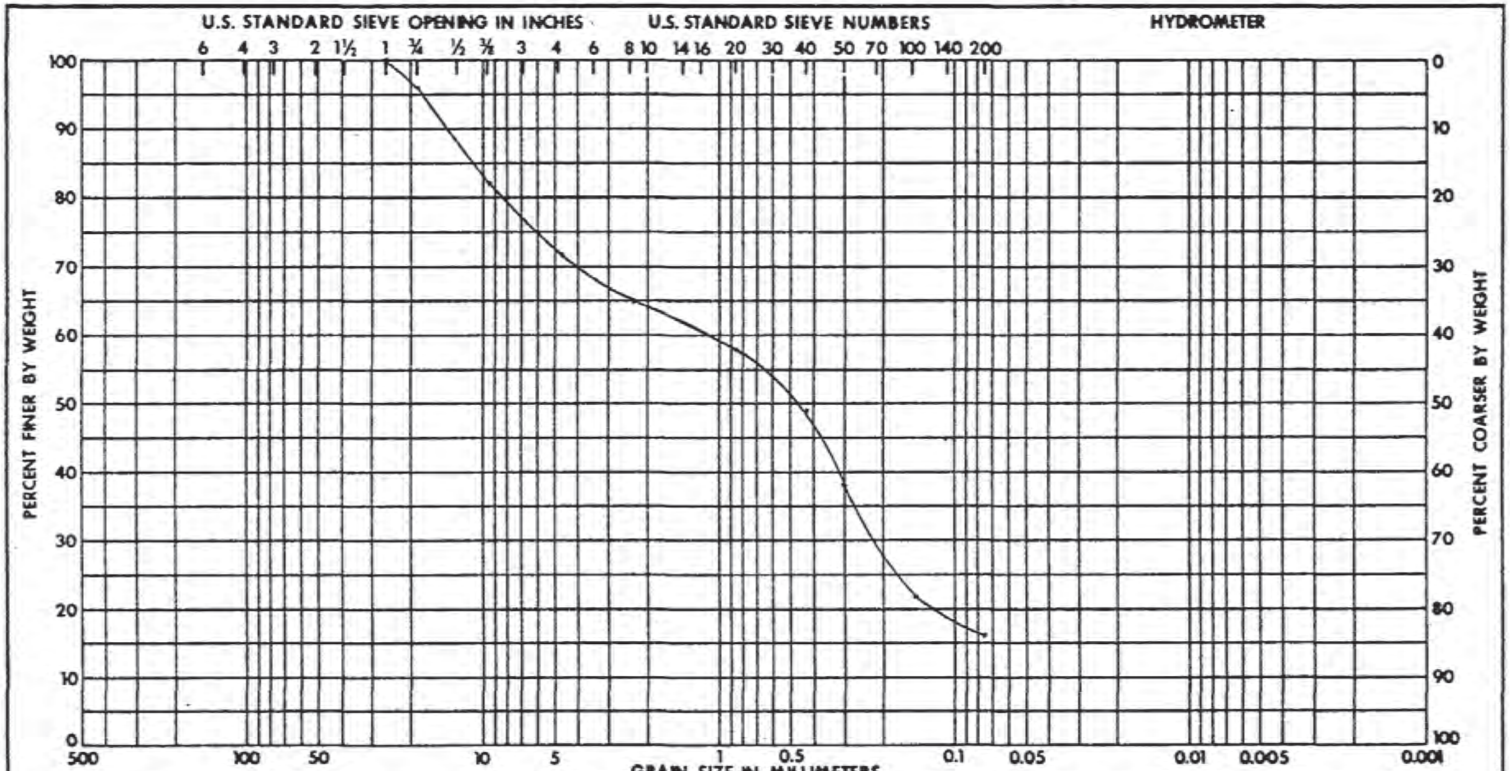
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6F	Sample No. 2A
Station	Range
Date 11-2-77	Elevation 3663-3653

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ____________ Reviewed by: ____________



COBBLES	GRAVEL 28 %		SAND 56 %			16 % SILT OR CLAY 0
	COARSE	FINE	COARSE	MEDIUM	FINE	

Soil Symbol	G-SM	Liquid Limit, %	NP
Moisture Content, %	21.9	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

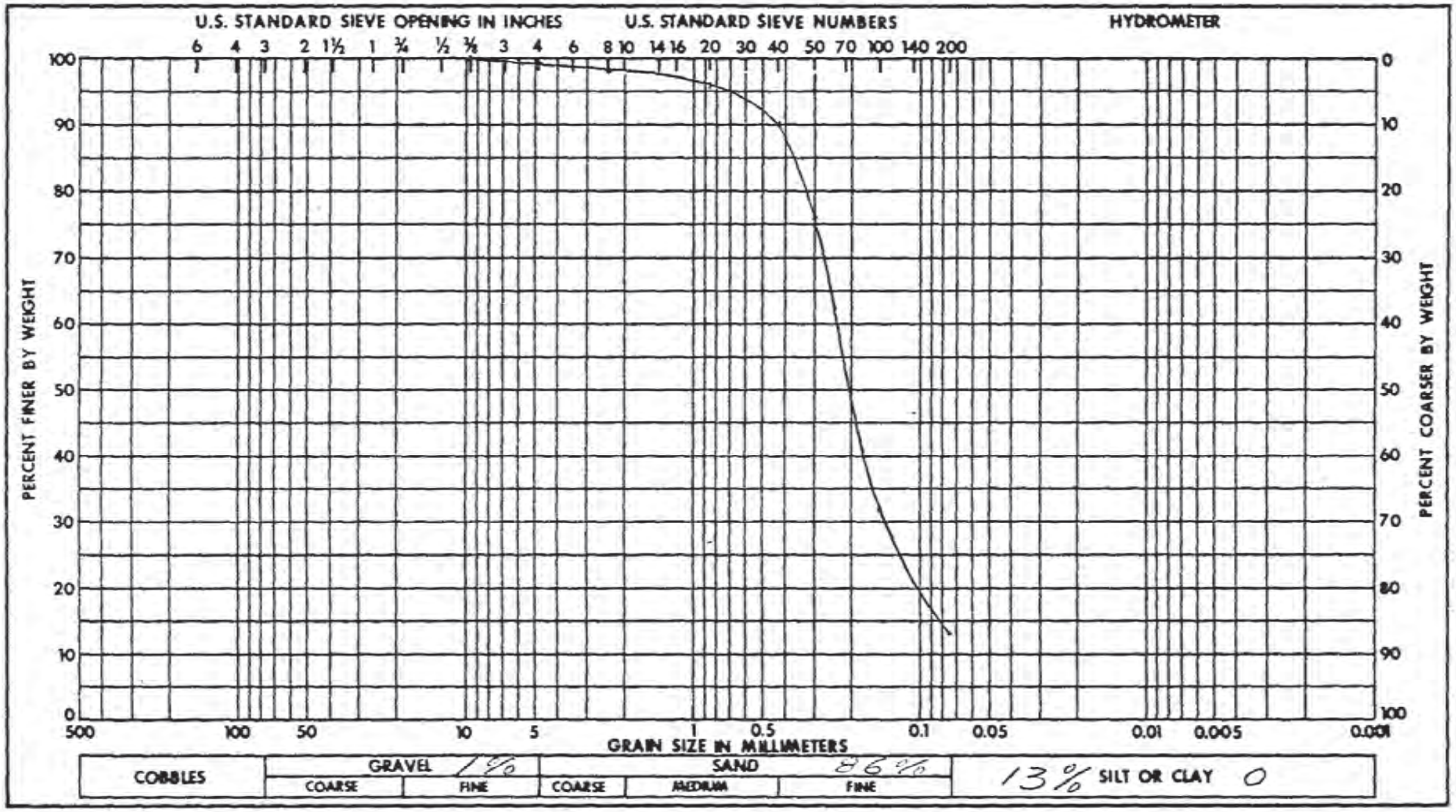
Remarks:

Project Johnsonville S. P.	
Feature	
Boring No. SS-6F	Sample No. 3A
Station	Range
Date 11-2-77	Elevation 3643-3633

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: ____________ Reviewed by: ____________



Soil Symbol	SM	Liquid Limit, %	NP
Moisture Content, %	37.3	Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

Remarks:

Project Johnsonville S. P.

Feature

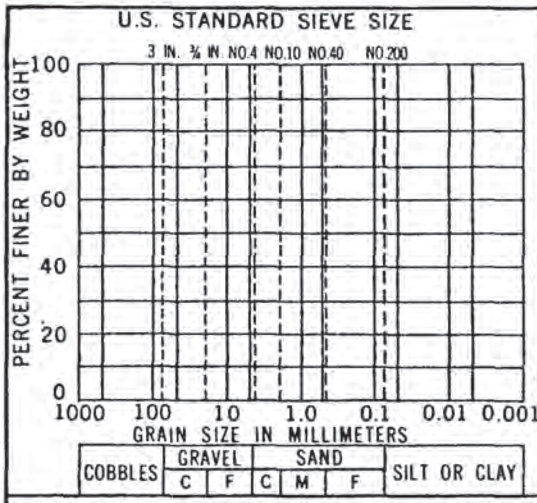
Boring No. SS-6F — Sample No. 4A

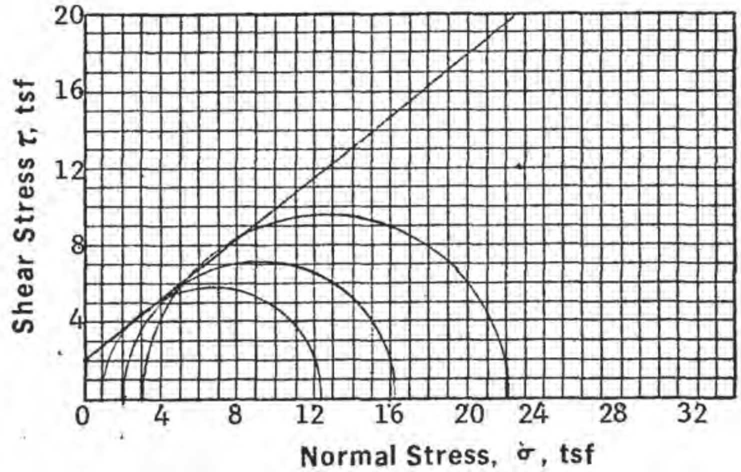
Station — Range

Date 11-2-77 — Elevation 362.3-361.3

GRAIN SIZE ANALYSIS

Tested by: ____________ Reviewed by: ____________

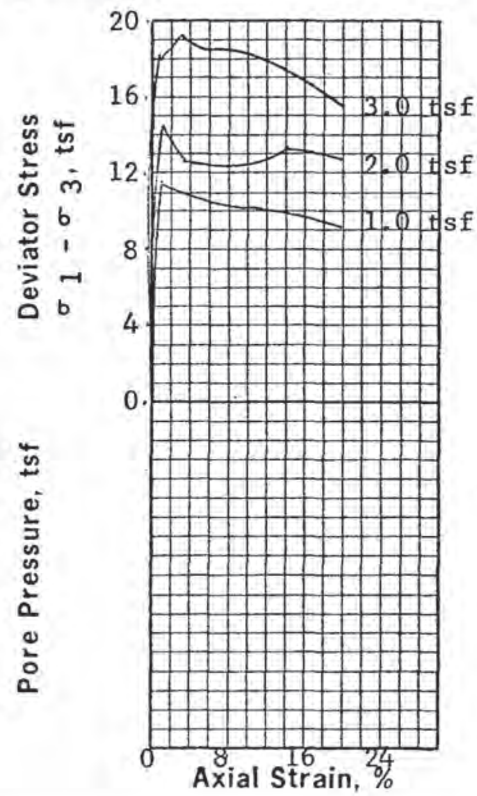




Type of Specimen Remolded	
Classification	
LL.	**G**
PI.	**D_{10}**

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	39.0	.81	2.00
Effective	--	--	--

Specimen Number		1	2	3	4
Initial	Moisture Content, %	9.8	10.1	8.8	
	Dry Density, pcf	123.1	122.2	123.9	
	Void Ratio	.390	.399	.380	
	Saturation, %	68.5	69.0	63.0	
Before Shearing	Moisture Content after Saturation, %	12.3	13.9	12.5	
	Saturation, %	100	100	100	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content, %		12.3	13.9	12.5	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		12.40	16.18	22.05	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		2	2	3	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		8.00	8.00	8.00	
Specimen Diameter, in.		4.00	4.00	4.00	



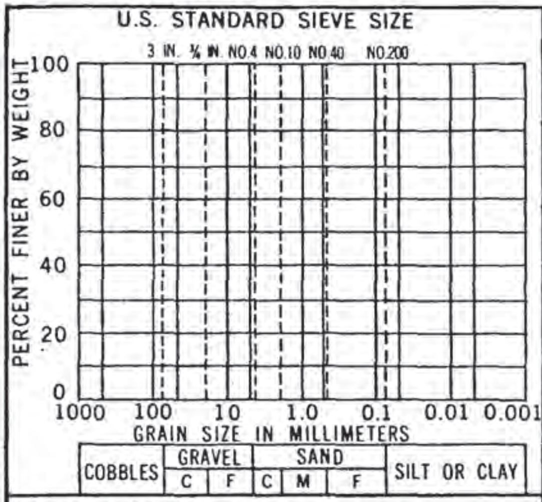
Project: Johnsonville Steam Plant

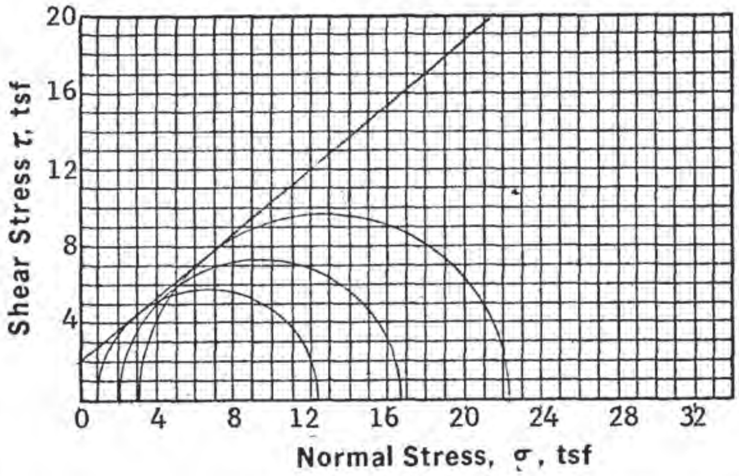
Remarks: Bottom Ash

Feature	
Boring No.	**Sample No.**
Station	Range
Date 10-7-77	**Elev.**

TRIAXIAL COMPRESSION TEST (Q)

TVA 10195 (CONST-6-77) Tested by: CEC Reviewed by: JCS

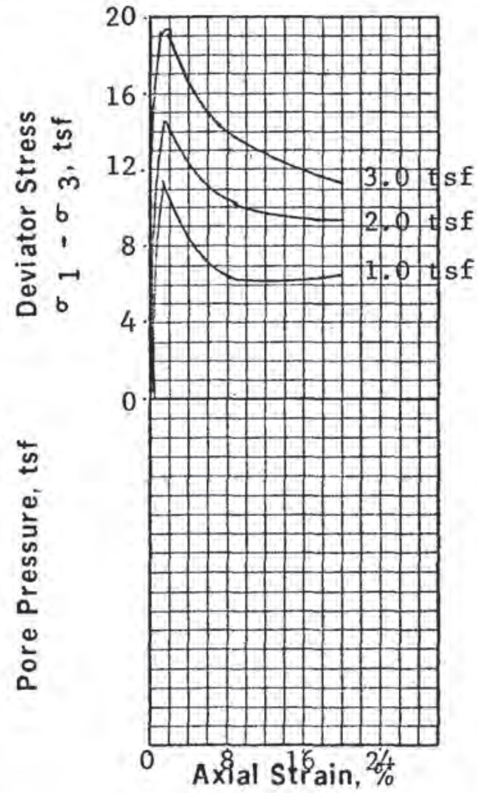




Type of Specimen	Remolded
Classification	
LL.	G
PI.	D_{10}

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	40.0	.84	2.00
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	9.2	9.0	9.8	
	Dry Density, pcf	124.5	125.5	122.9	
	Void Ratio	.374	.363	.391	
	Saturation, %	67.1	67.7	68.6	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		9.0	8.9	9.6	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		12.54	16.71	22.53	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		2	2	2.5	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		8.00	8.00	8.00	
Specimen Diameter, in.		4.00	4.00	4.00	

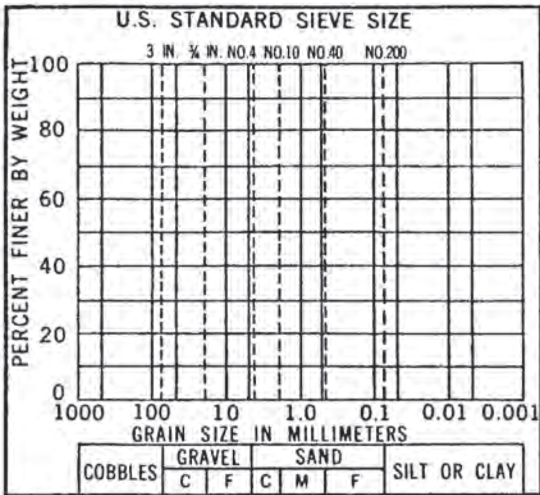


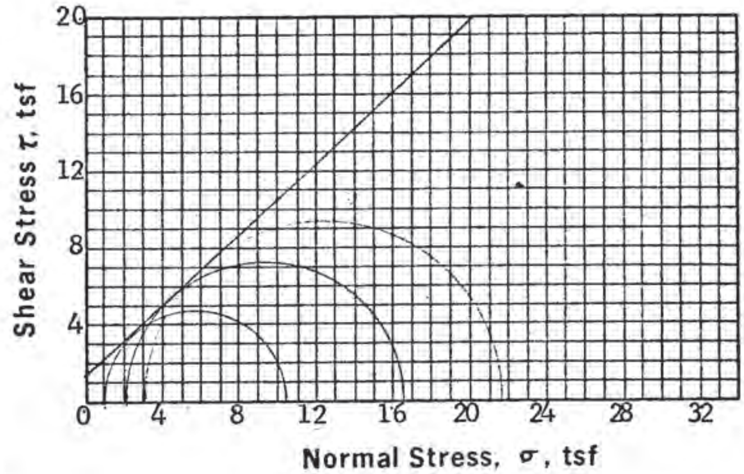
Remarks: Bottom Ash

Project: Johnsonville Steam Plant	
Feature	
Boring No.	Sample No.
Station	Range
Date 10-6-77	Elev.

TRIAXIAL COMPRESSION TEST (Q)

 Tested by: CEC Reviewed by: JCJ

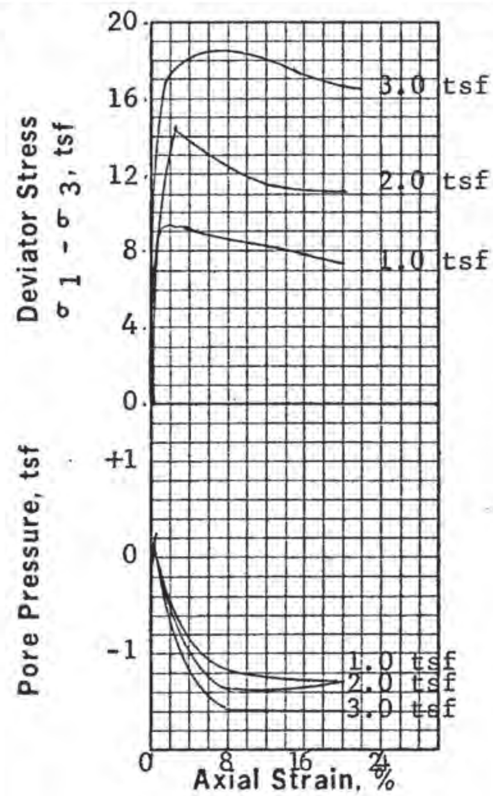




Type of Specimen	Remolded
Classification	
LL.	G
PI.	D_{10}

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	42.0	.90	1.50
Effective	37.5	.77	1.20

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	8.8	9.8	9.6	
	Dry Density, pcf	124.2	123.4	123.6	
	Void Ratio	.377	.386	.384	
	Saturation, %	64.2	69.7	68.6	
Before Shearing	Moisture Content after Saturation, %	13.7	14.1	14.0	
	Saturation, %	100	100	100	
	Moisture Content after Consolidation, %	13.1	14.0	14.0	
	Void Ratio after Consolidation	.375	.378	.363	
	Final Moisture Content ,%	13.1	14.0	14.0	
	Minor Principal Stress, σ_3, tsf	1.00	2.00	3.00	
	Major Principal Stress, σ_1, tsf	10.48	16.60	21.71	
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	1.55	2.99	4.40	
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	11.03	17.59	23.11	
	Time to Failure, min.	8	12	30	
	Rate of strain, %/min.	0.20	0.20	0.20	
	Specimen Height, in.	8.00	8.00	8.00	
	Specimen Diameter, in.	4.00	4.00	4.00	

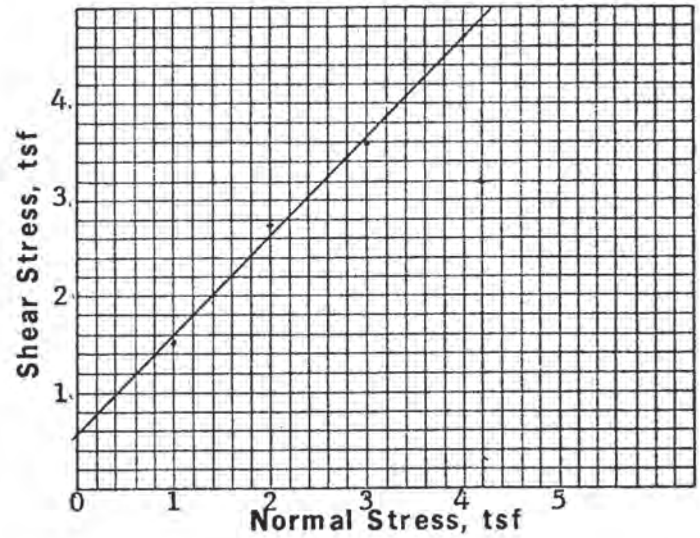


Remarks: Bottom Ash

Project: Johnsonville Steam Plant	
Feature	
Boring No.	Sample No.
Station	Range
Date 10-7-77	Elev.

TRIAXIAL COMPRESSION TEST (R)

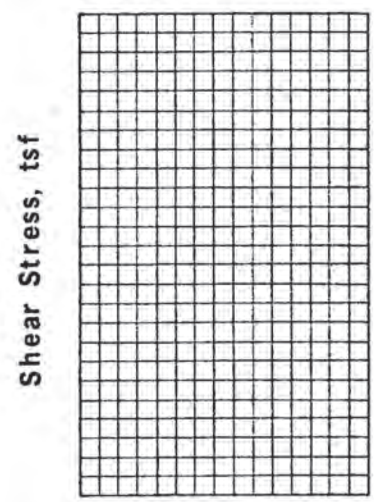
TVA 10195 (CONST-6-77) Tested by: CEC Reviewed by: JCS



Type of Specimen Remolded	
Classification	
LL.	**G**
PI.	**D_{10}**

Shear Strength	ø Deg.	Tan.ø	C, tsf
	45.5	1.02	0.55

	Test Number	1	2	3	4
Initial	Moisture Content, %				
	Dry Density, pcf	123.4	123.4	123.6	
	Void Ratio	.387	.387	.384	
	Saturation, %				
Final	Moisture Content, %	13.8	13.7	13.5	
	Saturation, %	100	100	100	
Normal Stress, tsf		1.00	2.00	3.00	
Max. Shear Stress, tsf		1.54	2.73	3.59	
Time to Failure, min.		55	100	80	
Deformation, in./min.		.004	.004	.004	
Specimen Height, in.		6.0	6.0	6.0	
Specimen Diameter, in.		12.0	12.0	12.0	



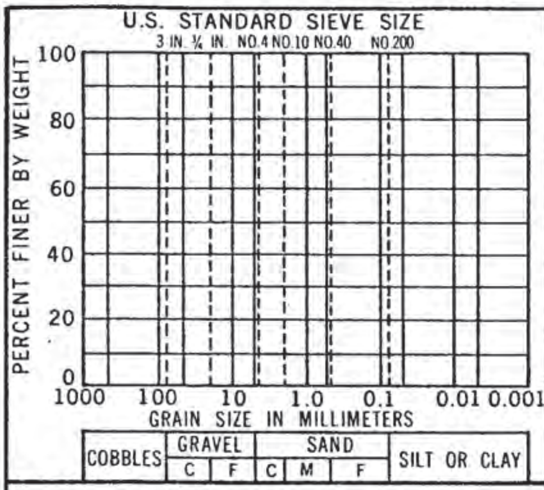
Horizontal Deformation, inches

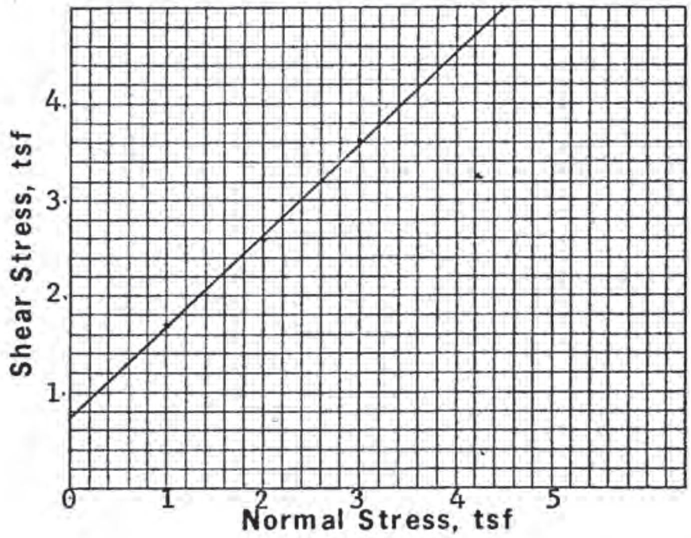
Remarks: Bottom Ash

Project: Johnsonville Steam Plant	
Feature	
Boring No.	**Sample No.**
Station	Range
Date 10-5-77	Elev.

DIRECT SHEAR TEST (S)

TVA 10194 (CONST-6-77) Tested by: TAL Reviewed by: JCB

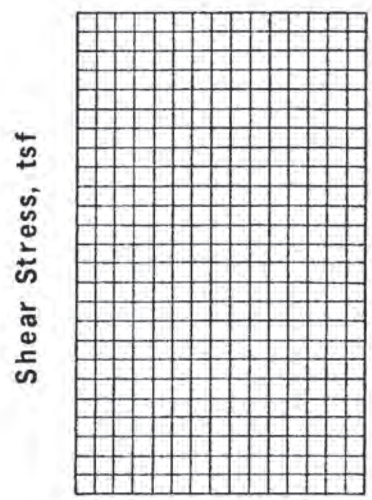




Type of Specimen	Remolded
Classification	
LL.	**G**
PI.	**D_{10}**

Shear Strength	ø Deg.	Tan.ø	C, tsf
	43.5	.95	0.72

	Test Number	1	2	3	4
Initial	Moisture Content, %				
	Dry Density, pcf	125.6	124.0	124.4	
	Void Ratio	.362	.380	.375	
	Saturation, %				
Final	Moisture Content, %	13.0	13.5	13.0	
	Saturation, %	100	100	100	
	Normal Stress, tsf	1.00	2.00	3.00	
	Max. Shear Stress, tsf	1.70	2.59	3.61	
	Time to Failure, min.	40	53	75	
	Deformation, in./min.	.004	.004	.004	
	Specimen Height, in.	6.0	6.0	6.0	
	Specimen Diameter, in.	12.0	12.0	12.0	



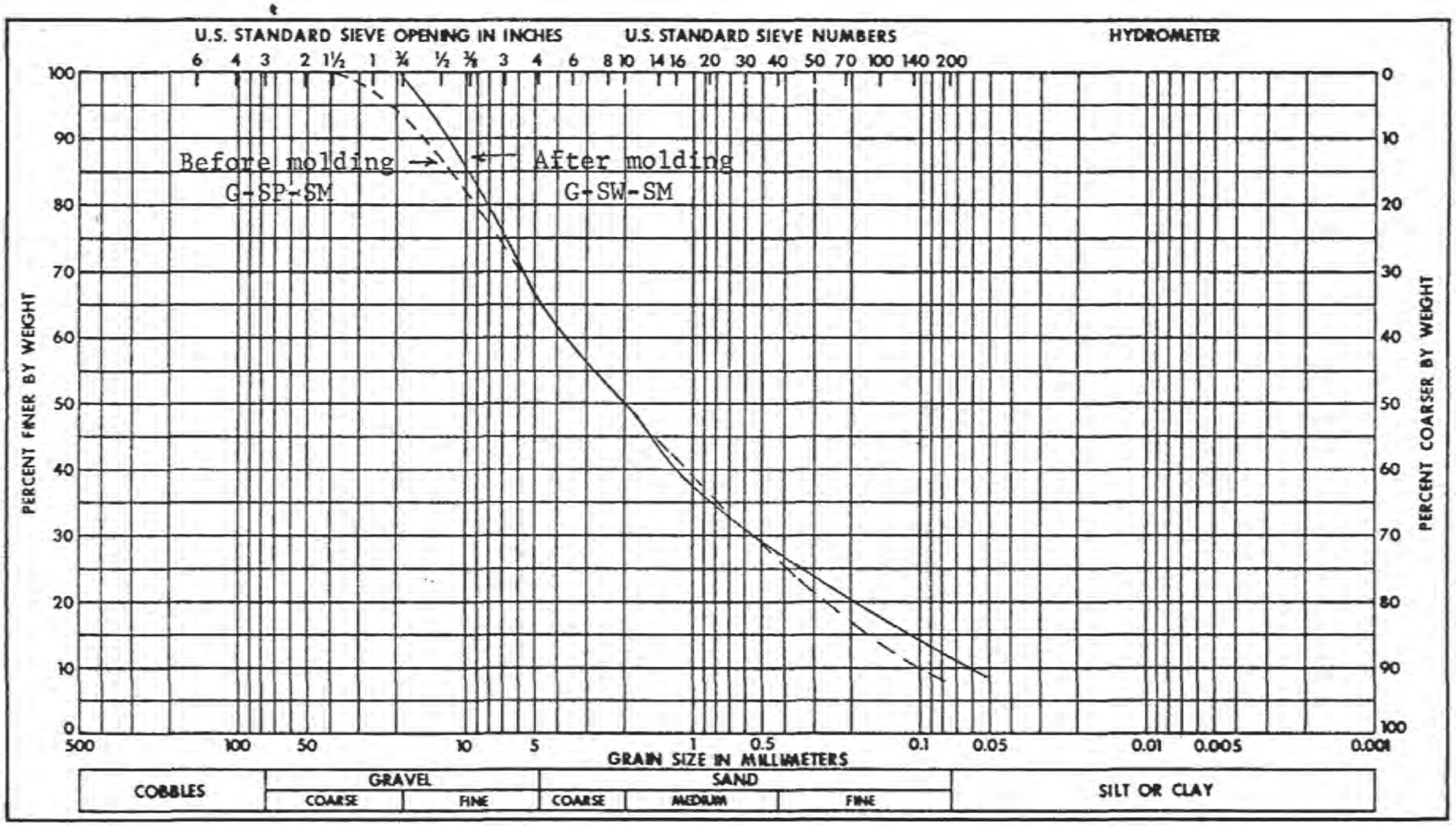
Horizontal Deformation, inches

Remarks: Bottom Ash

Project: Johnsonville Steam Plant	
Feature	
Boring No.	**Sample No.**
Station	Range
Date 10-5-77	Elev.

DIRECT SHEAR TEST (S)

TVA 10194 (CONST-6-77) Tested by: TAL Reviewed by: ____



Soil Symbol		Liquid Limit, %	NP
Moisture Content, %		Plastic Limit, %	NP
Specific Gravity		Plasticity Index, %	NP
		Shrinkage Limit, %	

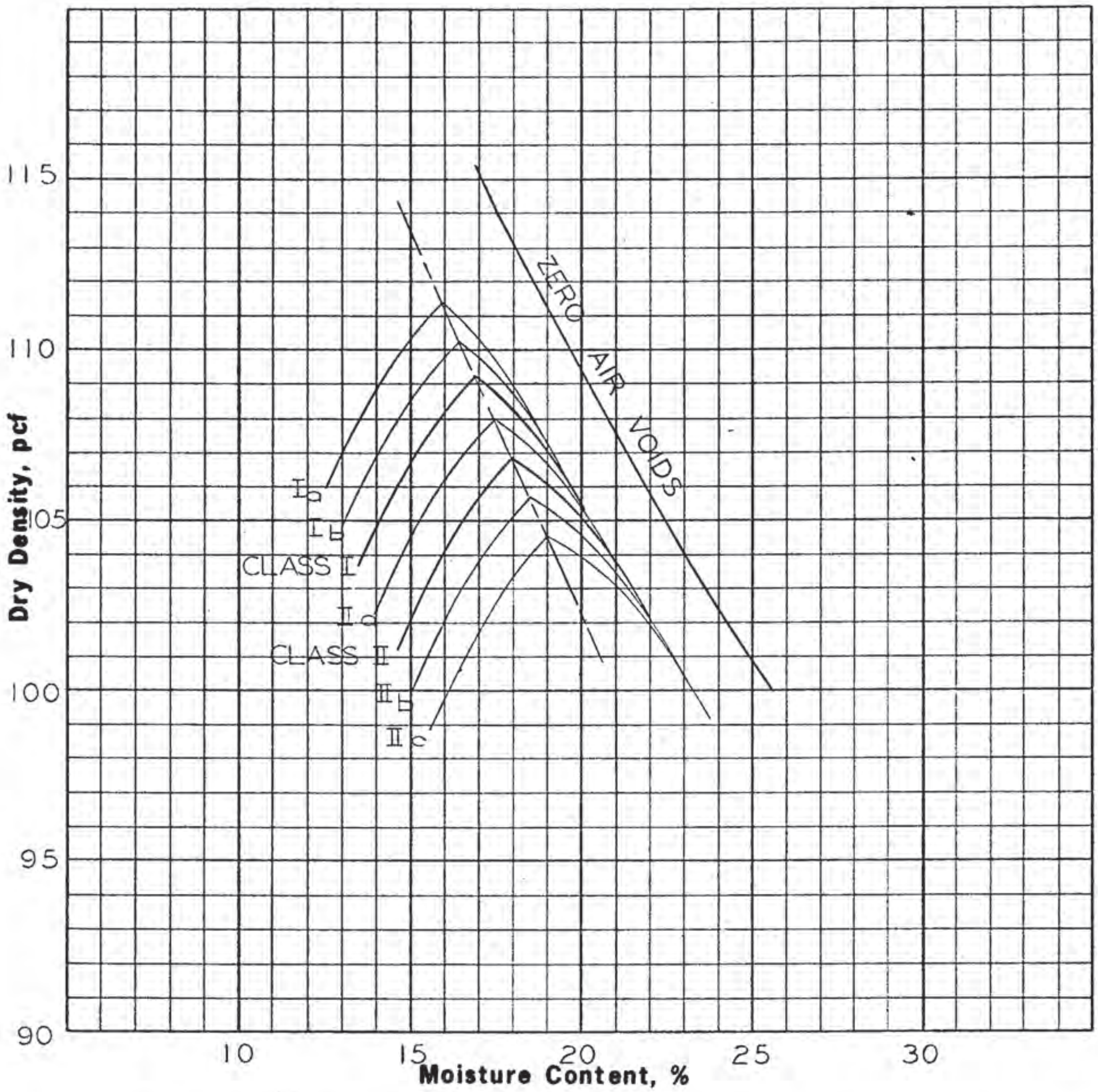
Remarks: Bottom Ash

Project Johnsonville Steam Plant	
Feature	
Boring No.	**Sample No.**
Station	Range
Date 10-5-77	**Elevation**

GRAIN SIZE ANALYSIS

TVA 10199 (CONST-6-77)

Tested by: TAL Reviewed by: gCo



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
I-CL	0	21	42	37	2.69	42.1	23.6	16.9	109.2
II-CL	0	11	47	42	2.71	46.7	28.2	18.0	106.8

Plus No. 4 Specific Gravity, S S D	2.33
Plus No. 4 Absorption, %	6.9

Remarks:

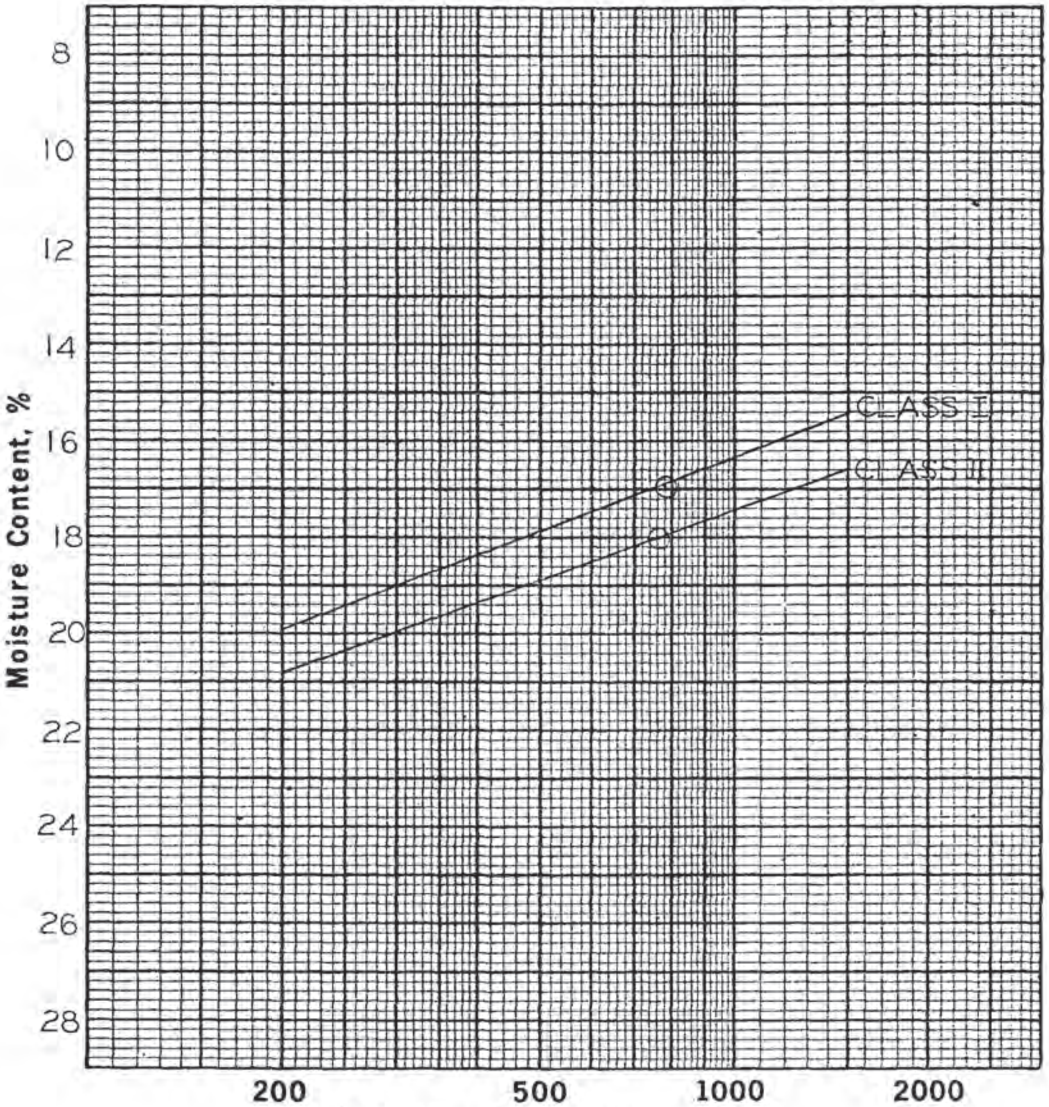
Project JOHNSONVILLE S. P.

Feature BORROW AREA A AND B

Date Tested

COMPACTION TEST (FAMILY OF CURVES)

TVA 10201 (CONST-6-77) Tested by: RW Reviewed by:



Soil Class	Optimum Moisture, %	Maximum Density, pcf	Penetration Resistance, psi
I-CL	16.9	109.2	790
II-CL	18.0	106.8	765

Remarks:

⊙ Denotes Optimum Moisture

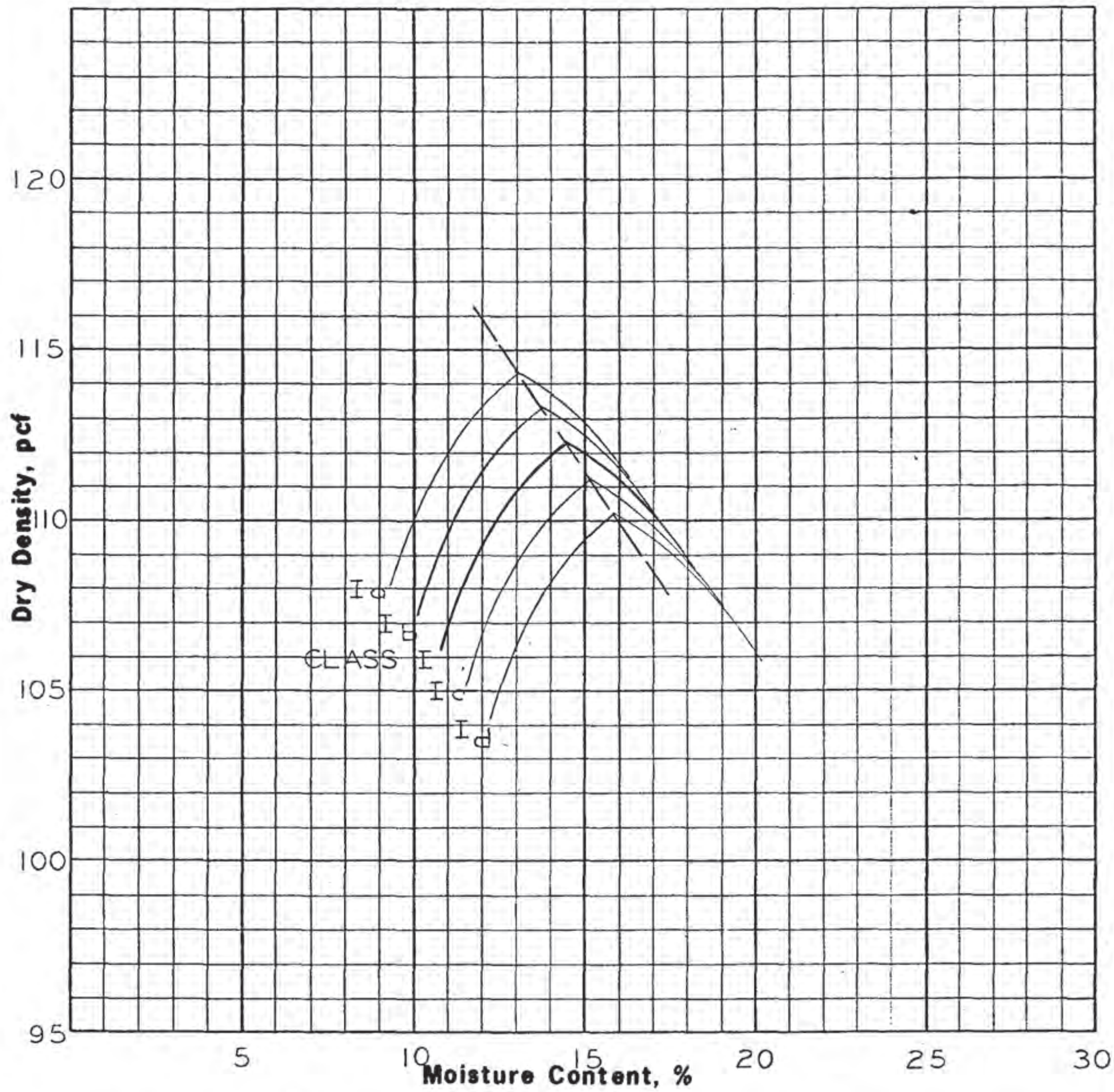
Project JOHNSONVILLE S. P.

Feature BORROW AREA A AND B

Date Tested

MOISTURE - PENETRATION TEST

TVA 10200 (CONST-6-77) Tested by: RW Reviewed by:



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
I-GC	40	28	14	18	2.69	45.1	25.7	14.5	112.3

Plus No. 4 Specific Gravity, S S D	2.33
Plus No. 4 Absorption, %	6.9

Remarks:

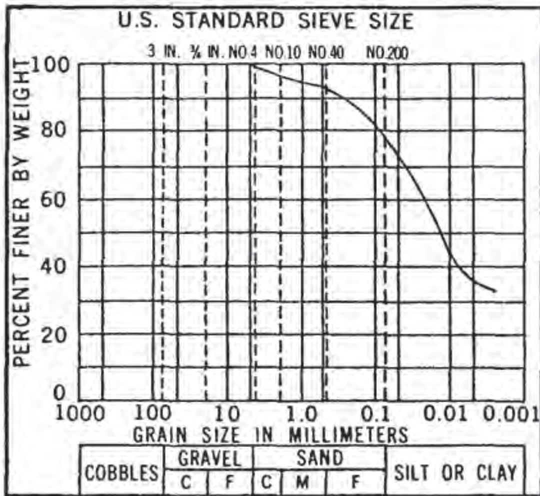
Project JOHNSONVILLE S. P.
GRAVELLY SOILS

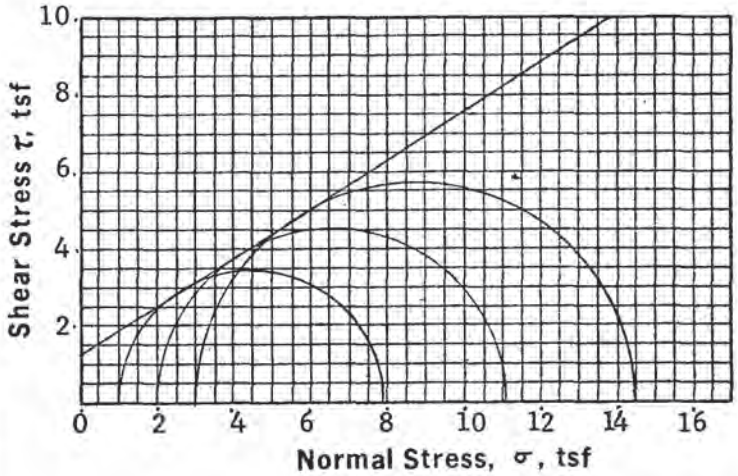
Feature BORROW AREA A

Date Tested 10-7-77

COMPACTION TEST (FAMILY OF CURVES)

TVA 10201 (CONST-6-77) Tested by: RW Reviewed by: ____

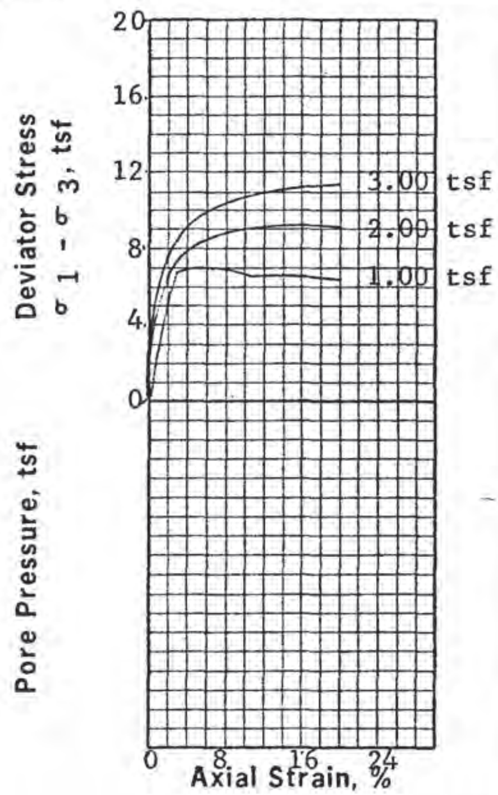




Type of Specimen	Remolded*
Classification	CL
LL. 42.1	**G** 2.69
PI. 23.6	**D_{10}** --

Shear Strength	**ø Deg.**	**Tan ø**	**C, tsf**
Apparent	32.0	.62	1.30
Effective	--	--	--

	Specimen Number	**1**	**2**	**3**	**4**
Initial	**Moisture Content, %**	13.8	13.8	13.7	
	Dry Density, pcf	103.7	103.7	103.8	
	Void Ratio	.620	.620	.617	
	Saturation, %	60.1	60.1	59.9	
Before Shearing	**Moisture Content after Saturation, %**	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		13.8	13.8	13.7	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		7.93	11.06	14.45	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		5	15	19	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.17	3.17	3.17	
Specimen Diameter, in.		1.40	1.40	1.40	

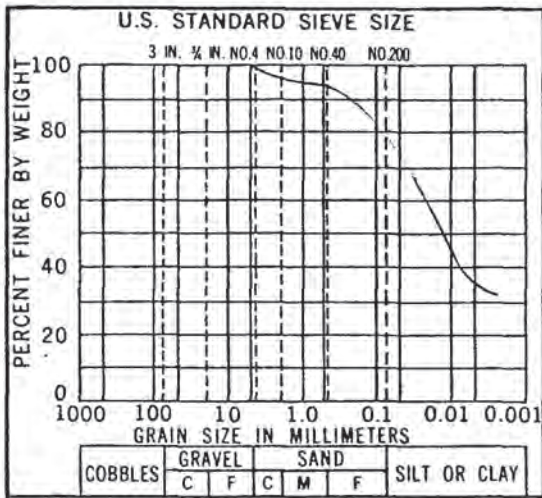


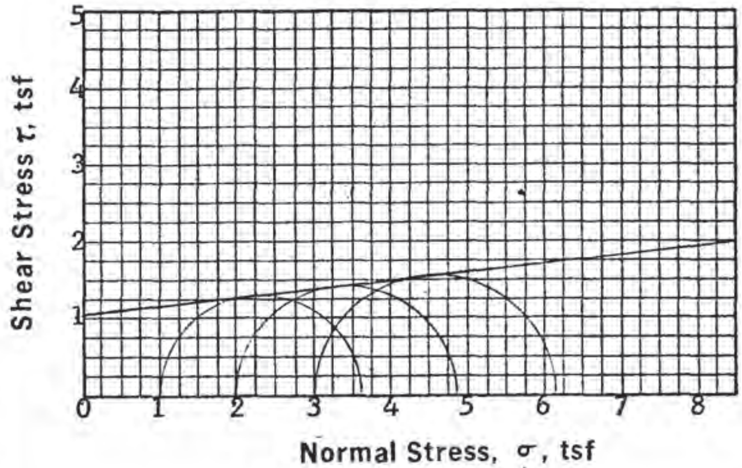
Remarks: *Remolded at 3 percent dry of optimum moisture and at 95 percent of standard maximum dry density.

Project: Johnsonville Steam Plant	
Feature Borrow Area A & B	
Boring No.	**Sample No.** Class I
Station	**Range**
Date 10-14-77	**Elev.**

TRIAXIAL COMPRESSION TEST (Q)

Tested by: GMD-TAL Reviewed by: JCS

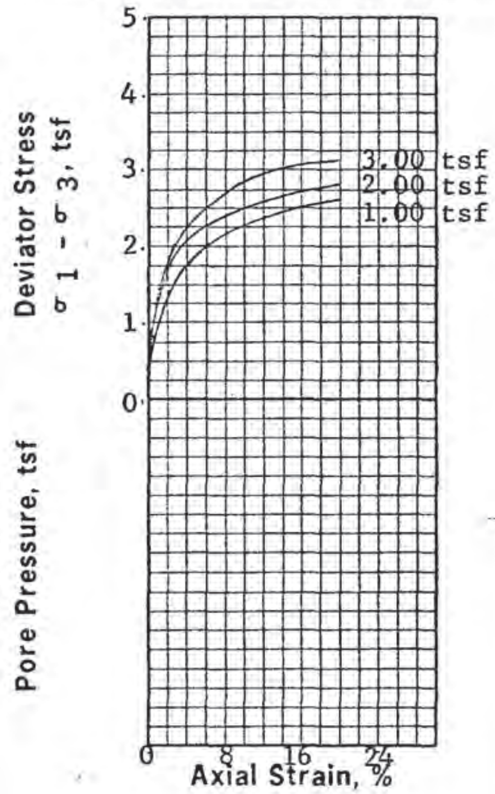




Type of Specimen	Remolded*
Classification	CL
LL. 42.1	G 2.69
PI. 23.6	D_{10} --

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	6.0	.11	1.05
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	19.7	19.6	19.6	
	Dry Density, pcf	103.8	103.9	103.9	
	Void Ratio	.617	.616	.616	
	Saturation, %	85.8	85.5	85.3	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
	Final Moisture Content ,%	19.6	19.5	19.5	
	Minor Principal Stress, σ_3, tsf	1.00	2.00	3.00	
	Major Principal Stress, σ_1, tsf	3.59	4.80	6.12	
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	--	--	--	
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	--	--	--	
	Time to Failure, min.	20	20	20	
	Rate of strain, %/min.	1.00	1.00	1.00	
	Specimen Height, in.	3.17	3.17	3.17	
	Specimen Diameter, in.	1.40	1.40	1.40	

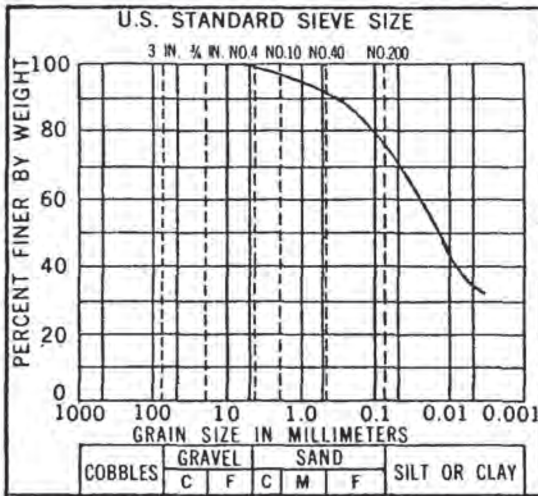


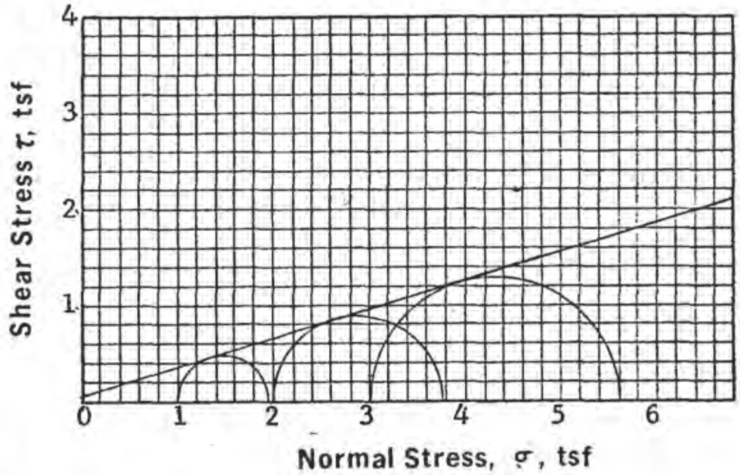
Remarks: *Remolded at 3% wet of optimum moisture and at 95% of standard maximum dry density.

Project: Johnsonville Steam Plant	
Feature Borrow Area A & B	
Boring No.	Sample No. Class I
Station	Range
Date 10-14-77	Elev.

TRIAXIAL COMPRESSION TEST (Q)

 Tested by: ~~EMD~~ Reviewed by: JCS

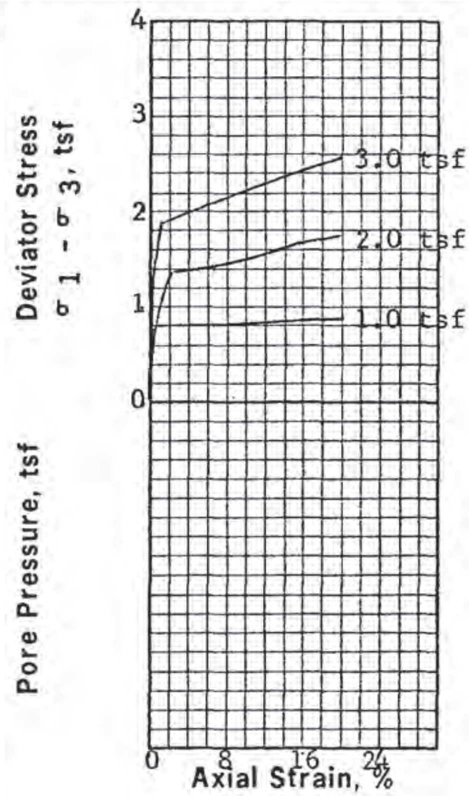




Type of Specimen	Remolded*		
Classification	CL		
LL.	42.1	G	2.69
PI.	23.6	D_{10}	--

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	16.5	.30	0.06
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	13.9	13.9	13.8	
	Dry Density, pcf	103.8	103.8	103.8	
	Void Ratio	.619	.619	.618	
	Saturation, %	60.5	60.5	60.2	
Before Shearing	Moisture Content after Saturation, %	23.0	23.0	23.0	
	Saturation, %	100	100	100	
	Moisture Content after Consolidation, %	22.7	21.7	20.8	
	Void Ratio after Consolidation	.573	.556	.528	
Final Moisture Content ,%		22.7	21.7	20.8	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		1.92	3.78	5.59	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		90	90	90	
Rate of strain, %/min.		0.20	0.20	0.20	
Specimen Height, in.		3.17	3.17	3.17	
Specimen Diameter, in.		1.40	1.40	1.40	

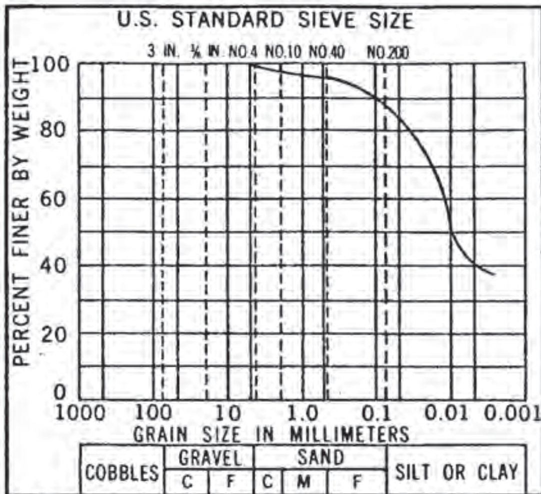


Remarks: Remolded at 3 percent dry of optimum moisture and at 95 percent of standard maximum dry density.

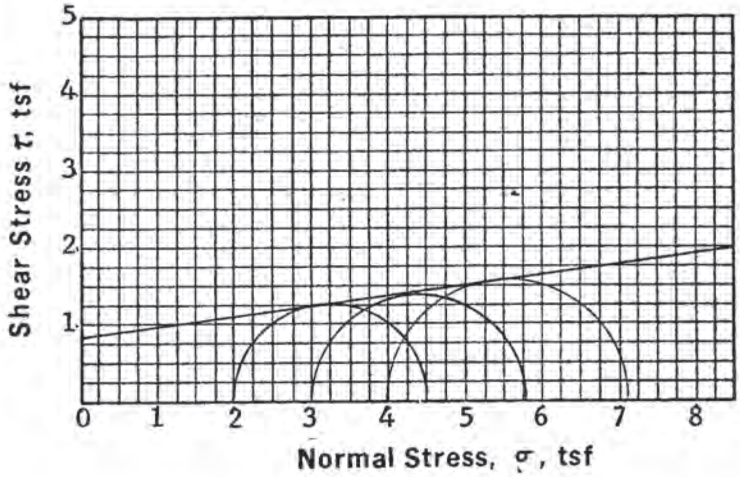
Project: Johnsonville Steam Plant	
Feature Borrow Area A & B	
Boring No.	**Sample No.** Class I
Station	**Range**
Date 10-13-77	**Elev.**

TRIAXIAL COMPRESSION TEST (R)

TVA 10195 (CONST-6-77) Tested by: CEC Reviewed by: JCS

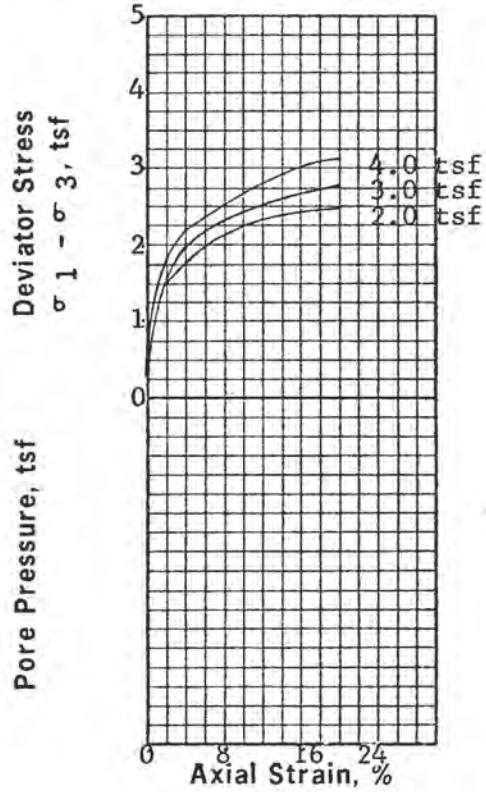


Type of Specimen	Remolded*		
Classification	CL		
LL.	46.7	G	2.71
PI.	28.2	D_{10}	--



Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	7.5	.13	0.82
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	20.9	20.9	20.8	
	Dry Density, pcf	101.7	101.7	101.8	
	Void Ratio	.663	.663	.662	
	Saturation, %	85.2	85.2	85.0	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
	Final Moisture Content ,%	20.8	20.8	20.7	
	Minor Principal Stress, σ_3, tsf	2.00	3.00	4.00	
	Major Principal Stress, σ_1, tsf	4.49	5.77	7.12	
	Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf	--	--	--	
	Effective Major Principal Stress, $\bar{\sigma}_1$, tsf	--	--	--	
	Time to Failure, min.	20	20	20	
	Rate of strain, %/min.	1.00	1.00	1.00	
	Specimen Height, in.	3.17	3.17	3.17	
	Specimen Diameter, in.	1.40	1.40	1.40	

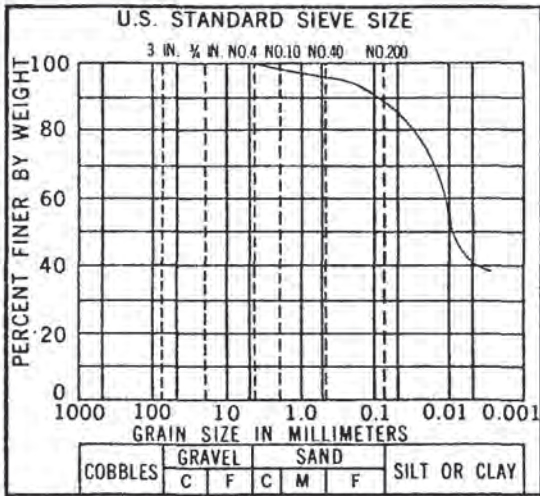


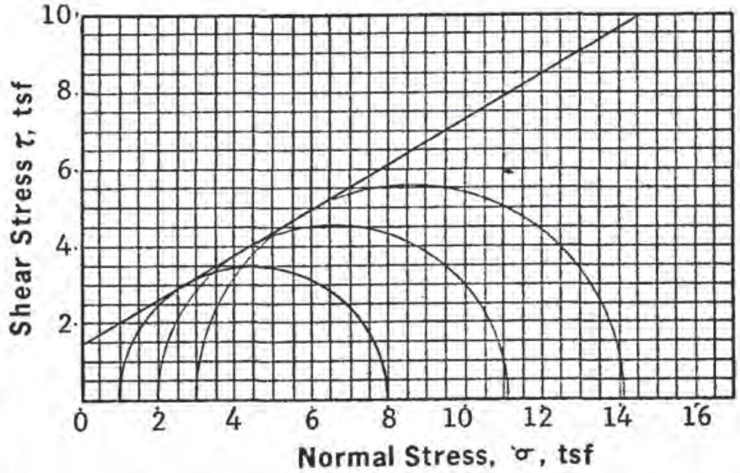
Remarks: *Remolded at 3 percent wet of optimum moisture and at 95 percent of standard maximum dry density.

Project:	Johnsonville Steam Plant		
Feature	Borrow Area A & B		
Boring No.		Sample No.	Class II
Station		Range	
Date	10-14-77	Elev.	

TRIAXIAL COMPRESSION TEST (Q)

TVA 10195 (CONST-6-77) Tested by: GMD Reviewed by: JCS

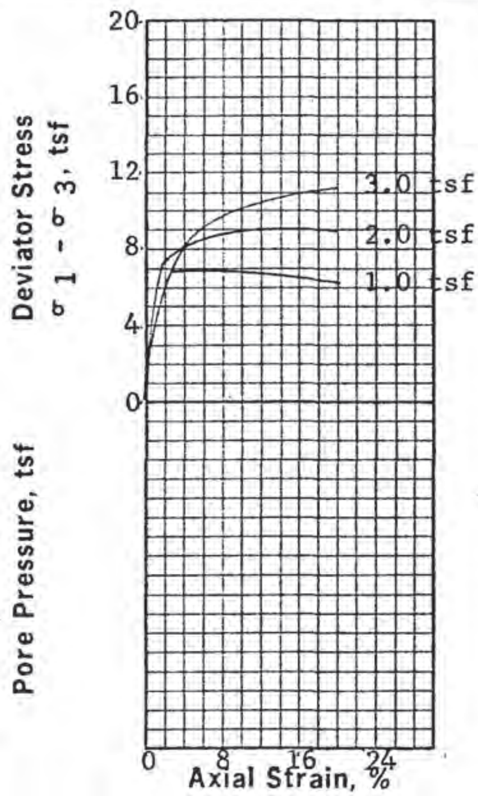




Type of Specimen	Remolded*		
Classification	CL		
LL. 46.7		**G** 2.71	
PI. 28.2		**D_{10}** --	

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	30.0	.58	0.75
Effective	--	--	--

Specimen Number		1	2	3	4
Initial	Moisture Content, %	14.7	14.9	14.6	
	Dry Density, pcf	101.7	101.6	101.8	
	Void Ratio	.663	.666	.662	
	Saturation, %	60.2	60.7	59.9	
Before Shearing	Moisture Content after Saturation, %	--	--	--	
	Saturation, %	--	--	--	
	Moisture Content after Consolidation, %	--	--	--	
	Void Ratio after Consolidation	--	--	--	
Final Moisture Content ,%		14.6	14.7	14.6	
Minor Principal Stress, σ_3, tsf		1.00	2.00	3.00	
Major Principal Stress, σ_1, tsf		7.99	11.15	14.14	
Effective Minor Principal Stress, $\bar{\sigma}_3$, tsf		--	--	--	
Effective Major Principal Stress, $\bar{\sigma}_1$, tsf		--	--	--	
Time to Failure, min.		3	13	20	
Rate of strain, %/min.		1.00	1.00	1.00	
Specimen Height, in.		3.17	3.17	3.17	
Specimen Diameter, in.		1.40	1.40	1.40	

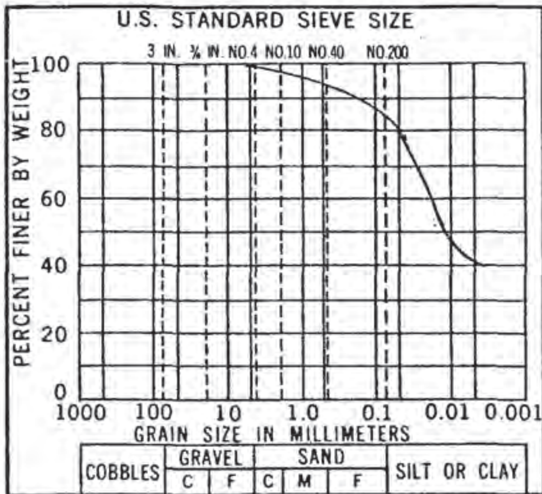


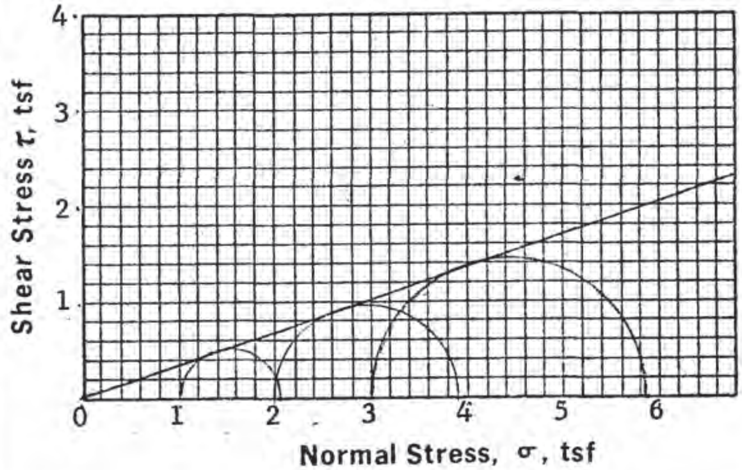
Remarks: *Remolded at 3 percent dry of optimum moisture and at 95 percent of standard maximum dry density.

Project: Johnsonville Steam Plant			
Feature Borrow Area A & B			
Boring No.		**Sample No.** Class II	
Station		**Range**	
Date 10-14-77		**Elev.**	

TRIAXIAL COMPRESSION TEST (Q)

TVA 10195 (CONST-6-77) Tested by: GMD - TAL Reviewed by: JCS

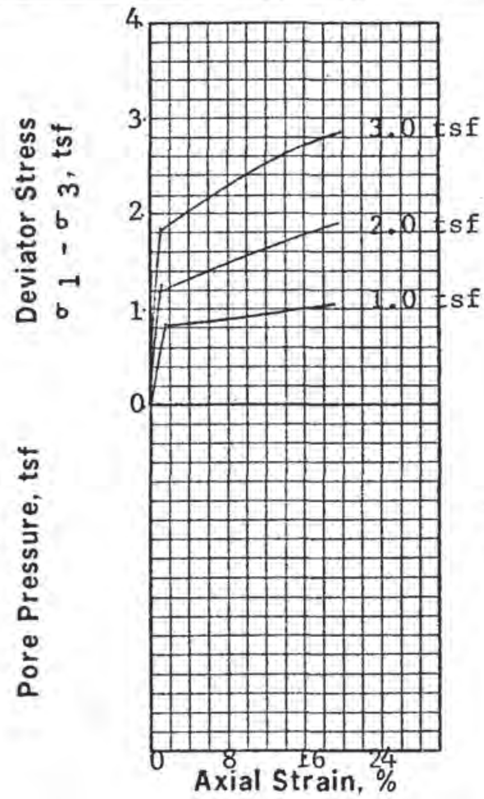




Type of Specimen	Remolded*
Classification	CL
LL. 46.7	G 2.71
PI. 28.2	D_{10} --

Shear Strength	ø Deg.	Tan ø	C, tsf
Apparent	18.0	.33	0.05
Effective	--	--	--

	Specimen Number	1	2	3	4
Initial	Moisture Content, %	14.7	14.7	14.7	
	Dry Density, pcf	101.8	101.8	101.8	
	Void Ratio	.662	.662	.662	
	Saturation, %	60.2	60.2	60.1	
Before Shearing	Moisture Content after Saturation, %	24.4	24.4	24.4	
	Saturation, %	100	100	100	
	Moisture Content after Consolidation, %	23.4	22.5	21.8	
	Void Ratio after Consolidation	.631	.600	.551	
	Final Moisture Content ,%	23.4	22.5	21.8	
	Minor Principal Stress, σ 3, tsf	1.00	2.00	3.00	
	Major Principal Stress, σ 1, tsf	2.07	3.93	5.86	
	Effective Minor Principal Stress, $\bar{\sigma}$ 3, tsf	--	--	--	
	Effective Major Principal Stress, $\bar{\sigma}$ 1, tsf	--	--	--	
	Time to Failure, min.	90	90	90	
	Rate of strain, %/min.	0.20	0.20	0.20	
	Specimen Height, in.	3.17	3.17	3.17	
	Specimen Diameter, in.	1.40	1.40	1.40	

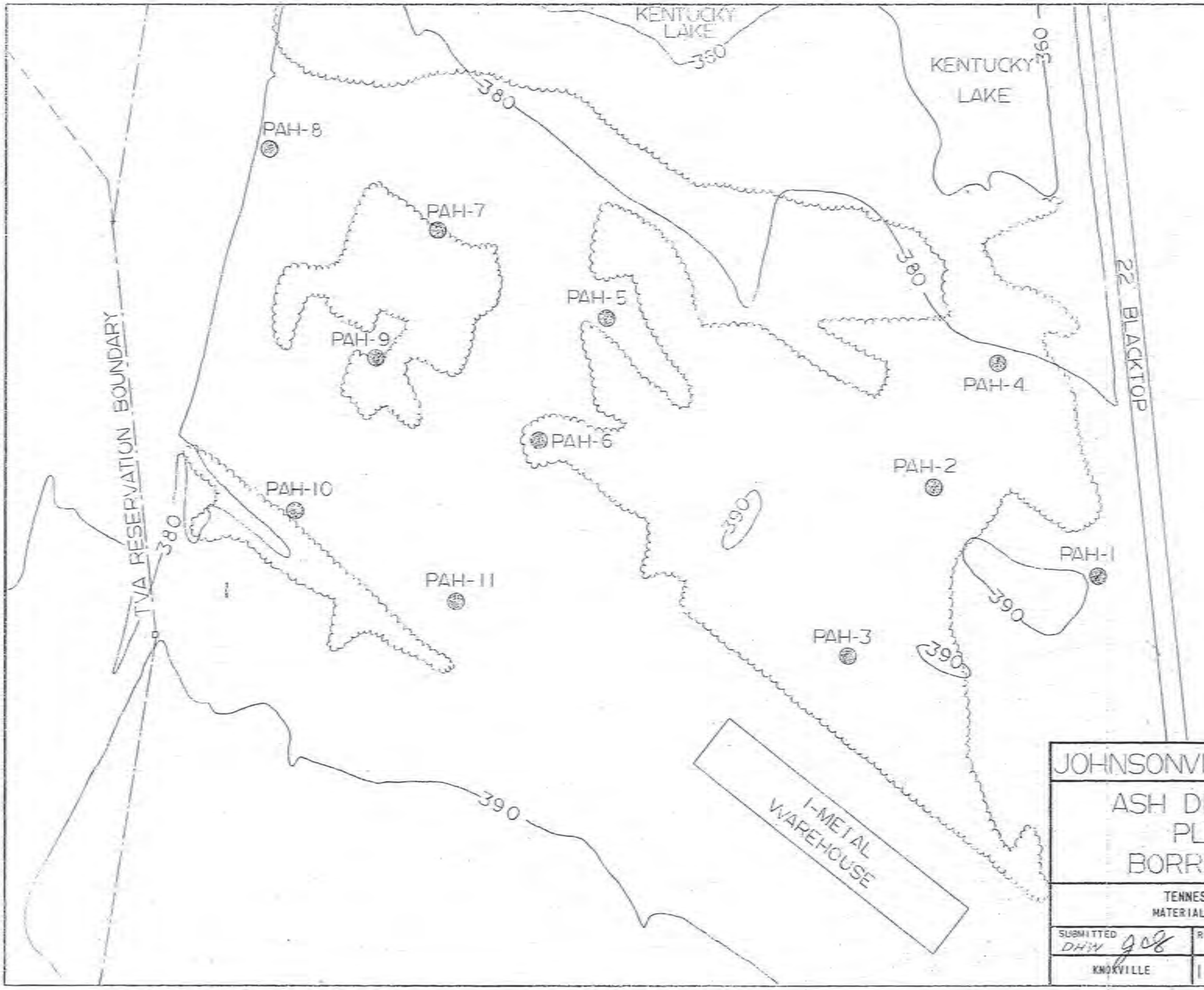


Remarks: *Remolded at 3 percent dry of optimum moisture and at 95 percent of standard maximum dry density.

Project: Johnsonville Steam Plant	
Feature Borrow Area A & B	
Boring No.	Sample No. Class II
Station	Range
Date 10-14-77	Elev.

TRIAXIAL COMPRESSION TEST (R)

 Tested by: CEC Reviewed by: JCS



LEGEND

⊛ – AUGER BORING

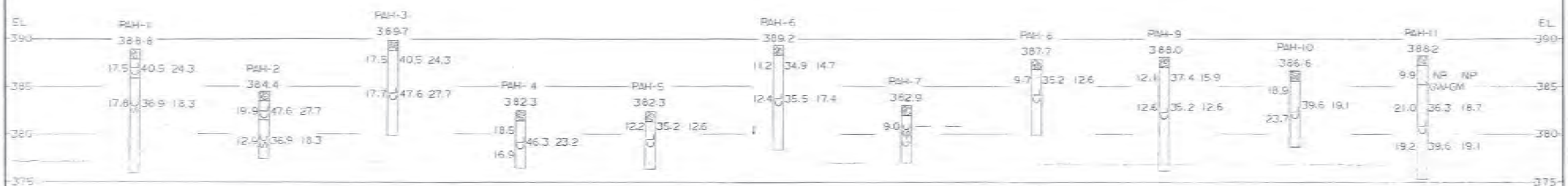
SCALE: 1"=100'

JOHNSONVILLE STEAM PLANT

ASH DISPOSAL DIKE
PLAN OF
BORROW AREA B

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED DHW JCB	RECOMMENDED			APPROVED
KNOXVILLE	11-1-77	30	CS	3	604B887R0



SYMBOLS

— TOPSOIL

— SANDY GRAVEL

LEGEND

BORING NO.

ELEVATION

NATURAL MOISTURE CONTENT | CLASSIFICATION | LIQUID LIMIT | PLASTICITY INDEX

SCALE: 1"=5'

JOHNSONVILLE STEAM PLANT

ASH DISPOSAL DIKE
BORROW AREA B
PAH 1 THROUGH PAH 11

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED | RECOMMENDED | APPROVED

KNOXVILLE | 11-7-73 | 30 | CS | 2 | 804K685R0

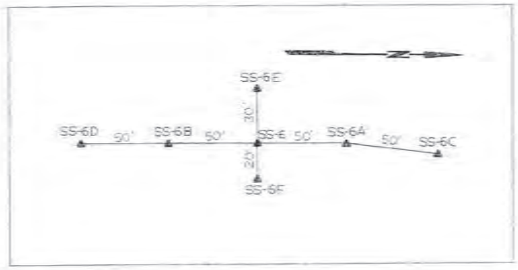
SCALE: 1"=100'

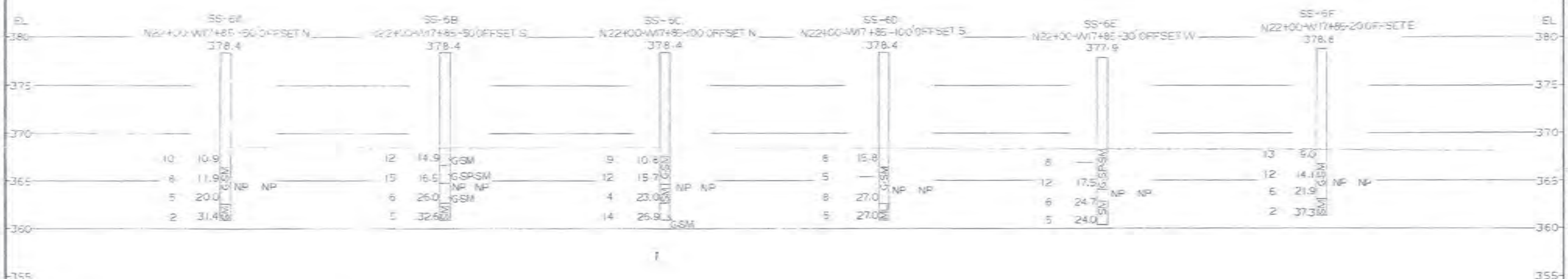
JOHNSONVILLE STEAM PLANT

ASH DISPOSAL DIKE
PLAN OF
BORROW AREA A

TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED	RECOMMENDED	APPROVED
KNOXVILLE	11-1-77 30 CS 3	504K686R0





SYMBOLS

▲ -SPLITSPOON BORING

LEGEND

BORING NO.
COORDINATES
ELEVATION

BLOWS NATURAL MOISTURE CONTENT | CLASSIFICATION | LIQUID LIMIT PLASTICITY INDEX

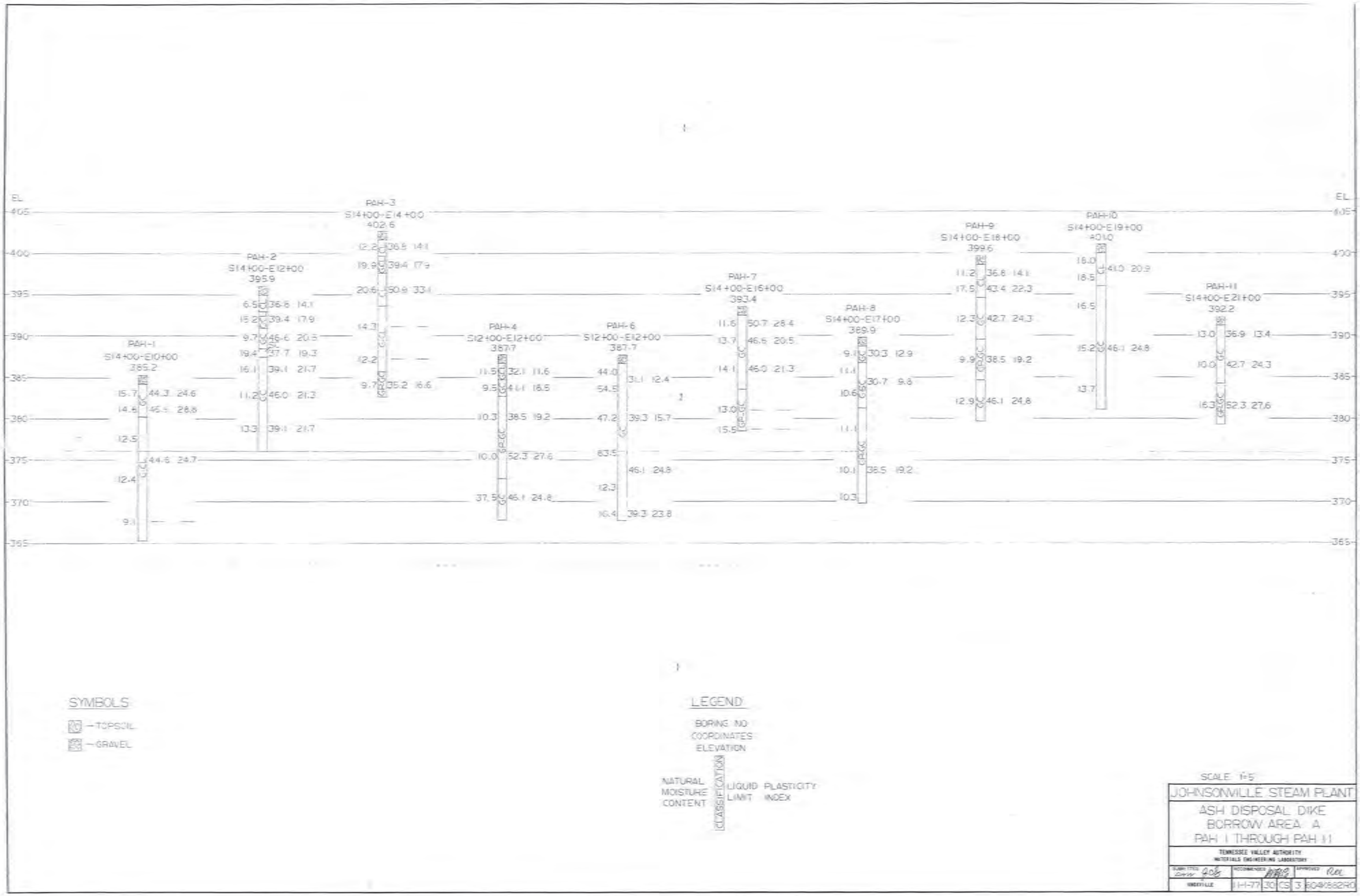
NOTE: BLOWS PER FOOT WITH A 140LB HAMMER AND A 30 INCH DROP ON A 2 INCH OD SPILTSPOON SAMPLER

SCALE: 1=5'

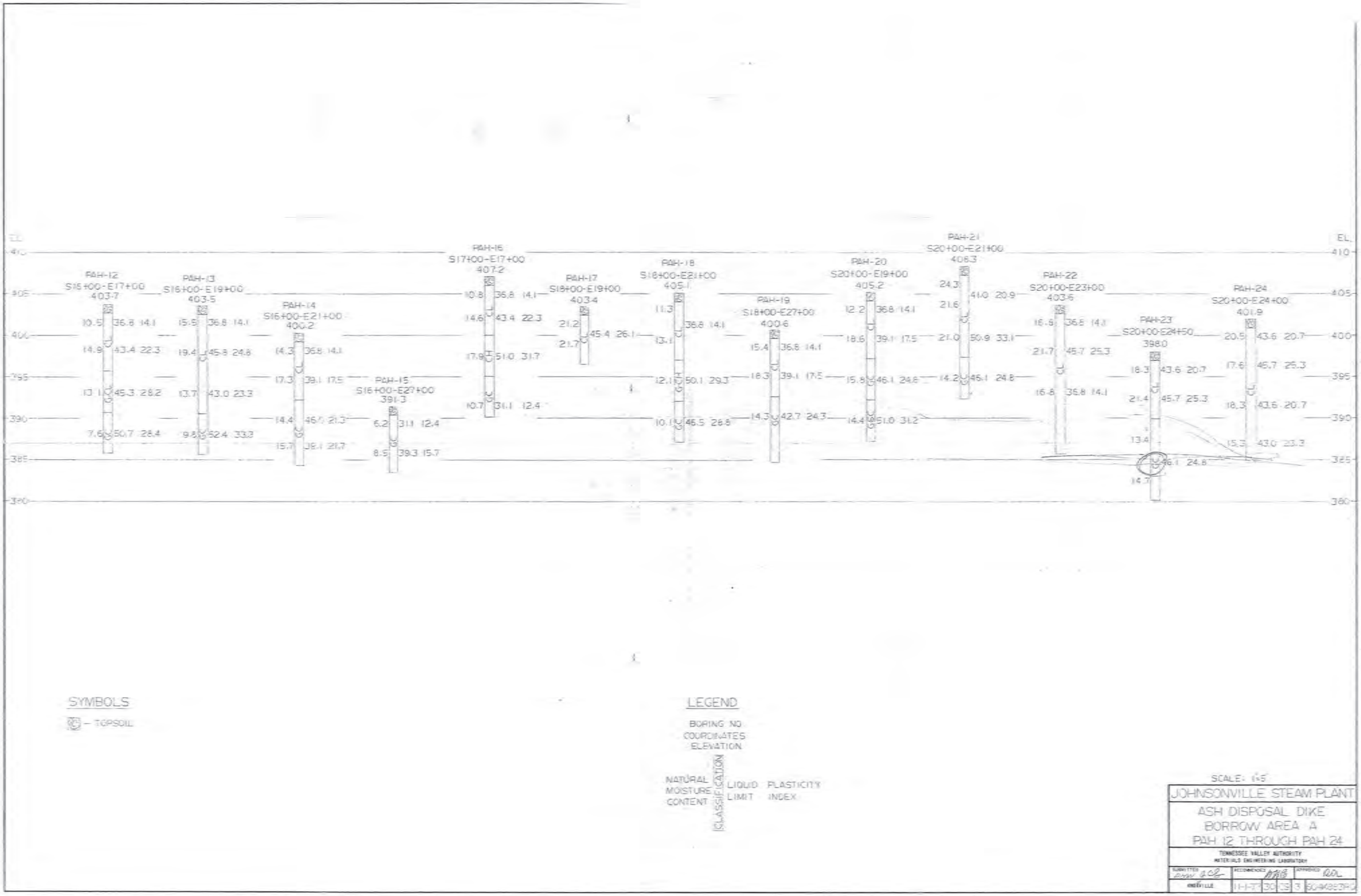
JOHNSONVILLE STEAM PLANT
ASH DISPOSAL DIKE
FOUNDATION INVESTIGATION
SS 6A THROUGH SS 6F

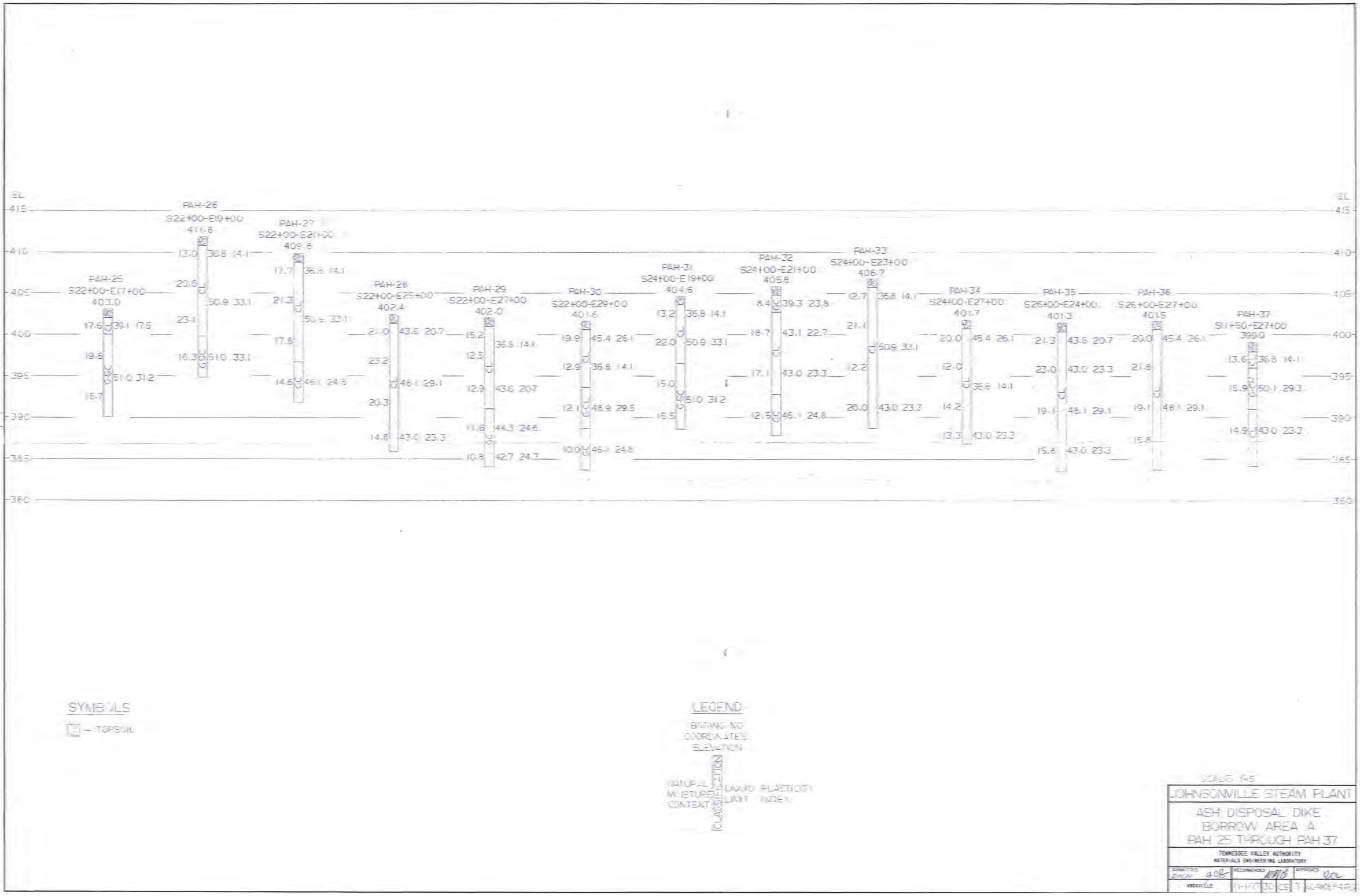
TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY

SUBMITTED | RECOMMENDED | APPROVED



PAH-1
S14+00-E10+00
385.2
PAH-2
S14+00-E12+00
395.9
PAH-3
S14+00-E14+00
402.6
PAH-4
S12+00-E12+00
387.7
PAH-6
S12+00-E12+00
387.7
PAH-7
S14+00-E16+00
393.4
PAH-8
S14+00-E17+00
389.9
PAH-9
S14+00-E18+00
399.6
PAH-10
S14+00-E19+00
401.0
PAH-11
S14+00-E21+00
392.2
SYMBOLS
—TOPSOIL
—GRAVEL
LEGEND
BORING NO
COORDINATES
ELEVATION
NATURAL MOISTURE CONTENT
CLASSIFICATION
LIQUID LIMIT
PLASTICITY INDEX
SCALE 1"=5'
JOHNSONVILLE STEAM PLANT
ASH DISPOSAL DIKE
BORROW AREA A
PAH 1 THROUGH PAH 11
TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY
11-1-77 30 CS 3 604K562R0


EL.
410
405
400
395
390
385
380
PAH-12
S16+00-E17+00
403.7
PAH-13
S16+00-E19+00
403.5
PAH-14
S16+00-E21+00
400.2
PAH-15
S16+00-E27+00
391.3
PAH-16
S17+00-E17+00
407.2
PAH-17
S18+00-E19+00
403.4
PAH-18
S18+00-E21+00
405.1
PAH-19
S18+00-E27+00
400.6
PAH-20
S20+00-E19+00
405.2
PAH-21
S20+00-E21+00
406.3
PAH-22
S20+00-E23+00
403.6
PAH-23
S20+00-E24+50
398.0
PAH-24
S20+00-E24+00
401.9
SYMBOLS
TOPSOIL
LEGEND
BORING NO.
COORDINATES
ELEVATION
NATURAL MOISTURE CONTENT
CLASSIFICATION
LIQUID LIMIT
PLASTICITY INDEX
SCALE: 1"=5'
JOHNSONVILLE STEAM PLANT
ASH DISPOSAL DIKE
BORROW AREA A
PAH 12 THROUGH PAH 24
TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY
KNOXVILLE



EL
PAH-25
S22+00-E17+00
403.0
PAH-26
S22+00-E19+00
411.8
PAH-27
S22+00-E21+00
409.8
PAH-28
S22+00-E25+00
402.4
PAH-29
S22+00-E27+00
402.0
PAH-30
S22+00-E29+00
401.6
PAH-31
S24+00-E19+00
404.6
PAH-32
S24+00-E21+00
405.8
PAH-33
S24+00-E23+00
406.7
PAH-34
S24+00-E27+00
401.7
PAH-35
S26+00-E24+00
401.3
PAH-36
S26+00-E27+00
401.5
PAH-37
S11+50-E27+00
399.0
SYMBOLS
– TOPSOIL
LEGEND
BORING NO
COORDINATES
ELEVATION
CLASSIFICATION
NATURAL MOISTURE CONTENT
LIQUID LIMIT
PLASTICITY INDEX
SCALE: 1"=5'
JOHNSONVILLE STEAM PLANT
ASH DISPOSAL DIKE
BORROW AREA A
PAH 25 THROUGH PAH 37
TENNESSEE VALLEY AUTHORITY
MATERIALS ENGINEERING LABORATORY
KNOXVILLE

REPORT OF ASH POND INVESTIGATION

JOHNSONVILLE FOSSIL PLANT
NEWJOHNSONVILLE, TENNESSEE

August 28, 2003

Prepared For:

TENNESSEE VALLEY AUTHORITY

Chattanooga, Tennessee

Prepared By:

MACTEC ENGINEERING AND CONSULTING
1725 LOUISVILLE DRIVE
KNOXVILLE, TENNESSEE 37921
865-588-8544

47

MACTEC Project 3031032091/01

MACTEC

MACTEC

August 28, 2003

Mr. Ron Purkey
Tennessee Valley Authority
1101 Market Street, LP-2G
Chattanooga, Tennessee 37402

Subject: **Report of Ash Pond Investigation**
Johnsonville Fossil Plant
New Johnsonville, Tennessee
MACTEC Project 3031032091/01

Dear Mr. Purkey:

MACTEC Engineering and Consulting, Inc., (MACTEC) is pleased to submit this Report of Ash Pond Investigation at the Johnsonville Fossil Plant in New Johnsonville, Tennessee. This report reviews the background information, discusses the site area and subsurface conditions, outlines the elements of our investigation, and presents the results and our conclusions.

Background

Based on conversations we had with Mr. Lynn Petty and Mr. Larry Bowers of TVA and a site visit on July 24, 2003, we understood that TVA wanted us to utilize our Geoprobe™ sampling system to collect samples in the ash pond area so that in-place densities could be determined. Additionally, a quantification of the amount of ash being excavated by dipping from a flow channel was also desired. We understand that TVA wants to use this information to evaluate various options, including schedules and costs, for the storage and removal of ash by TransAsh, Inc.

Study Area

The project site is located in New Johnsonville, Tennessee approximately 8 miles southeast of the city of Camden in Humphreys County, Tennessee (see Figure 1).

Geoprobe Services

We utilized our Geoprobe sampling system to obtain ash samples from both the active ash pond and an Abandoned Ash Pond. The probehole locations are shown on Figure 2. Two holes were probed at each location and were extended to refusal or to native soils. In an effort to get as much recovery as possible a combination of methods were utilized. Generally, we began probing each hole using a Macro-Core Soil Sampler in general accordance Geoprobe's Technical Bulletin No. 95-8500, and we used it until groundwater was encountered. After groundwater was encountered, we used the DT21 Dual Tube Soil Sampling System in general accordance with Geoprobe's Technical Bulletin No. 982100. Both methods are described in Appendix A.

Subsequent to retrieval of the ash samples, the acetate liners in which they were retrieved were sealed, and the samples were transported to our laboratory were they were analyzed for Moisture Content and Dry Unit Weight.

Table 1 below indicates the findings, and boring logs are included in Appendix B.

TABLE 1
NATURAL MOISTURE CONTENT
AND DRY UNIT WEIGHT OF FOSSIL PLANT ASH
LABORATORY TEST RESULTS
TVA Johnsonville
MACTEC Project 30310362091

Boring Number	Sample Type	Sample Depth (ft)	Moisture Content (%)	Dry Unit Weight (pounds per cubic foot)
B-1	4' Geoprobe	0-4.0	24.3	69.4
B-1	3' Geoprobe	4.0-6.0	25.1	84.3
B-1	3' Geoprobe	6.0-9-0	32.1	67.1
B-1	3' Geoprobe	9.0-12.0	49.8	67.1
B-1	3' Geoprobe	12.0-15.0	47.4	70.1
B-1	3' Geoprobe	15.0-18.0	66.5	57.0
B-1	3' Geoprobe	18.0-21.0	55.8	63.9
B-1	3' Geoprobe	21.0-24.0	51.6	63.3
B-1	3' Geoprobe	24.0-27.0	53.9	64.2
B-1	3' Geoprobe	27.0-30.0	44.5	72.3
B-1	4' Geoprobe	30.0-34.0	54.1	65.7
B-1	4' Geoprobe	34.0-38.0	64.5	60.2

TABLE 1
NATURAL MOISTURE CONTENT
AND DRY UNIT WEIGHT OF FOSSIL PLANT ASH
LABORATORY TEST RESULTS
TVA Johnsonville
MACTEC Project 30310362091

Boring Number	Sample Type	Sample Depth (ft)	Moisture Content (%)	Dry Unit Weight (pounds per cubic foot)
B-1	4' Geoprobe	38.0-42.0	63.5	61.8
B-2	3' Geoprobe	0.0-3.0	37.1	70.4
B-2	3' Geoprobe	3.0-6.0	74.2	54.6
B-2	3' Geoprobe	6.0-9.0	42.9	73.6
B-2	3' Geoprobe	9.0-12.0	43.3	72.3
B-2	3' Geoprobe	12.0-15.0	39.6	73.6
B-2	3' Geoprobe	15.0-18.0	122.6	38.0*
B-2	3' Geoprobe	18.0-21.0	No Tube	No Tube
B-2	3' Geoprobe	21.0-24.0	121.9	38.8*
B-2	3' Geoprobe	24.0-27.0	146.3	34.9*
B-2	3' Geoprobe	27.0-29.0	70.5	56.7
B-3	4' Geoprobe	0.0-4.0	14.2	83.1
B-3	4' Geoprobe	8.0-12.0	9.0	95.3
B-3	4' Geoprobe	12.0-16.0	13.1	114.0
B-3	4' Geoprobe	16.0-18.0	17.5	113.9
B-4	4' Geoprobe	17.0-21.0	22.8	92.6
B-4	4' Geoprobe	21.0-25.0	28.9	90.0
B-4	4' Geoprobe	24.0-28.0	21.2	105.4
* Potential loss of sample during retrieval			Prepared by SDS on 8/28/03 Checked by [illegible] on 8/28/03	

Dipped Ash Evaluation

During our site visit, we observed ash removal by dipping. Trans Ash has been utilizing two different excavators to remove ash from the perimeter drainage channel. We were requested to estimate the quantity of dry ash removed by this method.

Excavator Bucket Calibration

Prior to testing, the excavator bucket volume was calibrated by slowly allowing water to flow through a water meter and gradually filling the bucket in conjunction with geometrical calculations (i.e., measuring the dimensions of the bucket). We determined that the bucket on excavator No. 1 had a volume of 0.88 cubic yards and that excavator No. 2 had a bucket volume of 0.56 cubic yards.

Ash Weight

We collected a total of five ash samples from the West side perimeter drainage channel and three samples from the East side channel with excavator No. 1. Excavator No. 2 was not operational at the time of our tests. Figure 2 shows the approximate sampling locations. The ash samples were saturated. We measured each sample's weight and volume and recorded the bucket used, and the relative ash volume contained therein. Subsequently, we collected ash samples in sealed jars for laboratory moisture content testing.

Based on the laboratory moisture content test results and our field measurements we estimated the weight of dry ash per excavator scoop. We estimate excavator No. 1 removes approximately 1,475 pounds of dry ash per average scoop. By extrapolation, we estimate excavator No. 2 would remove approximately 940 pounds of dry ash per average scoop. It should be noted that there are many variables in the dipping operation such as size of excavator bucket being utilized, dipping location, time, and operator. These variables should be considered when estimating the total ash volume removed. The results of our dipping test results are included in the following Table.

TABLE 2
DIPPING TEST RESULTS
EXCAVATOR NO. 1
TVA Johnsonville
MACTEC Project 30310362091

Dipping Sample No.	Channel Location	Moisture Content	Estimated Scoop Volume (cy)	Dry Ash Per Scoop (lb)
1	West Side	48.0	1.0	1624.4
2		47.0	0.9	1499.0
3		45.0	0.8	1381.6
4		46.0	0.9	1535.0
5		46.0	0.9	1575.7
6	East side	53.0	0.9	1498.3
7		50.0	0.9	1572.9
8		55.0	0.8	1144.6
Average		48.8	0.9	1478.9
			Prepared by MMN on 8/28/03 Checked by [illegible] on 8/28/03	

Mr. Purkey, we appreciate the opportunity to provide these services to the Tennessee Valley Authority. If you have any questions regarding this report, please contact us at (865) 588-8544.

Sincerely,

MACTEC Engineering and Consulting, Inc.

Scott D. Smith, P.G.
Principal Geologist

Mohomed M. Nofal, P.E.
Senior Engineer

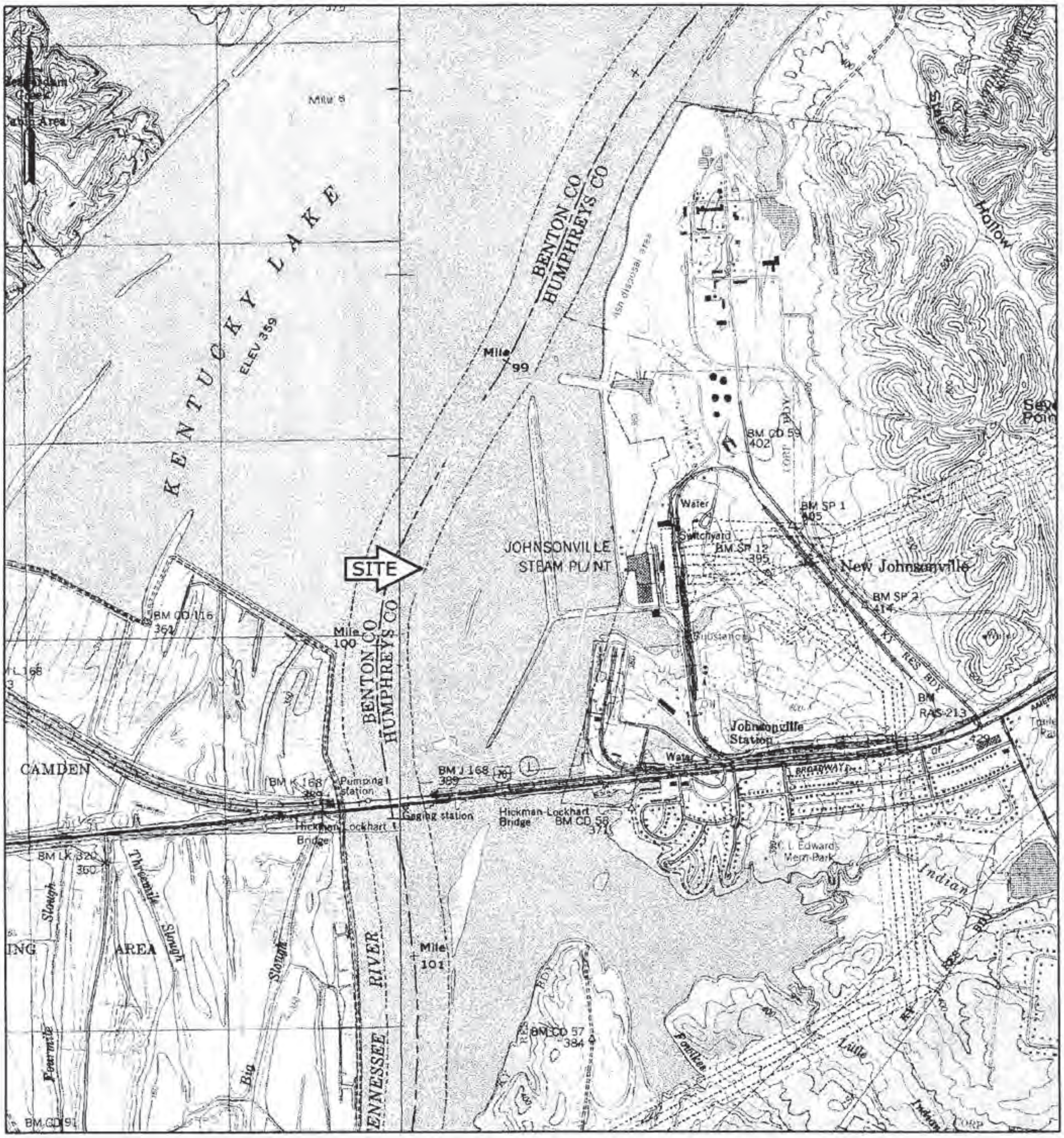
Samuel D. Stone, P.E.
Senior Principal Engineer

SAMUEL D. STONE, JR. REGISTERED ENGINEER XVI AGRICULTURE COMMERCE NO. 13847 STATE OF TENNESSEE

SDS/MMN/SDS:mrd

Attachments

FIGURES



SOURCE: USGS TOPOGRAPHIC MAPS OF CAMDEN AND JOHNSONVILLE, TN QUADRANGLES

MACTEC

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Knoxville, Tennessee 37921-5904
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FIGURE 1: SITE LOCATION MAP
TVA - JOHNSONVILLE FOSSIL PLANT
NEW JOHNSONVILLE, TENNESSEE

DRAFTING BY:	PREPARED BY:	CHECKED BY:
JOB NUMBER: 3031032091/0001	DATE: AUGUST 22, 2003	SCALE: 0 2500'

COORDINATES: N 36°01'37" W 87°59'36"

3031032091_01_fig1.dwg Wed, 27 Aug 2003 - 2:50pm REverett

SOURCE: USGS AERIAL PHOTOGRAPH OF NEW JOHNSONVILLE, TENNESSEE DATED FEBRUARY 2, 1999.

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Knoxville, Tennessee 37921-5904
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FIGURE 2: BORING / GRAB SAMPLE LOCATION PLAN
TVA - JOHNSONVILLE FOSSIL PLANT
NEW JOHNSONVILLE, TENNESSEE

COORDINATES: N 36°01'37" W 87°59'36"

DRAFTING BY:	PREPARED BY: SDS	CHECKED BY:
JOB NUMBER: 3031032091/0001	DATE: AUGUST 25, 2003	SCALE: NOT KNOWN

3031032091_01_fig2.dwg Wed, 27 Aug 2003 - 3:37pm REverenc

APPENDIX A

GEOPROBE TECHNICAL BULLETINS

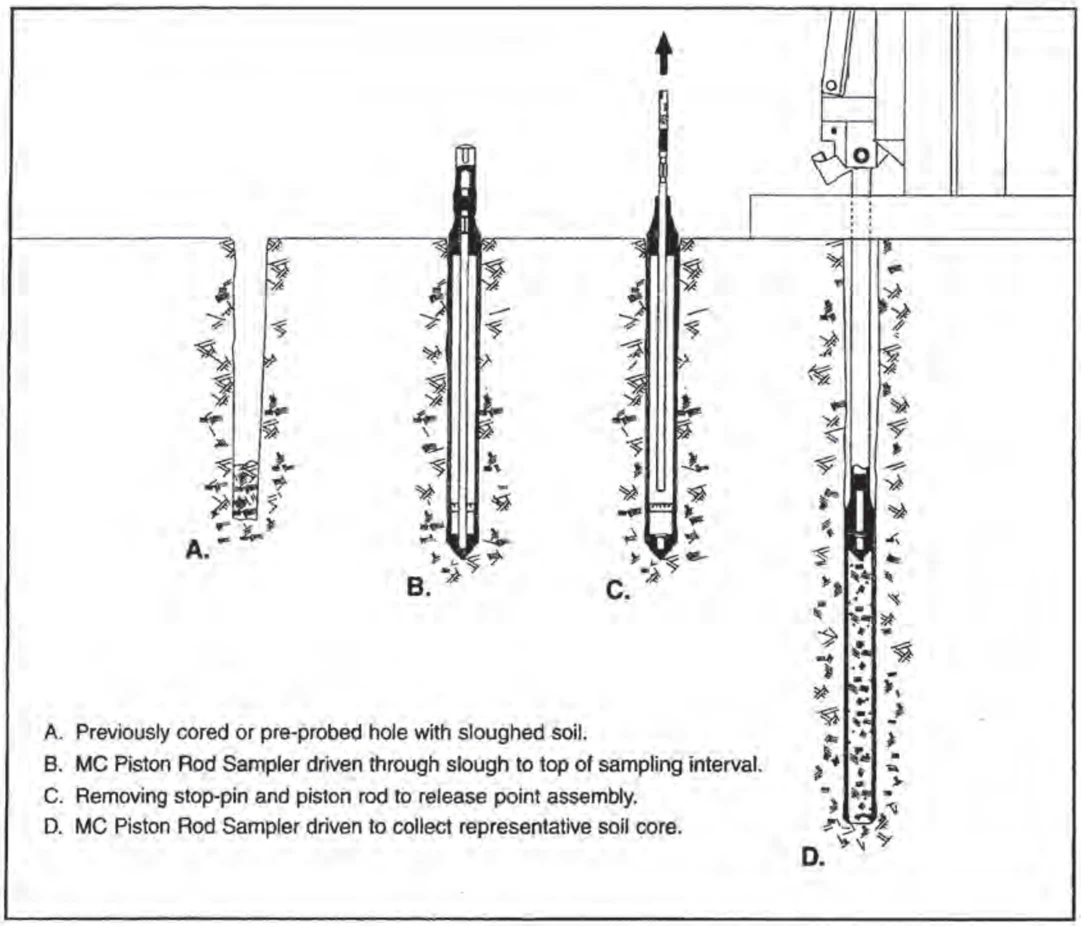
Geoprobe Macro-Core® Soil Sampler

Standard Operating Procedure

Technical Bulletin No. 95-8500

PREPARED: November, 1995

REVISED: September, 1998



A. Previously cored or pre-probed hole with sloughed soil.
B. MC Piston Rod Sampler driven through slough to top of sampling interval.
C. Removing stop-pin and piston rod to release point assembly.
D. MC Piston Rod Sampler driven to collect representative soil core.

OPERATION OF MACRO-CORE® PISTON ROD SOIL SAMPLING SYSTEM

1.0 OBJECTIVE

The objective of this procedure is to collect a representative soil sample at depth and recover it for visual inspection and/or chemical analysis.

2.0 BACKGROUND

2.1 Definitions

Geoprobe®*: A brand name of high quality, hydraulically-powered machines that utilize both static force and percussion to advance sampling and logging tools into the subsurface.
** Geoprobe® is a registered trademark of Kejr, Inc., Salina, Kansas*

Macro-Core® Soil Sampler*: A solid barrel, direct push device for collecting continuous core samples of unconsolidated materials at depth. Although other lengths are available, the standard Macro-Core® Sampler has an assembled length of approximately 52 inches (1321 mm) with an outside diameter (OD) of 2.2 inches (56 mm). Collected samples measure up to 1300 ml in volume in the form of a 1.5-inch x 45-inch (38 mm x 1143 mm) core contained inside a removable liner. The Macro-Core® Sampler may be used in an open-tube or closed-point configuration.
** Macro-Core® is a registered trademark of Kejr, Inc., Salina, Kansas*

Liner: A removable/replaceable, thin-walled tube inserted inside the Macro-Core® sample tube for the purpose of containing and storing soil samples. While other lengths are available, the standard Macro-Core® Liner is 1.75 inches OD x 46 inches long (44 mm x 1168 mm). Liner materials include stainless steel, Teflon®, PVC, and PETG.

2.2 Discussion

In this procedure, an assembled Macro-Core® Soil Sampler is driven one sampling interval into the subsurface and then retrieved using a Geoprobe soil probing machine. The collected soil core is removed from the sampler along with the used liner. After decon, the Macro-Core® sampler is reassembled using a new liner. The clean sampler is then advanced back down the same hole to collect the next soil core. The Macro-Core® Sampler may be used as an open-tube or closed-point sampler.

The Macro-Core® Soil Sampler is most commonly used as an open-tube sampler (Fig. 2.1A). In this configuration, coring starts at the ground surface with a sampler that is open at the leading end. The sampler is driven into the subsurface and then pulled from the ground to retrieve the first soil core. In stable soils, an open-tube sampler is advanced back down the same hole to collect the next core.

In unstable soils which tend to collapse into the core hole, the Macro-Core® Sampler can be equipped with a piston rod point assembly (Fig. 2.1B). The point fits firmly into the cutting shoe and is held in place by a piston rod and stop-pin. The MC Piston Rod System prevents collapsed soil from entering the sampler as it is advanced to the bottom of an existing hole, thus ensuring collection of a reprentative sample.

The Macro-Core® Piston Rod Sampler is not designed to be driven through undisturbed soil. A probe hole must be opened above the sampling interval either by removing continuous soil cores with an open-tube sampler, or by advancing a Macro-Core® Pre-Probe to depth.

Once a hole is opened to the appropriate depth, an assembled MC Piston Rod Sampler is advanced through any slough material to the top of the next sampling interval. Extension rods are inserted through the probe rod string and threaded onto the MC Stop-Pin Assembly. When unthreaded, the stop-pin is removed from the tool string with the extension rods. (MC Piston rod is removed with stop-pin if MC Stop-Pin Coupler is utilized). With the point assembly now released, the tool string is driven into the subsurface to fill the sampler with soil. The point assembly is later retrieved from the sampler with the liner and soil core.

Loose soils may fall from the bottom of the sampler as it is retrieved from depth. The MC Core Catcher (Fig. 3.1) alleviates this problem. Excellent results are obtained when the core catcher is used with saturated sands and other non-cohesive soils. A core catcher should not be used with tight soils as it may actually inhibit sample recovery. Constructed of PVC, the core catcher is suitable for use with all Geoprobe liners.

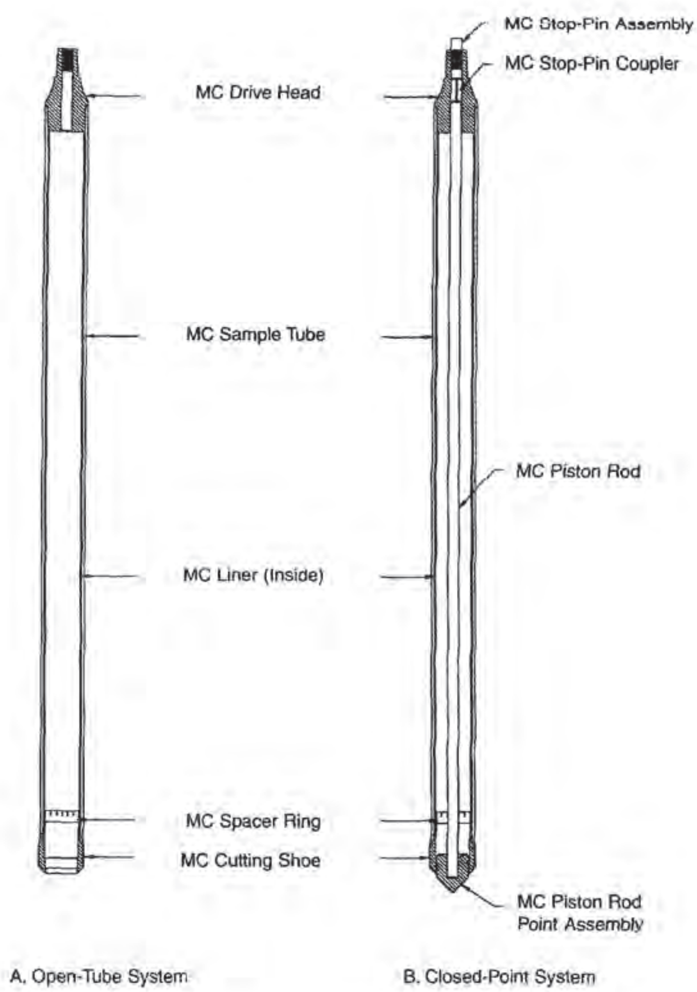


FIGURE 2.1
Macro-Core® Soil Sampler Configurations

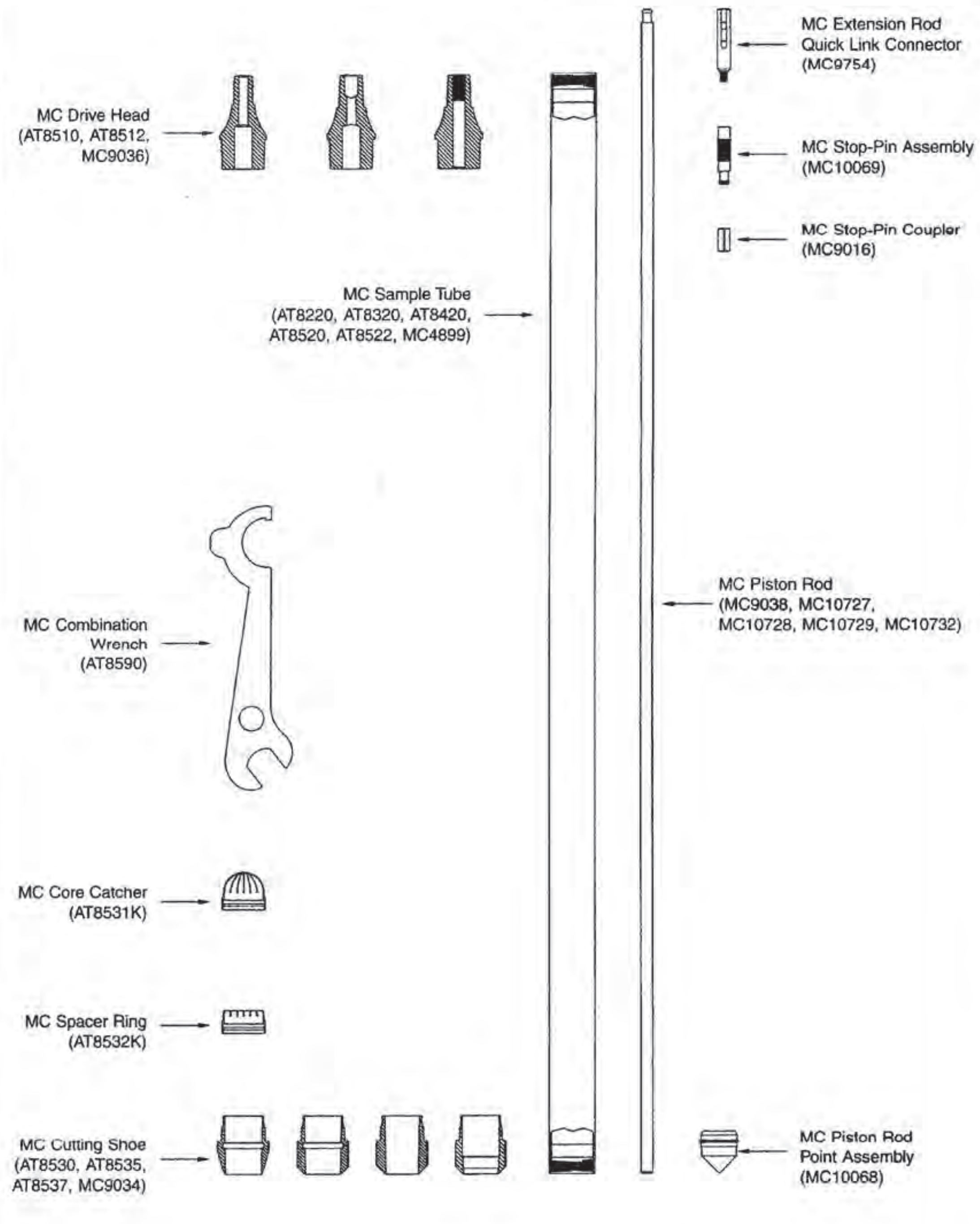


FIGURE 3.1
Macro-Core® Soil Sampler Parts

3.0 REQUIRED EQUIPMENT

The following equipment is used to recover samples using the Geoprobe Macro-Core® Soil Sampler and probing system. Although many options are available (sampler length, liner material, etc.), the basic sampler configuration does not change. Refer to Figure 3.1 (previous page) to view the major components of the Macro-Core® sampler.

MACRO-CORE® SAMPLER PARTS	PART NUMBER
MC Drive Head, for use with 1.0-inch probe rods	AT8510
MC Drive Head, for use with 1.25-inch probe rods	AT8512
MC Sample Tube, 24-inch, unplated	AT8220
MC Sample Tube, 36-inch, unplated	AT8320
MC Sample Tube, 1-meter, unplated	AT8420
MC Sample Tube, 48-inch, Ni-plated	AT8520
MC Sample Tube, 48-inch, unplated	AT8522
MC Sampler Tube, 60-inch, unplated	MC4889
MC Cutting Shoe, standard	AT8530
MC Cutting Shoe, heavy-duty	AT8535
MC Cutting Shoe, 0.125 inches undersized	AT8537
MC Combination Wrench	AT8590
Nylon Brush for MC Sample Tubes	BU700

MACRO-CORE® PISTON ROD SYSTEM PARTS	PART NUMBER
O-Rings for MC Stop-Pin (pkg. of 25)	AT6312R
O-Rings for MC Piston Rod Point (pkg. of 25)	DT4070R
MC Stop-Pin Coupler (pkg. of 5)	MC9016
MC Cutting Shoe, for use with piston rod point	MC9034
MC Drive Head, for use with 1.25-inch probe rods and stop-pin	MC9036
MC Piston Rod, 48-inch	MC9038
MC Extension Rod Quick Link Connector	MC9754
MC Piston Rod Point Assembly	MC10068
MC Stop-Pin Assembly	MC10069
MC Piston Rod/Stop-Pin Assembly, 48-inch	MC10070
MC Piston Rod, 60-inch	MC10727
MC Piston Rod, 36-inch	MC10728
MC Piston Rod, 24-inch	MC10729
MC Piston Rod, 1-meter	MC10732
MC Piston Rod/Stop-Pin Assembly, 60-inch	MC11881
MC Piston Rod/Stop-Pin Assembly, 36-inch	MC12028
MC Piston Rod/Stop-Pin Assembly, 24-inch	MC12029
MC Piston Rod/Stop-Pin Assembly, 1-meter	MC12030
MC Quick Link Kit	MC12131

MACRO-CORE® LINERS AND ACCESSORIES	PART NUMBER
MC Stainless Steel Liner Assembly, 48-inch	AT7235
MC Teflon® Liner Assembly, 48-inch	AT724
MC PETG Liner, thin-wall, 48-inch, (box of 66)	AT725K
MC Vinyl End Caps (66 pair)	AT726K
MC Heavy-Duty PETG Liner Assembly, 48-inch (box of 66)	AT825K
MC PVC Liner Assembly, clear, 24-inch (box of 66)	AT922K
MC PVC Liner Assembly, clear, 36-inch (box of 66)	AT923K
MC PVC Liner Assembly, clear, 1-meter (box of 66)	AT924K
MC PVC Liner Assembly, clear, 48-inch (box of 66)	AT925K
MC Liner Cutter Kit	AT8000K
MC Liner Cutting Tool*	AT8010
MC Liner Cutter Holder*	AT8020
MC Liner Cutter Blades (pkg. of 5)*	AT8030
MC Liner Circular Cutting Tool	AT8050
MC Core Catchers (pkg. of 25)	AT8531K
MC Spacer Rings (pkg. of 25)	AT8532K
MC PVC Liner Assembly, clear, 60-inch (box of 66)	11984

GEOPROBE TOOLS**	PART NUMBER
Drive Cap, for use with 1.25-inch probe rods	AT1200
Slotted Drive Cap, for use with 1.25-inch probe rods	AT1202
Pull Cap, for use with 1.25-inch probe rods	AT1204
Probe Rod, 1.25 inches x 36 inches	AT1236
Probe Rod, 1.25 inches x 1 meter	AT1239
Probe Rod, 1.25 inches x 48 inches	AT1248
Probe Rod, 1.25 inches x 60 inches	AT1260
MC Pre-Probe, 2-inch OD	AT1247
MC Pre-Probe, 2.5-inch OD	AT1242
MC Pre-Probe, 3-inch OD	AT1252
Extension Rod, 36-inch	AT67
Extension Rod, 48-inch	AT671
Extension Rod, 1-meter	AT675
Extension Rod Coupler	AT68
Extension Rod Handle	AT69
Extension Rod Quick Links	AT694K
Machine Vise	FA300

ADDITIONAL TOOLS

Combination Wrench, 1/2-inch (or) Adjustable Wrench
Pipe Wrenches (2)

*The items are included in the MC Liner Cutter Kit (AT8000K).
**Geoprobe tools and accessories are also available for use with 1.0-inch OD (outside diameter) probe rods.

4.0 OPERATION

Size and material options have resulted in an extensive list of Macro-Core® part numbers. To simplify the instructions presented in this document, part numbers are listed in the illustrations only. Refer to Pages 6 and 7 for a complete parts listing.

4.1 Decontamination

Before and after each use, thoroughly clean all parts of the soil sampling system according to project requirements. A new, clean liner is recommended for each sample if using PETG, PVC, or Teflon® liners.

Stainless Steel Liners from Geoprobe Systems are cleaned at the factory with an agitated detergent bath at a temperature of approximately 180 degrees F. After rinsing with 180-degree tap water, the liner is air dried, wrapped in PVC outer cladding, and capped with vinyl end caps.

Thoroughly clean the sampler before assembly, not only to remove contaminants but also to ensure correct operation. Dirty threads complicate assembly and may lead to sampler failure. Sand is particularly troublesome as it can bind liners in the sample tube resulting in wasted time and lost samples.

4.2 Field Blank

It is suggested that a field blank be taken on a representative sample liner prior to starting a project and at regular intervals during extended projects. Liners can become contaminated in storage. A field blank will prove that the liners do not carry contaminates which can be transferred to soil samples. The following information is offered as an example method which may be used to take a field blank. Make the appropriate modifications for the specific analytes of interest to the investigation.

Example Procedure:

REQUIRED EQUIPMENT

MC Liner	(1)
MC Vinyl End Caps	(2)
Distilled Water	*(100 ml)*
VOA Vial (or other appropriate sample container)	(1)

1. Place a vinyl end cap on one end of the liner.

2. Pour 100 milliliters of distilled water (or other suitable extracting fluid) into the liner.

3. Place a vinyl end cap on the open end of the liner.

4. From the vertical position, repeatedly invert the liner so that the distilled water contacts the entire inner surface. Repeat this step for one minute.

5. Remove one end cap from the liner, empty contents into an appropriate sample container, and cap the container.

6. Perform analysis on the extract water for the analytes of interest to the investigation.

4.3 Open-Tube Sampler Assembly

1a. (With MC Core Catcher) Place the open end of an MC Core Catcher over the threaded end of an MC Cutting Shoe as shown in Figure 4.1. Apply pressure to the core catcher until it snaps into the machined groove on the cutting shoe.

NOTE: AT725K (thin-wall PETG) liners have a swedged end which is generally slipped directly over the groove in the cutting shoe (Fig. 4.2). To use a core catcher with these liners, cut approximately 0.25 inches (6 mm) of material from the swedged end of the liner and proceed to Step 2.

1b. (Without MC Core Catcher) Push the base of an MC Spacer Ring onto the threaded end of a cutting shoe until it snaps into place (Fig. 4.3).

NOTE: With the exception of AT-725K (thin-wall PETG) liners, all liners must utilize either a spacer ring or core catcher. PETG liners have a swedged end which slides directly over the end of the cutting shoe. Attach the liner to the cutting shoe (Fig. 4.2) before proceeding to Step 2.

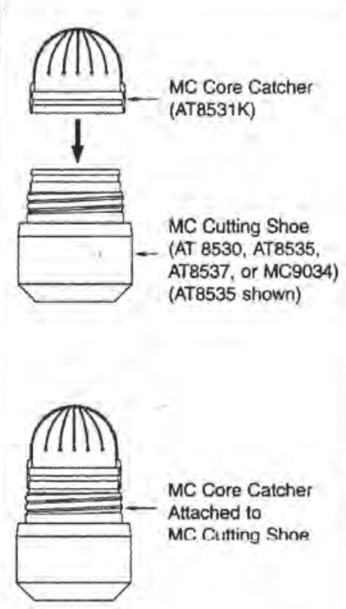


FIGURE 4.1
Core Catcher Attachment

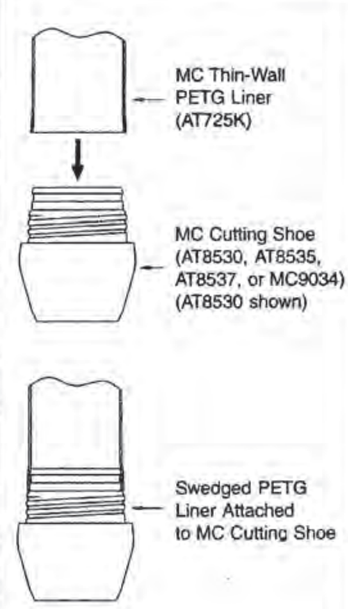


FIGURE 4.2
Thin-Wall Liner Attachment

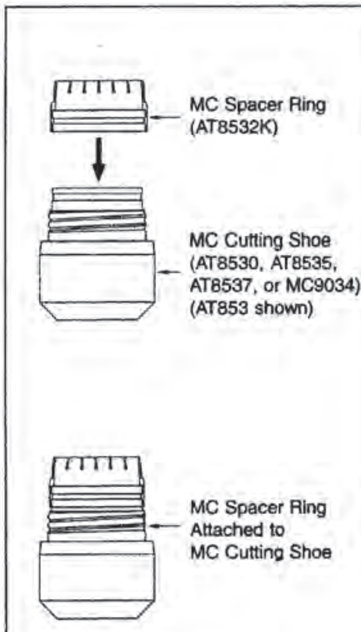


FIGURE 4.3
Spacer Ring Attachment

Refer to Figure 4.4 for identification of sampler parts and assembly sequence

2. Thread the cutting shoe into one end of an MC Sample Tube (Fig. 4.5). Tighten shoe with MC Combination Wrench (Fig. 4.6) until end of sample tube contacts machined shoulder of cutting shoe.

3. Insert a liner into the opposite end of the sample tube (Figure 4.7). The liner is all ready installed if using thin-wall PETG liners (AT725K) without an MC Core Catcher.

4. Thread an MC Drive Head into the top of the sample tube (Fig. 4.8) and securely tighten with the MC Combination Wrench (Fig. 4.9). *Ensure that the end of the sample tube contacts the machined shoulder of the drive head.*

Sampler Assembly is Complete.

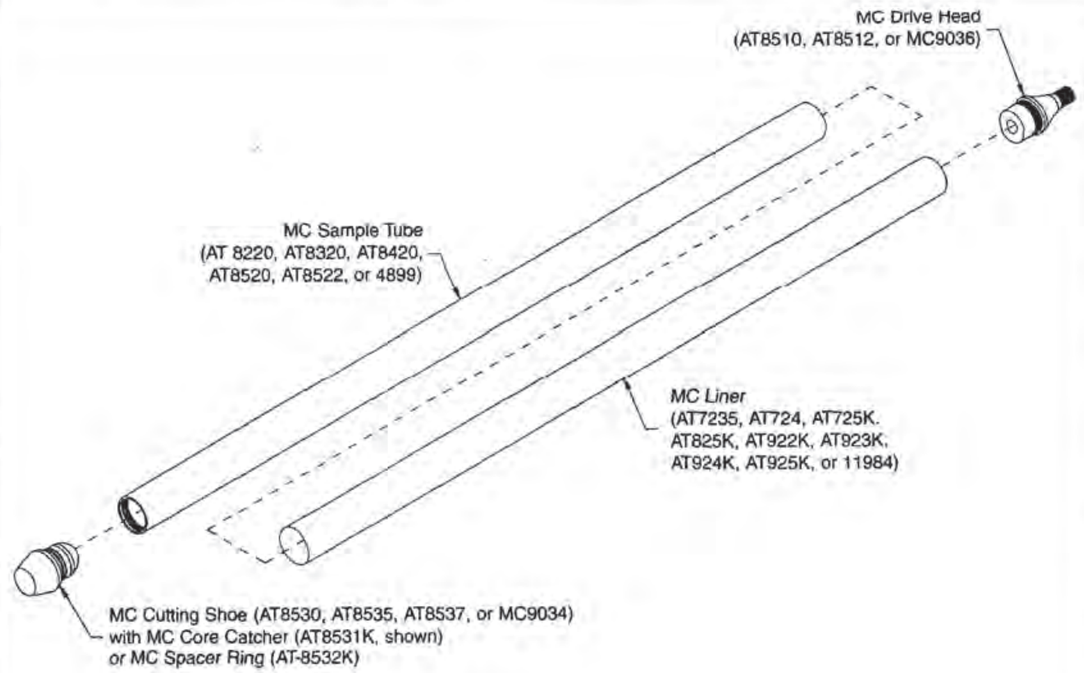


FIGURE 4.4
Macro-Core® Open-Tube Sampler Assembly

Figure 4.5. Thread an MC Cutting Shoe (shown with MC Core Catcher) into either end of a MC Sample Tube.

Figure 4.6. Tighten MC Cutting Shoe with MC Combination Wrench.

Figure 4.7. Insert liner into opposite end of MC Sample Tube.

Figure 4.8. Thread MC Drive Head into top of MC Sample Tube.

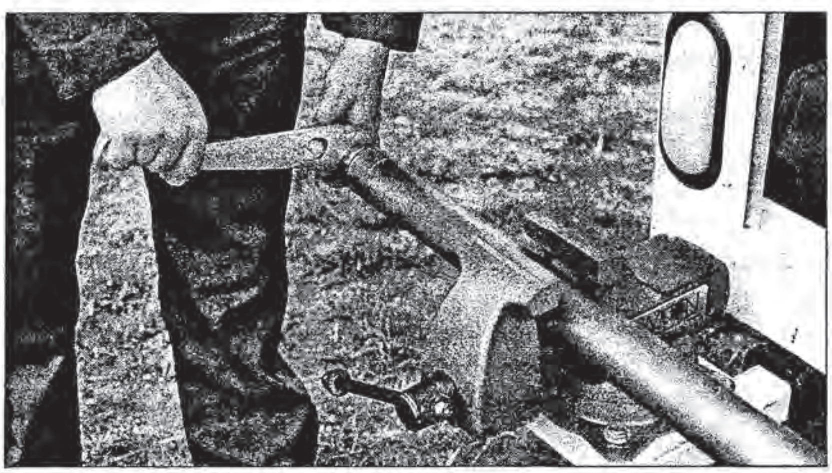


Figure 4.9. Tighten MC Drive Head with MC Combination Wrench. A vise is often used to hold the MC Sample Tube during this step.

4.4 Stop-Pin Coupler

The Stop-Pin Coupler attaches the Stop-Pin to the Piston Rod (Fig. 4.10). When connected together, these three parts form the Stop-Pin/Piston Rod Assembly. All three items may be ordered either individually or together as one complete assembly. Refer to Section 3.0 for specific assembly and item part numbers.

It is not always necessary to use the stop-pin coupler with the MC Piston Rod System. The coupler allows the piston rod to be removed from the sampler along with the stop-pin so that sample recovery is not hindered by the weight of the piston rod. If you find that recovery is not a problem with the formation you are sampling (such as clays), do not use the stop-pin coupler.

If sampling in formations where sample recovery may be a problem (such as loose sands), the stop-pin coupler is highly recommended. Removing the piston rod with the stop-pin significantly reduces the amount of tooling weight that the soil core must support as the sampler is driven. Sample compression is also reduced when the stop-pin coupler is utilized.

Instructions for connecting the stop-pin coupler to the stop-pin and piston rod are given below.

1. Hold a piston rod in vertical position with leading end resting on a solid surface.
2. Place a Stop-Pin Coupler on top of the Piston Rod and tap with a hammer to seat (Fig. 4.11).
3. Snap a Stop-Pin into the coupler using a hammer or 12-inch probe rod and drive cap (Fig. 4.12).

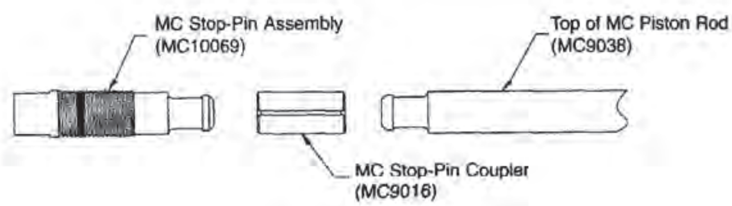


FIGURE 4.10
MC Stop-Pin Coupler Attaches MC Stop-Pin to MC Piston Rod

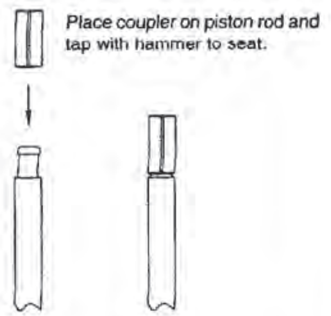


FIGURE 4.11
Tap Stop-Pin Coupler onto Piston Rod

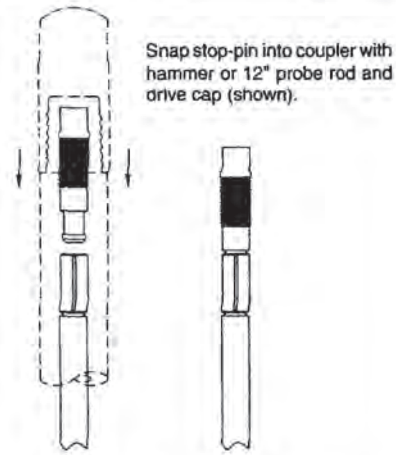


FIGURE 4.12
Tap Stop-Pin into Coupler with Probe Rod

4.5 MC Piston Rod Sampler (closed-point system) Assembly

The MC Piston Rod System seals the leading end of the sampler with a point assembly that is held in place with a piston rod and stop-pin. Once advanced to the top of the sampling interval, the stop-pin is removed with extension rods that are inserted down through the probe rod string. The piston rod will be extracted along with the stop-pin if a stop-pin coupler was used. Refer to Section 4.4 for help in determining when a stop-pin coupler is needed.

NOTE: The MC Piston Rod System requires an MC9036 MC Drive Head and an MC9034 MC Cutting Shoe. No other Macro-Core® drive heads or cutting shoes are compatible with this system. The larger 1.25-inch OD Probe Rods are also required to operate MC Piston Rod System.

1. Install an O-ring in the machined groove on the piston rod point (Fig. 4.13). Lubricate the O-ring with a small amount of deionized water.

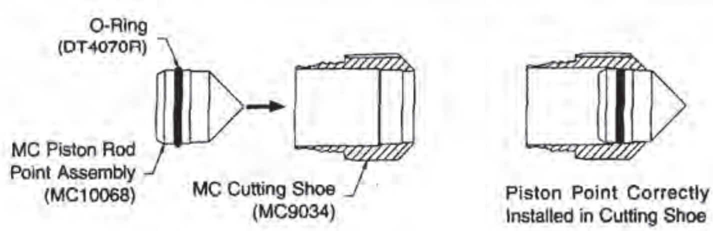


FIGURE 4.13
Installation of MC Piston Rod Point Assembly in MC Cutting Shoe

2. Push the piston rod point completely into the cutting shoe as shown in Figure 4.13.

3a. **(With MC Core Catcher)** Place the open end of a core catcher over the threaded end of the cutting shoe as shown in Figure 4.14. Apply pressure to the core catcher until it snaps into the machined groove on the cutting shoe.

NOTE: AT725K (thin-wall PETG) liners have a swedged end that is slipped directly over the groove in the cutting shoe (Fig. 4.15). To use a core catcher with these liners, simply cut approximately 0.25 inches (6 mm) of material from the swedged end of the liner and continue to Step 4.

3b. **(Without Core Catcher)** Push the base of an MC Spacer Ring onto the threaded end of the cutting shoe until it snaps into place (Fig. 4.16).

NOTE: With the exception of AT725K (thin-wall PETG) liners, all liners must utilize either a spacer ring or core catcher. Thin-wall liners have a swedged end which slides directly over the end of the cutting shoe. If using thin-wall liners, attach the liner to the cutting shoe (Fig. 4.15) before proceeding.

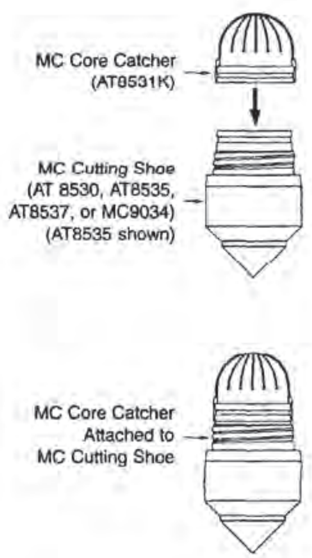


FIGURE 4.14
Core Catcher Attachment With Point Assembly

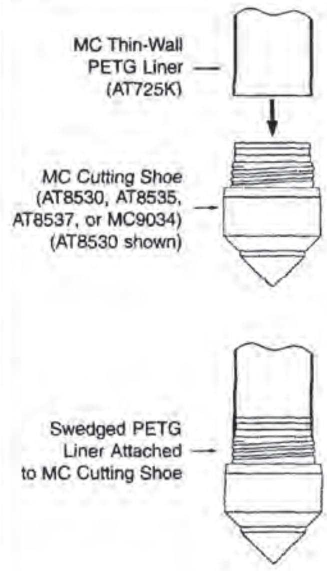


FIGURE 4.15
Thin-Wall Liner Attachment With Point Assembly

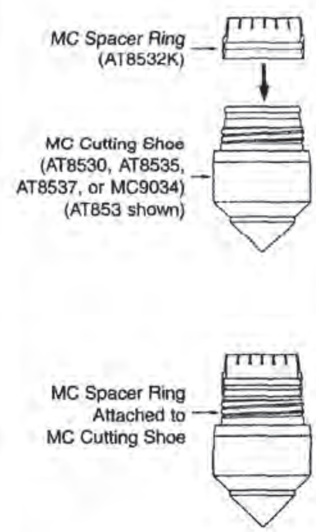


FIGURE 4.16
Spacer Ring Attachment With Point Assembly

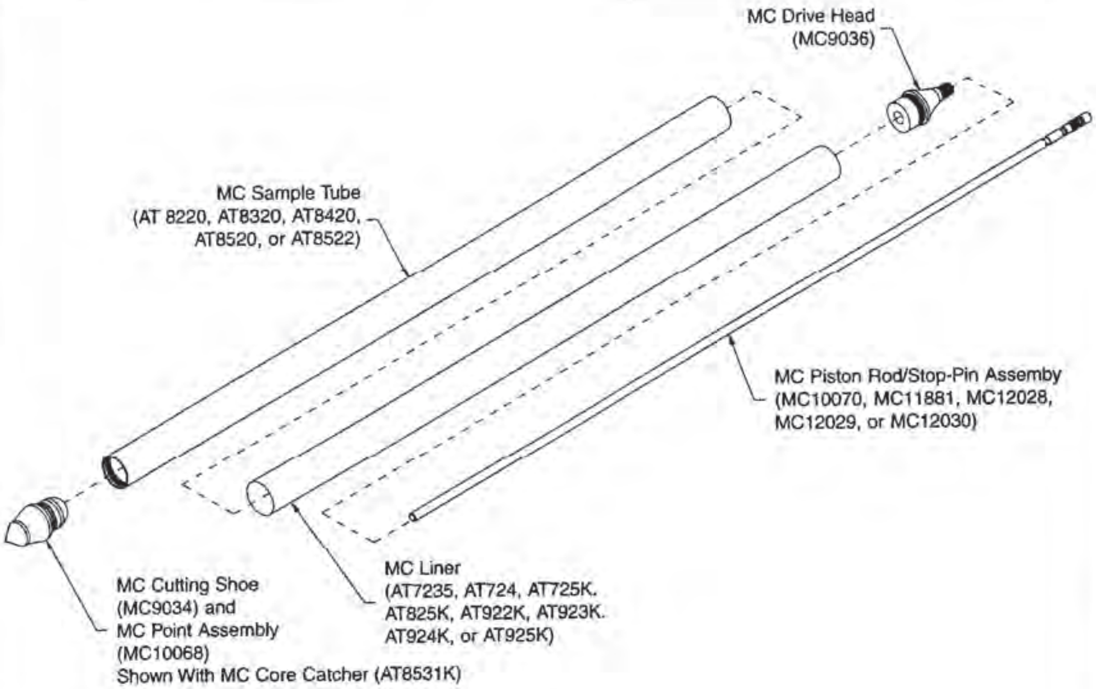


FIGURE 4.17
Macro-Core® Closed-Point Sampler Assembly

Refer to Figure 4.17 for identification of sampler parts and assembly sequence

4. Thread the cutting shoe (with point) into one end of an MC Sample Tube. Tighten until the end of the sample tube contacts the machined shoulder of the cutting shoe.

5. Insert an appropriate MC Liner into the sample tube (Fig. 4.18). The liner is all ready installed if using thin-wall PETG liners without a core catcher.

6. Thread an MC Drive Head into the top of the sample tube (Fig. 4.19) and securely tighten with the combination wrench (Fig. 4.20) until the end of the sample tube contacts the machined shoulder of the drive head.

(continued on Page 16)

Figure 4.18. Insert liner into opposite end of MC Sample Tube.

Figure 4.19. Thread MC Drive Head into top of MC Sample Tube.

Figure 4.20. Tighten MC Drive Head with MC Combination Wrench. A vise is often used to hold the MC Sample Tube during this step.

7. Insert an MC Piston Rod/Stop-Pin Assembly through the drive head until the stop-pin threads contact the top of the drive head (Fig. 4.21). Ensure that an O-ring has been placed on the stop-pin.

   The leading end of the piston rod may hangup on the core catcher during assembly. When this happens, raise the assembly 6-8 inches above the core catcher and then allow the assembly to fall back down into the sampler. This should allow the piston rod to pass through the fingers of the core catcher.

   Note: The MC Stop-Pin Coupler may be omitted under certain sampling conditions. Refer to Section 4.4 for information regarding when a coupler is needed and instructions for coupler installation.

8. Thread the stop-pin into the drive head (left-hand threads) with an adjustable or 1/2-inch combination wrench. Fully tighten the stop-pin and then back it off slightly (~10 degrees). This avoids locking the stop-pin threads and allows it to later be unthreaded from the ground surface with extension rods.

Sampler Assembly is Complete.

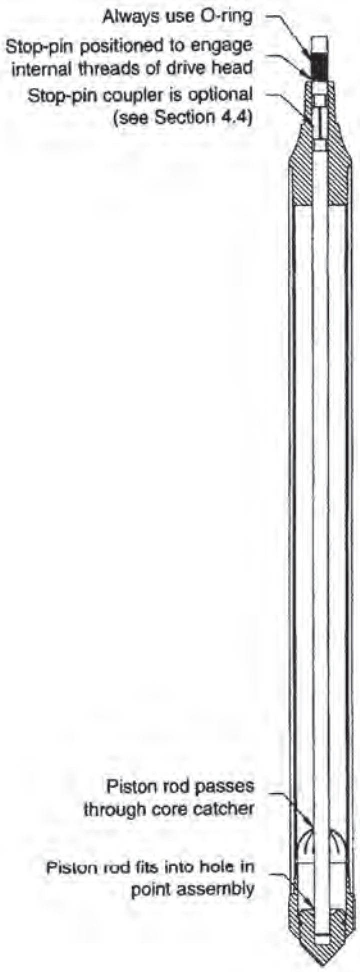


FIGURE 4.21
MC Piston Rod/Stop-Pin Assembly Installs Through MC Drive Head

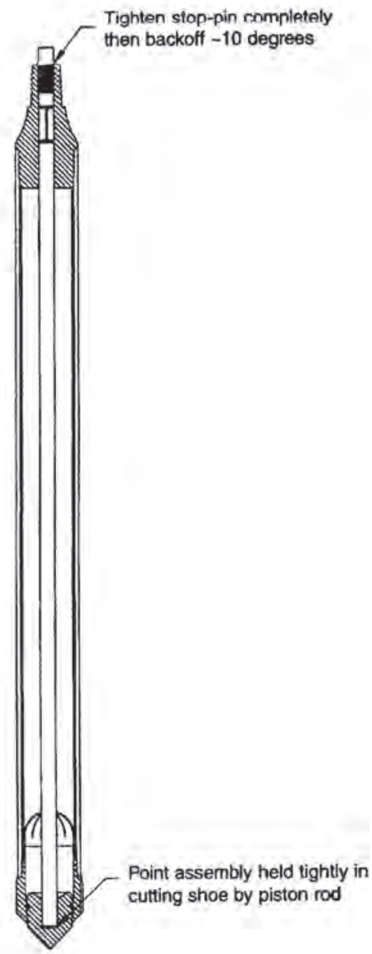


FIGURE 4.22
Thread MC Stop-Pin tachment with Piston Assembly

4.6 Pilot Hole

A pilot hole prevents excessive sampler wear in tough soils and saves time when a discrete soil core is desired. The pilot hole is created by driving a 2.0-, 2.5-, or 3.0-inch MC Pre-Probe (see Section 3.0 for part numbers) to the top of the sampling interval. Soil surfaces containing gravel, asphalt, hard sands, or rubble should be pre-probed to reduce wear on the cutting shoe and to avoid damage to the sampler. To save time when collecting a discrete soil core, pre-probe to the sampling interval rather than coring to depth with the sampler.

4.7 Open-Tube Sampling

The Macro-Core® Open-Tube Sampler is used to gather continuous soil cores beginning from ground surface. A representative soil sample is obtained by driving the assembled sampler one sampling interval into the subsurface through undisturbed soil. Upon retrieving the sampler, the liner and soil core are removed. The sampler is then properly decontaminated, reassembled with a new liner, and inserted back down the same hole to collect the next soil core.

Instructions for operationg of the Open-Tube Macro-Core® Sampler are given in this section.

1. Thread a Drive Cap (AT1200) onto the drive head of an assembled Open-Tube Macro-Core® Sampler as shown in Figure 4.23. (Refer to Section 4.3 for sampler assembly).

2. Raise the probe unit hammer assembly to its highest position by fully extending the probe cylinder.

3. Position the MC Sampler for driving as shown in Figure 4.24. Place the sampler directly under the hammer with the cutting shoe centered between the toes of the probe foot. The sampler should now be parallel to the probe derrick. Step back from the unit and visually check sampler alignment.

4. Apply static weight and hammer percussion to advance the sampler until the drive head reaches the ground surface (Fig. 4.25A)

   ***NOTE:* Activate hammer percussion whenever collecting soil. Percussion helps shear the soil at the leading end of the sampler so that it moves into the sample tube for increased recovery.**

5. Raise the hammer assembly a few inches to provide access to the top of the sampler.

6. Remove the drive cap and thread a Pull Cap (AT1204) onto the sampler drive head.

7. Lower the hammer assembly and hook the hammer latch over the pull cap (Fig. 4.26). Raise the hammer assembly to pull the sampler completely out of the ground.

8. Procede to Section 4.9 for instructions on recovering the soil core from the MC Sampler.

To sample consecutive soil cores, advance a clean sampler down the previously opened hole (Fig. 4.25B) to the top of the next sampling interval (Fig. 4.25C). Drive the tool string the length of the sampler to collect the next soil core (Fig. 4.25D). Switch to an MC Piston Rod Sampler if excessive side slough is encountered.

***NOTE:* *Use caution when advancing or retrieving the sampler within an open hole.* Low side friction may allow the sampler and probe rods to drop down the hole when released. To prevent equipment loss, hold onto the tool string with a pipe wrench when needed.**

Figure 4.23. Thread drive cap onto sampler drive head.

Figure 4.24 MC Sampler positioned for driving into subsurface.

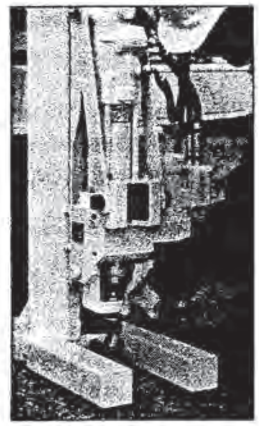


Figure 4.26. Hook hammer latch onto pull cap.

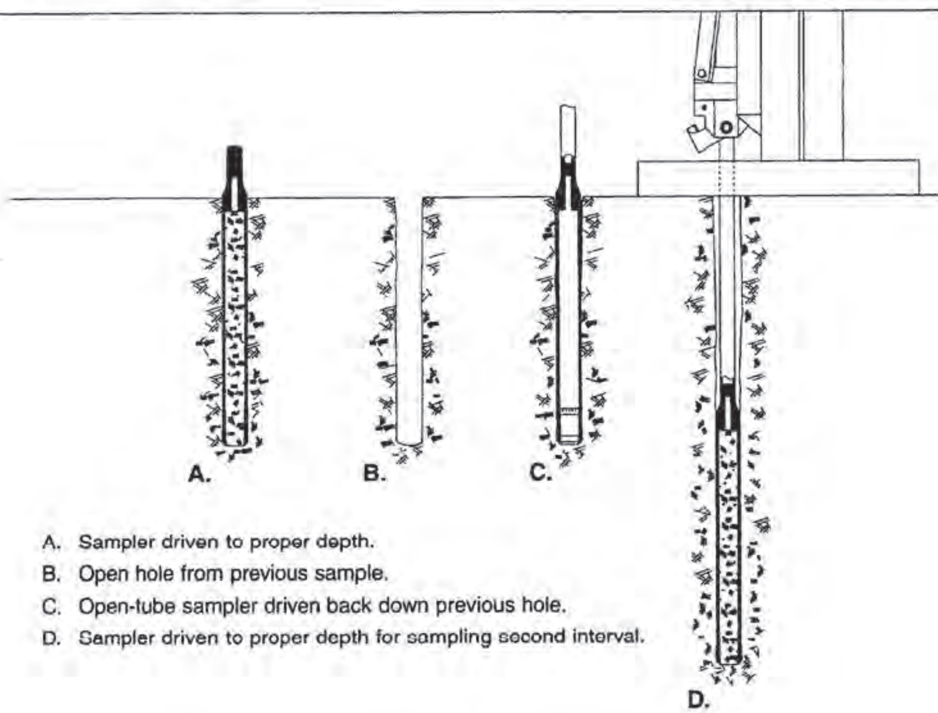


FIGURE 4.25
Phases of Macro-Core® Open-Tube Soil Sampling

4.8 Closed-Point Sampling with the MC Piston Rod System

Material collapsing from the probe hole sidewall can make it difficult to collect representative soil cores from significant depths with an open-tube sampler. To overcome this problem, the Macro-Core® Sampler can be equipped with a point assembly that is held tightly in the cutting shoe with a piston rod and threaded stop-pin. This allows the sealed sampler to pass through the slough material and then opened at the appropriate sampling interval. Intructions for sampling with the MC Piston Rod System are given in this section.

NOTE: The MC Piston Rod System is designed for continuous core sampling. A probe hole must be opened above the sampling interval either by removing soil with an open-tube Macro-Core® Sampler or by preprobing to depth. Never drive the MC Piston Rod System through undisturbed soil.

1. Attach a Slotted Drive Cap (AT1202) to the drive head of an assembled MC Piston Rod Sampler as shown in Figure 4.27. (Refer to Section 4.5 for sampler assembly.)

   NOTE: The MC Stop-Pin extends slightly from the top of the MC Drive Head. A slotted drive cap is therefore required to allow room for the stop-pin (Fig. 4.27). A standard drive cap may be used once probe rods are added to the tool string.

2. Raise the probe unit hammer assembly to its highest position by fully extending the probe cylinder.

3. Place the leading end of the MC Sampler into the **previously opened hole** (Fig. 4.28A).

4. Advance the sampler down the open hole for the full stroke of the probe machine.

   NOTE: Use caution when advancing the sampler down an open hole. Low side friction may allow the sampler and probe rods to drop down the hole when released. To prevent equipment loss, hold onto the tool string with a pipe wrench when needed.

5. Remove the slotted drive cap and thread a probe rod onto the MC Drive Head. Thread a standard Drive Cap (AT1200) onto the probe rod.

6. Continue advancing the sampler and adding probe rods to the tool string until the desired sampling interval is reached (Fig. 4.28B).

7. Raise the hammer assembly and retract the probe derrick to gain access to the top probe rod.

8. Remove the drive cap and insert extension rods down the inside of the probe rod string. A male Extension Rod Quick Link and an MC Extension Rod Quick Link Connector should be placed on the leading end of the extension rod string (Fig. 4.29) if an MC Stop-Pin Coupler was used during assembly. Nothing is placed on the leading extension rod if a stop-pin coupler was not used.

   Use Extension Rod Couplers or Extension Rod Quick Links (Fig. 4.30) to connect extension rods together until the leading rod contacts the stop-pin . Use an Extension Rod Jig (Fig. 4.30) to hold the down-hole rods while adding more rods to the string.

9. Attach an Extension Rod Handle (Fig. 4.30) to the rod string and slowly rotate the handle clockwise to engage the stop-pin threads. The rods will become harder to turn when the stop-pin threads are fully engaged. Pull up on the rod string to ensure that it is connected to the stop-pin. Continue rotating and periodically lifting the extension rods until the stop-pin is completely unthreaded from the drive head.

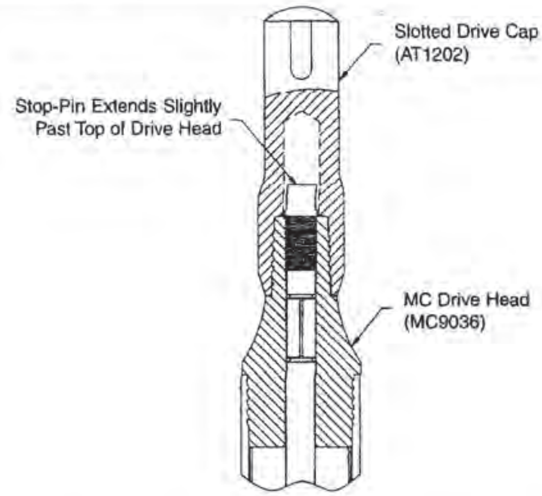
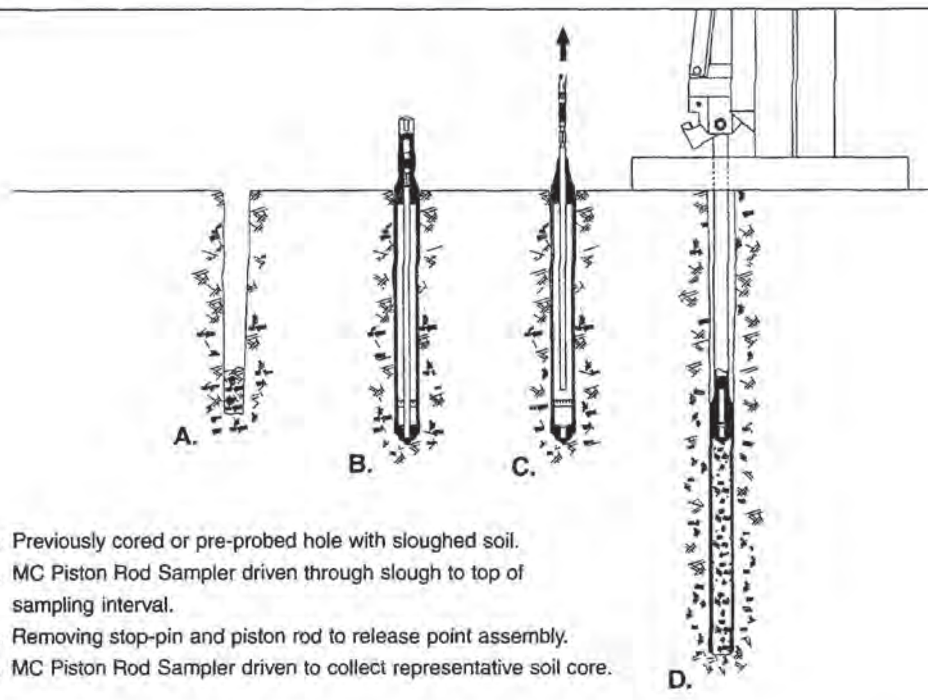


FIGURE 4.27
Slotted Drive Cap Accomodates Stop-Pin



A. Previously cored or pre-probed hole with sloughed soil.
B. MC Piston Rod Sampler driven through slough to top of sampling interval.
C. Removing stop-pin and piston rod to release point assembly.
D. MC Piston Rod Sampler driven to collect representative soil core.

FIGURE 4.28
Phases of Macro-Core® Closed-Point (Piston Rod System) Sampling

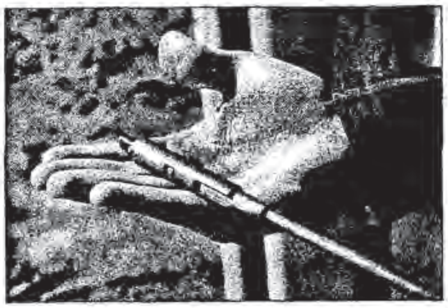


Figure 4.29. Use an MC Extension Rod Quick Link Connector if stop-pin coupler was used in sampler.

NOTE: If the stop-pin is excessively difficult to unthread, pull the entire tool string up approximately 2 inches. This should relieve the force exerted on the point assembly and make releasing the stop-pin much easier.

10. Lift and remove extension rods until the stop-pin is visible above the drive head (Fig. 4.28-C). The stop-pin and piston rod will both be removed from the sampler if a stop-pin coupler was used during assembly (Fig. 4.31-A). Only the stop-pin will be connected to the last extension rod if a coupler was not used (Fig. 4.31-B). Remove the extension rod and stop-pin if the piston rod is not attached.

11. If the piston rod is attached to the stop-pin, carefully unhook the extension rod and male quick link from the MC Extension Rod Quick Link Connector (Fig. 4.31-A). Take care not to deform the stop-pin coupler when removing the extension rod. Now remove the piston rod from inside the tool string.

12. Thread the Drive Cap (AT1200) onto a probe rod and then attach the probe rod to the tool string.

13. Completely raise the probe unit hammer assembly and reposition the probe derrick over the tool string.

14. Apply static weight and hammer percussion to advance the tool string the length of the sampler and collect the soil core (Fig. 4.28-D).

    NOTE: Activate hammer percussion whenever collecting soil. Percussion helps shear the soil at the leading end of the sampler so that it moves into the sample tube for increased recovery.

15. Raise the hammer assembly a few inches to provide access to the top of the tool string.

16. Remove the drive cap and thread a Pull Cap (AT1204) onto the top probe rod.

17. Lower the hammer assembly and hook the hammer latch over the pull cap. Raise the hammer assembly to pull the first probe rod out of the ground. Remove the rod and place the pull cap on the next rod of the tool string. Continue pulling probe rods until the MC Sampler is brought to the ground surface.

    NOTE: Use caution when retrieving the MC Sampler from depth. Low side friction may allow the sampler and probe rods to drop down the hole when released. To prevent equipment loss, hold onto the tool string with a pipe wrench when needed.

18. Procede to Section 4.9 for instructions on recovering the soil core from the MC Sampler.

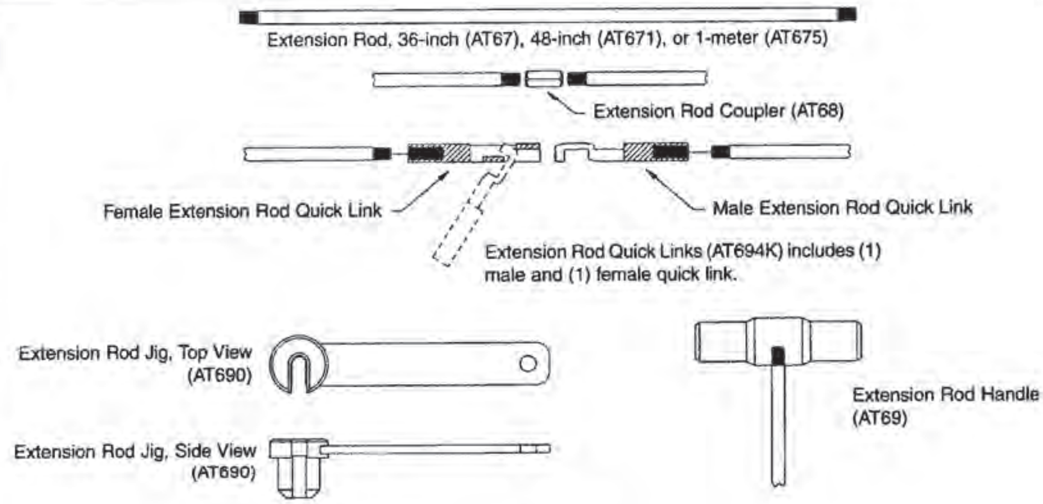


FIGURE 4.30
Extension Rods and Accessories

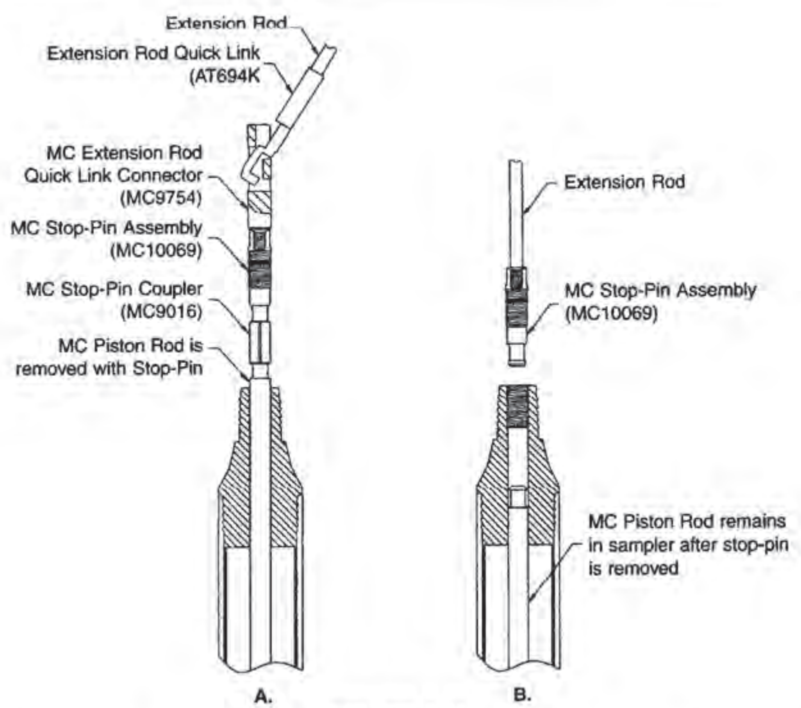


FIGURE 4.31
MC Piston Rod is Removed With Stop-Pin if Stop-Pin Coupler was Used

4.9 Soil Core Recovery

The soil sample is easily removed from the Macro-Core® Sampler by unthreading the cutting shoe and pulling out the liner. A few sharp taps on the cutting shoe with the combination wrench will often loosen the threads sufficiently to allow removal by hand. If needed, the exterior of the cutting shoe features a notch for attaching the combination wrench to loosen tight threads (Fig. 4.32). With the cutting shoe removed (Fig. 4.33), simply pull the liner and soil core from the sample tube (Fig. 4.34).

If the closed-point sampler is used, the MC Piston Rod Point Assembly is now retrieved from the end of the liner (Fig. 4.35). Secure the soil sample by placing a vinyl end cap on each end of the liner.

Undisturbed soil samples can be obtained from Teflon®, PVC, and PETG liners by splitting the liner. Geoprobe offers two tools for cutting sample liners. The MC Liner Cutter Kit (AT8000K) is used to make longitudinal cuts in the liner and includes a tool that holds the liner for cutting (Fig. 4.36). The MC Liner Circular Cutting Tool (AT8050) is used to segment the liner by cutting around the outside circumference of the liner (Fig. 4.37).

Figure 4.32. Loosening the MC Cutting Shoe with the MC Combination Wrench.

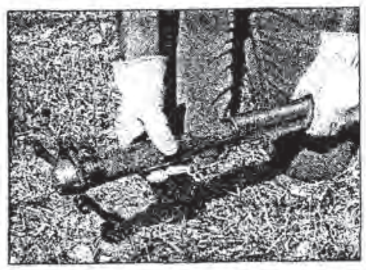


Figure 4.33. Removing MC Cutting Shoe and liner from MC Sampler Tube.

Figure 4.34. Macro-Core® liner filled with soil core.

Figure 4.35. MC Piston Rod Point Assembly is retrieved from top of liner.

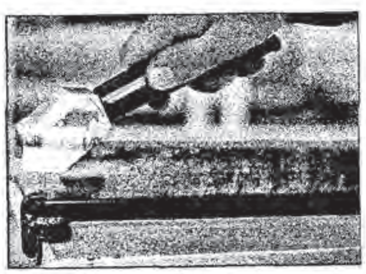


Figure 4.36. MC Liner Cutter makes two longitudinal cuts in polymer liners.

Figure 4.37. MC Circular Cutting Tool cuts around the outside of MC liner.

4.10 MC Piston Rod Sampler Tips

Macro-Core® Samplers are available in lengths of 24 inches, 36 inches, 1 meter, 48 inches, and 60 inches. This means that MC Sample Tubes, MC Liners, MC Piston Rods and MC Piston Rod/Stop-Pin Assemblies are also available in these five sizes. Keep this in mind when ordering Macro-Core® parts to ensure that the items you receive are of the appropriate length.

During development of the MC Piston Rod System, it was common for operators to remove the MC Piston Rod/Stop-Pin assembly from inside the probe rods with the last extension rod still threaded onto the stop-pin. The MC Stop-Pin Coupler is not designed to withstand the considerable side load placed on it by the extension rod and is easily damaged if the extension rod is allowed to swing around unsupported. The MC Quick Link Connector was developed to prevent damage to the coupler by allowing the last extension rod to be disconnected from the piston rod/stop-pin assembly before removing the assembly from the probe rods. Always use the quick link connector whenever the sampler is assembled with a stop-pin coupler.

4.11 Tips to Maximize Sampling Productivity

The following suggestions are based on the collective experiences of Geoprobe operators:

1. Organize your truck or van. Assign storage areas to all tools and equipment for easy location. Transport sample tubes, piston rods, extension rods, probe rods, and liners in racks. Above all, minimize the number of items lying loose in the back of the vehicle.

2. Take three or four samplers to the field. This allows the collection of several samples before stopping to clean and decontaminate the equipment. A system is sometimes used where one individual operates the probe while another marks the soil cores and decontaminates the used samplers.

3. A machine vise is recommended. With the sampler held in a vise, the operator has both hands free to remove the cutting shoe (Fig. 4.38), drive head, and sample liner (Fig. 4.39). Cleanup is also easier with both hands free. Geoprobe offers an optional Machine Vise (FA300) that mounts directly on the probe derrick (Fig. 4.40).

4. Extension Rod Quick Links (Fig. 4.41) are real time savers. A good method for deploying extension rods is to assemble sections of up to three rods using threaded connectors. Each section is then connected with Quick Links so that up to three rods can be added or removed from the string at once.

Figure 4.38. Removing MC Cutting Shoe with sample tube held in machine vise.

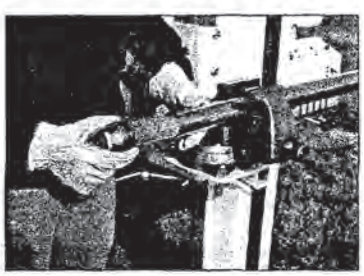


Figure 4.39. Removing filled liner with sample tube held in machine vise.

Figure 4.40. Machine vise mounted directly on Geoprobe Soil Probing Unit.

Figure 4.41. Using Extension Rod Quick Links to connect Extension Rods.

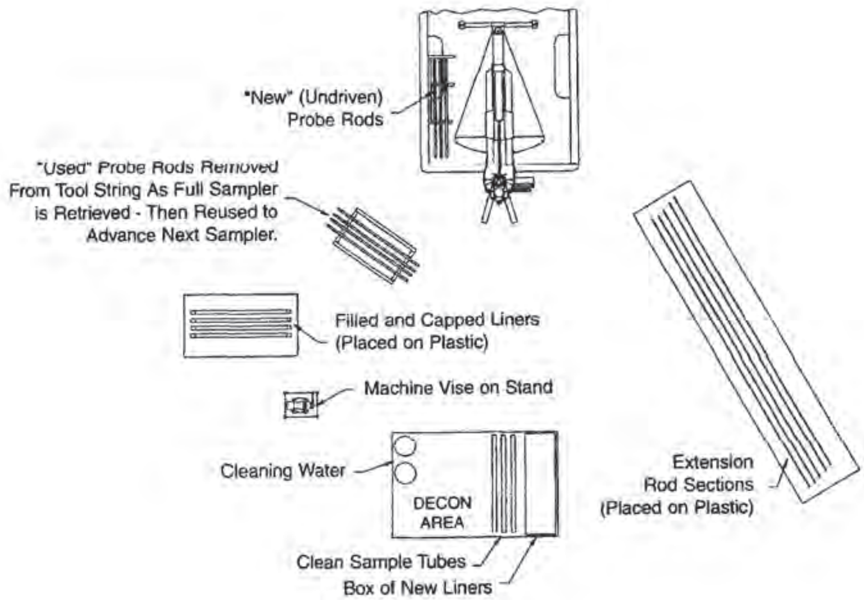


FIGURE 4.42
Equipment Layout Example to Maximize Sampling Productivity.

5. When releasing the stop-pin, a pair of locking pliers can be used to turn the extension rods. Locking pliers may be quicker and easier to install than the extension rod handle.

6. Organize your worksite. Practice with the sampler to identify a comfortable setup and then use this layout whenever sampling. An example layout is shown in Figure 4.42.

   A collapsible table or stand is handy to hold decontaminated sampler tubes and liners. Equipment may also be protected from contamination by placing it on a sheet of plastic on the ground.

   Instead of counting probe rods for each trip in-and-out of the probe hole, identify separate locations for "new" rods and "used" rods. Collect the first sample from the open hole using "new" rods. As each probe rod is removed during sampler retrieval, place it in the "used" rod location. Now advance a clean sampler back down the same hole using all of the rods from the "used" location. Add one "new" rod to the string and then drive the tools to collect the next soil core. Once again, remove each probe rod and place it in the "used" rod location as the sampler is retrieved. Repeat this cycle using all the "used" rods to reach the bottom of the probe hole, and one "new" rod to fill the sampler.

7. Cleanup is very important from the standpoint of operation as well as decontamination. Remove all dirt and grit from the threads of the drive head, cutting shoe, and sample tube with a nylon brush (BU700). Without sufficient cleaning, the cutting shoe and drive head will not thread completely onto the sample tube. The threads may be damaged if the sampler is driven in this condition.

Ensure that all soil is removed from inside the sample tube. Sand particles are especially troublesome as they can bind liners in the sampler. Full liners are difficult to remove under such conditions. In extreme cases the soil sample must be removed from the liner before it can be freed from the sample tube.

8. Although MC Drive Heads are available for open-tube sampling with 1.0-inch OD probe rods, 1.25-inch rods are recommended for the Macro-Core® Sampler. The larger rod diameter limits downhole deflection of the tool string and ultimately provides a more durable system. The double-lead thread design also makes the 1.25-inch rods thread together faster than previous 1-inch probe rods.

9. The Heavy-Duty MC Cutting Shoe (AT8535) is machined with more material at the critical wear areas. It can be used in place of the Standard MC Cutting Shoe (AT8530) and is designed to lengthen service life under tough probing conditions.

   Expansive clays and coarse sands can "grab" and collapse liners as the sample tube is filled with soil. A 1/8-inch Undersized MC Cutting Shoe (AT8537) helps alleviate this problem. The smaller core (1.375 inches OD) allows expanding clays and coarse sands to travel past the liner without binding.

   The standard, heavy-duty, and undersized cutting shoes will not accept the MC Piston Rod Point Assembly (MC10068). Only the MC9034 cutting shoe is compatible with the MC Piston Rod System.

10. Maximize the thread life of the sample tube by varying the ends in which the drive head and cutting shoe are installed. The dynamic forces developed while driving the sampler are such that the threads at the drive head wear more quickly than at the cutting shoe. Regularly switching ends will maintain relatively even wear on the sample tube.

5.0 REFERENCES

Geoprobe Systems, September, 1997, "97-98 Tools and Equipment Catalog."

Geoprobe Systems, May, 1995, "1995-96 Tools and Equipment Catalog."

Equipment and tool specifications, including weights, dimensions, materials, and operating specifications included in this brochure are subject to change without notice. Where specifications are critical to your application, please consult Geoprobe Systems 1-800-436-7762.

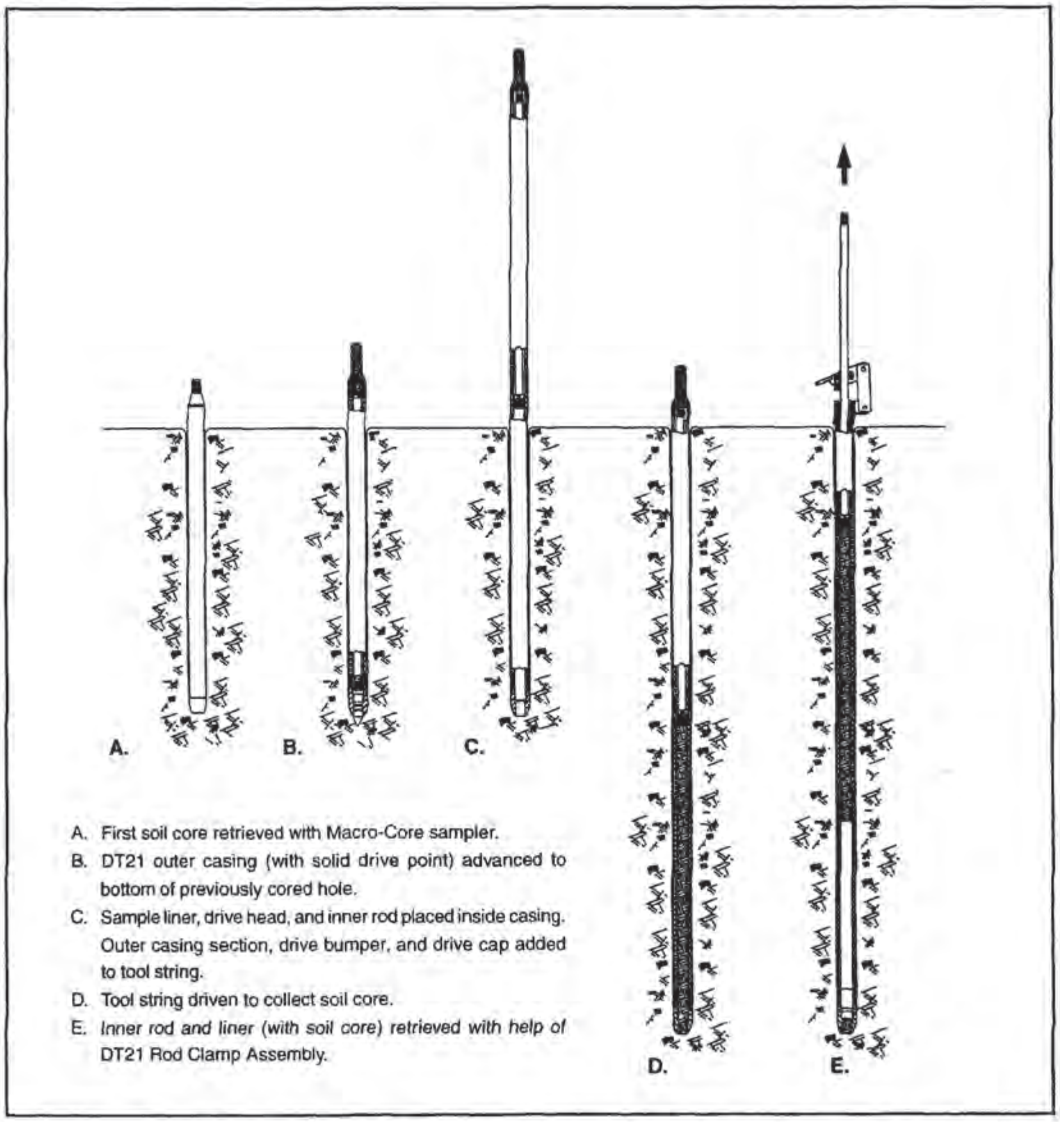
Geoprobe DT21 Dual Tube Soil Sampling System

Continuous Core Soil Sampler

Standard Operating Procedure

Technical Bulletin No. 982100

September, 1998



A. First soil core retrieved with Macro-Core sampler.
B. DT21 outer casing (with solid drive point) advanced to bottom of previously cored hole.
C. Sample liner, drive head, and inner rod placed inside casing. Outer casing section, drive bumper, and drive cap added to tool string.
D. Tool string driven to collect soil core.
E. *Inner rod and liner (with soil core) retrieved with help of* DT21 Rod Clamp Assembly.

OPERATION OF THE DUAL TUBE 21 SOIL SAMPLING SYSTEM

1.0 OBJECTIVE

The objective of this procedure is to collect a representative soil sample at depth through an enclosed casing and recover it for visual inspection and/or chemical analysis.

2.0 BACKGROUND

2.1 Definitions

Geoprobe®: A brand name of high quality, hydraulically-powered machines that utilize both static force and percussion to advance sampling and logging tools into the subsurface. The Geoprobe® brand name refers to both machines and tools manufactured by Geoprobe® Systems, Salina, Kansas. Geoprobe® tools are used to perform soil core and soil gas sampling, groundwater sampling, soil conductivity and contaminant logging, grouting, and materials injection.
** Geoprobe® is a registered trademark of Kejr Engineering, Inc., Salina, Kansas*

Dual Tube 21 Soil Sampling System: A direct push system for collecting continuous core samples of unconsolidated materials from within a sealed casing of Geoprobe 2.125-inch (54 mm) OD probe rods. Samples are collected and retrieved within a liner that is threaded onto the leading end of a string of Geoprobe 1.0-inch (25 mm) OD probe rods and inserted to the bottom of the outer casing. Collected samples measure up to approximately 800 ml in volume in the form of a 1.125-inch x 48-inch (29 mm x 1219 mm) core.

Liner: A 1.375-inch (35 mm) OD thin-walled, PETG tube that is inserted into the outer casing on the leading end of the inner rod string for the purpose of containing and retrieving core samples. Liner lengths include 25 inches (635 mm), 37 inches (940 mm), 40.4 inches (1026 mm), and 49 inches (1245 mm).

2.2 Discussion

Dual tube sampling gets its name from the fact that two sets of probe rods are used to retrieve continuous soil core samples from the subsurface. One set of rods is driven into the ground as an outer casing (Fig. 2.1). These rods receive the driving force from the hammer and provide a sealed casing through which soil samples may be recovered. The second, smaller set of rods are placed inside the outer casing with a sample liner attached to the leading end of the rod string (Fig. 2.1). These smaller rods hold the liner in place as the outer casing is driven to fill the liner with soil. The inner rods are then retracted to retrieve the full liner.

Standard Geoprobe 2.125-inch OD probe rods provide the outer casing for the DT21 Dual Tube Soil Sampling System. A cutting shoe is threaded into the leading end of the rod string. When driven into the subsurface, the cutting shoe shears a 1.125-inch OD soil core which is collected inside the casing in a clear plastic liner.

The second set of rods in the DT21 system are standard Geoprobe 1.0-inch OD probe rods. A sample liner is attached to the end of these smaller rods and then inserted into the casing. The 1.0-inch rods hold the liner tight against the cutting shoe as the outer casing is driven to collect the soil core. Once filled with soil, the liner is removed from the bottom of the outer casing by lifting out the 1.0-inch rods.

The outer, 2.125-inch probe rods provide a cased hole through which to sample. The main advantage of sampling through a cased hole is that there is no side slough to contend with. In addition, the outer casing effectively seals the probe hole when sampling through perched water tables. These factors mean that sample cross-contamination is eliminated. The DT21 sampling system is therefore ideal for continuous coring in both saturated and unsaturated zones.

A Solid Drive Tip (DT4070) can be placed on the leading end of the 1.0-inch probe rod string in place of a sample liner (Fig. 2.2). When installed in the outer casing, the drive tip firmly seats within the cutting shoe and effectively seals the tool string as it is driven into the subsurface. This enables the operator to advance the outer casing to the bottom of a pre-core hole or through undisturbed soil to reach the top of the sampling interval.

The DT21 system allows bottom-up grouting through the primary tool string. This means that a cement or bentonite grout mix can be pumped through the outer casing as it is withdrawn from the ground. This is in contrast to most other soil samplers which require driving a second set of tools back down the probe hole in order to deliver the grout mix.

An expendable cutting shoe enables the operator to install a Geoprobe Prepacked Screen Monitoring Well through the outer casing of the DT21 Dual Tube System. After the collection of continuous soil cores to the desired depth, prepacked screens can be inserted to the bottom of the outer casing on the leading end of a PVC riser string. The well is finished, complete with grout barrier, bentonite well seal, and a high-solids bentonite slurry/neat cement grout, during retrieval of the outer casing.

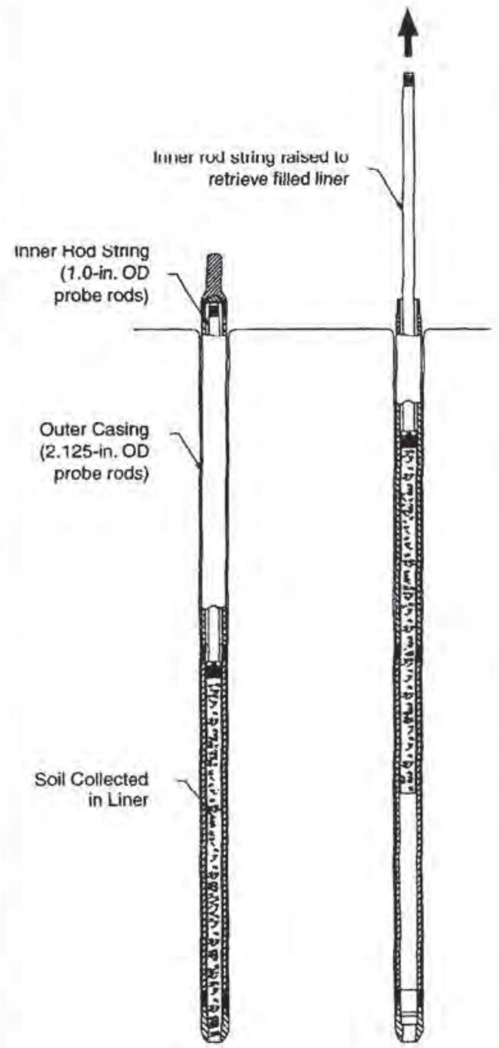


FIGURE 2.1
Outer Casing Driven With Liner

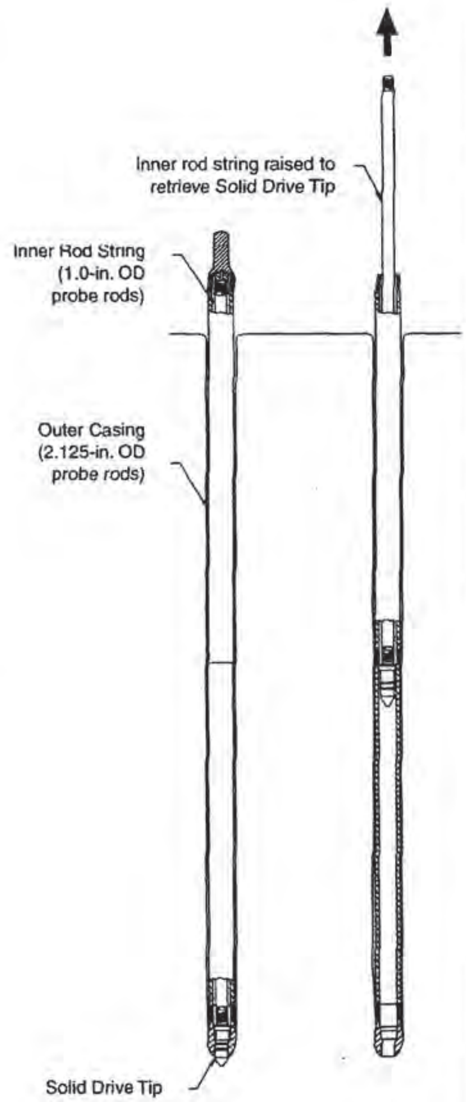


FIGURE 2.2
Outer Casing Driven With Solid Drive Tip

3.0 REQUIRED EQUIPMENT

The following equipment is used to recover samples with the Geoprobe Dual Tube 21 Soil Sampling and probing systems. Note that the operator may choose to utilize 2.125-inch probe rods in lengths of 36 inches (914 mm), 1 meter, or 48 inches (1219 mm). It is not necessary to have all three rod lengths on-hand. Refer to Figure 3.1 for parts identification.

DUAL TUBE 21 SAMPLER PARTS	QUANTITY	PART NUMBER
DT21 Drive Bumper, Pkg. of 5	-1-	DT4010K
DT21 Threadless Drive Cap (1.0-inch probe rods)	-1-	DT4020
DT21 Cutting Shoe, Large, 2.375 in. OD	-1-	DT4030
DT21 Cutting Shoe, Small, 2.205 in. OD	-1-	DT4035
DT21 Expendable Cutting Shoe Holder	-1-	DT4040
DT21 Expendable Cutting Shoe, 2.375 in. OD	variable	DT4045
O-rings for Expendable Cutting Shoe, Pkg. of 50	variable	DT4045R
DT21 Liners, PETG, 24-inch, Box of 50*	variable	DT4024K
DT21 Vinyl End Caps, Pkg. of 100 (50 pair)	variable	DT4026K
DT21 Liner, PETG, 36-inch, Box of 50*	variable	DT4036K
DT21 Liner, PETG, 1-meter, Box of 50*	variable	DT4039K
DT21 Liner, PETG, 48-inch, Box of 50*	variable	DT4048K
DT21 Liner Drive Head Assembly (1.0-inch probe rods)	-1-	DT4050
DT21 Rebuild Kit for Liner Drive Head	-1-	DT4051K
DT21 Rod Clamp Assembly (1.0-inch probe rods)	-1-	DT4060
DT21 Solid Drive Tip (1.0-inch probe rods)	-1-	DT4070
O-rings for Solid Drive Tip, Pkg. of 25	variable	DT4070R
GEOPROBE TOOLS AND EQUIPMENT	**QUANTITY**	**PART NUMBER**
Probe Rod, 1.0 inch OD x 36 inches*	variable	AT10B
Probe Rod, 1.0 inch OD x 39 inches (1 meter)*	variable	AT1039
Probe Rod, 1.0 inch OD x 48 inches*	variable	AT104B
Probe Rod, 1.0 inch OD x 24 inches*	variable	AT105B
O-rings for 2.125-inch Probe Rods	variable	AT2100R
Drive Cap (2.125-inch probe rods)	-1-	AT2101
Pull Cap (2.125-inch probe rods)	-1-	AT2104
Probe Rod, 2.125 inches OD x 36 inches*	variable	AT2136
Probe Rod, 2.125 inches OD x 39 inches (1 meter)*	variable	AT2139
Probe Rod, 2.125 inches OD x 48 inches*	variable	AT2148
MC Combination Wrench	-1-	AT8590
Rod Grip Pull System	-1-	GH3000K
ADDITIONAL TOOLS	**QUANTITY**	
Hex Key, 3/32 in.	-1-	
Utility Knife (with straight blade)	-1-	
Pipe Wrench	-2-	

* Match length of probe rods to desired liner length. Use 36-inch probe rods with 36-inch liners, 1-meter probe rods with 1-meter liners, and 48-inch probe rods with 24- and 48-inch liners. A 1.0 inch x 24 inches probe rod is also required when utilizing 24-inch sample liners.

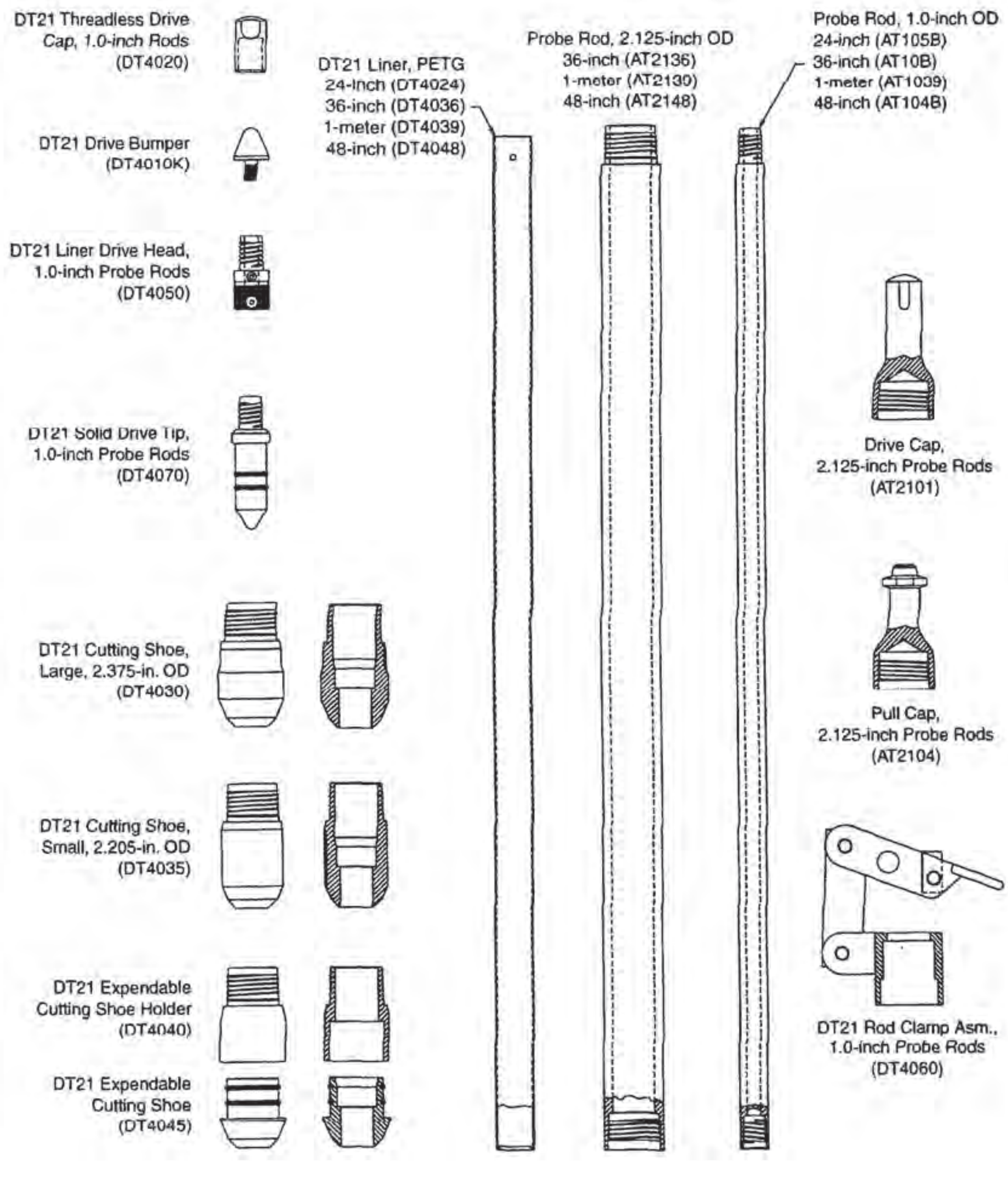


FIGURE 3.1
Dual Tube 21 Soil Sampling System Parts

3.1 Tool Options

Three major components of the DT21 Soil Sampling System are probe rods, sample liners, and cutting shoes. These items are manufactured in a variety of sizes to fit the specific needs of the operator. This section identifies the specific tool options available for use with the DT21 Dual Tube System.

Probe Rods

Standard Geoprobe 1.0-inch (25 mm) OD and 2.125-inch (54 mm) OD probe rods are required to operate the DT21 Soil Sampling System. The specific length of rods may be selected by the operator. Available rod lengths are 36 inches (914 mm), 48 inches (1,219 mm), and 1 meter. Both rod sets (1.0-inch and 2.125-inch) must be of the same length.

Sample Liners

Sample liners are made of a heavy-duty clear plastic for convenient inspection of the soil sample. Lengths of 24 inches (610 mm), 36 inches (914 mm), 48 inches (1219 mm), and 1 meter are available with an OD of 1.375 inches (35 mm). Choose the liner length corresponding to the length of probe rods used (e.g. 36-inch liners with 36-inch probe rods).

The shorter length of the 24-inch liners helps to recover samples from flowing sands and highly expansive clays. These liners are used with 48-inch probe rods, but also require a single 1.0-inch x 24-inch probe rod.

Cutting Shoes

Three cutting shoes are available for use with the DT21 Dual Tube System (Fig. 3.2). The DT21 Large Cutting Shoe (DT4030) and DT21 Small Cutting Shoe (DT4035) thread into the leading end of the 2.125-inch probe rods and are recovered after sampling. Dimensions for the large cutting shoe are 1.125 inches (29 mm) ID and 2.375 inches (60 mm) OD. The small cutting shoe also has an ID of 1.125 inches (29 mm) but the OD is only 2.205 inches (56 mm). To reduce side friction and make driving easier, the large cutting shoe (DT4030) is oversized to provide a small annulus between the outer casing and soil. By contrast, the small cutting shoe (DT4035) is for use in soil conditions where an annulus is undesirable.

The DT21 sampling system may also employ an expendable cutting shoe. In this arrangement, a DT21 Expendable Cutting Shoe Holder (DT4040) is threaded into the leading end of the outer casing. A DT21 Expendable Cutting Shoe (DT4045) is then inserted into the holder. Upon completion of soil sampling, the outer casing is withdrawn slightly. The expendable cutting shoe detaches from the holder, leaving an open casing through which a prepacked screen monitoring well may be installed. Dimensions for the expendable cutting shoe are the same as the large cutting shoe (ID = 1.125 in. (29 mm) and OD = 2.375 in. (60 mm)).

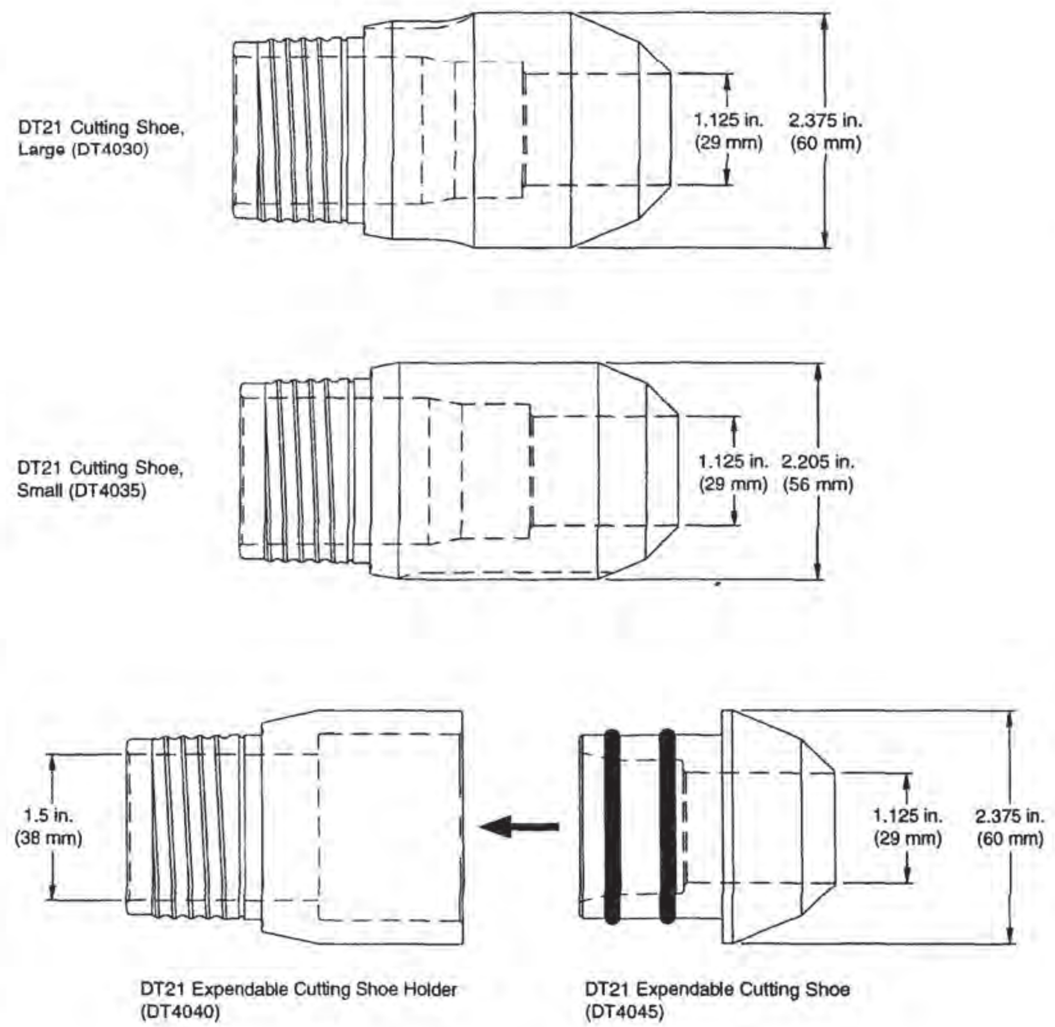


FIGURE 3.2
Cutting Shoe Options for the DT21 Dual Tube Soil Sampling System

4.0 OPERATION

4.1 Decontamination

Before and after each use, thoroughly clean all parts of the soil sampling system according to project requirements. Parts should also be inspected for wear or damage at this time. During sampling, a clean new liner is used for each soil core.

4.2 Operational Overview

The DT21 Soil Sampling System is designed to collect continuous soil cores. Sampling may begin either from ground surface or a predetermined depth below ground. Once sampling begins, consecutive soil cores must be removed as the outer casing is advanced to greater depths

When sampling is to begin at the ground surface, the first soil core should be collected with an Open-Tube Macro-Core Soil Sampler* (Fig. 4.1-A). The Macro-Core Sampler normally has better recovery from this interval than is possible with the DT21 Dual Tube System. This is especially true when the first core is composed of dry loose soil.

With the first soil core removed with the MC Sampler, a section of outer casing is sealed with a DT21 Solid Drive Tip and advanced to the bottom of the remaining probe hole (Fig.4.1-B). Once at the bottom of the pre-cored hole, the solid drive tip is removed from the outer casing. A liner is inserted to the bottom of the outer casing (Fig. 4.1-C) and the entire tool string is driven to fill the liner with soil (Fig. 4.1-D). The filled liner is removed from the outer casing to retrieve the second soil core (Fig. 4.1-E). A new liner is then inserted to the bottom of the outer casing and the entire assembly is driven to collect the third soil core. This process is repeated for the entire sampling interval.

When the sampling interval begins at some depth below ground surface, a DT21 Solid Drive Tip is installed in the outer casing and the entire assembly is driven from ground surface directly through undisturbed soil (Fig. 4.2-A). This enables the operator to reach the top of the sampling interval without stopping to remove unwanted soil cores. Once the interval is reached, the solid drive tip is removed (Fig 4.2-B) and sampling continues as described in the preceding paragraphs (Fig. 4.2-C, Fig. 4.2-D, and Fig. 4.2-E).

NOTE: Once the first soil core is collected, the DT21 Solid Drive Tip cannot be reinstalled in the cutting shoe. Consecutive soil cores must be removed in order for the outer casing to be driven to greater depths.

Specific instructions for the assembly and operation of the DT21 Dual Tube Soil Sampling System are given in the following sections.

*Refer to Geoprobe Macro-Core Soil Sampler Standard Operating Procedure (Technical Bulletin No. 958500).

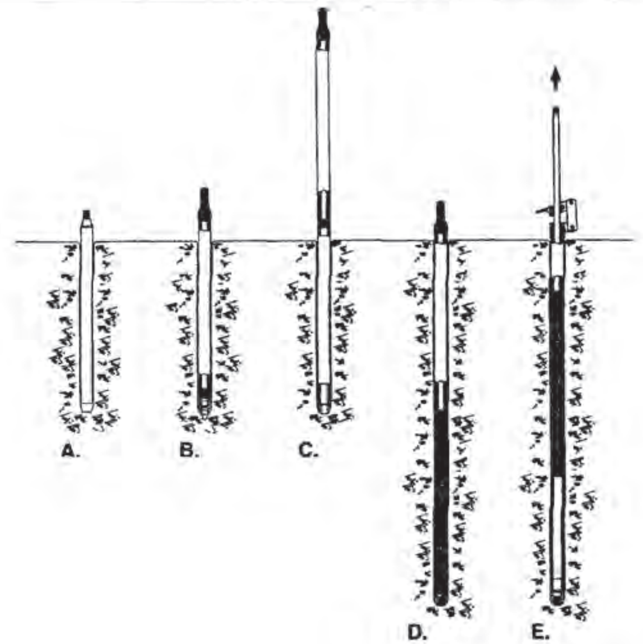


FIGURE 4.1
Continuous Core Sampling From Ground Suface with Dual Tube 21 System

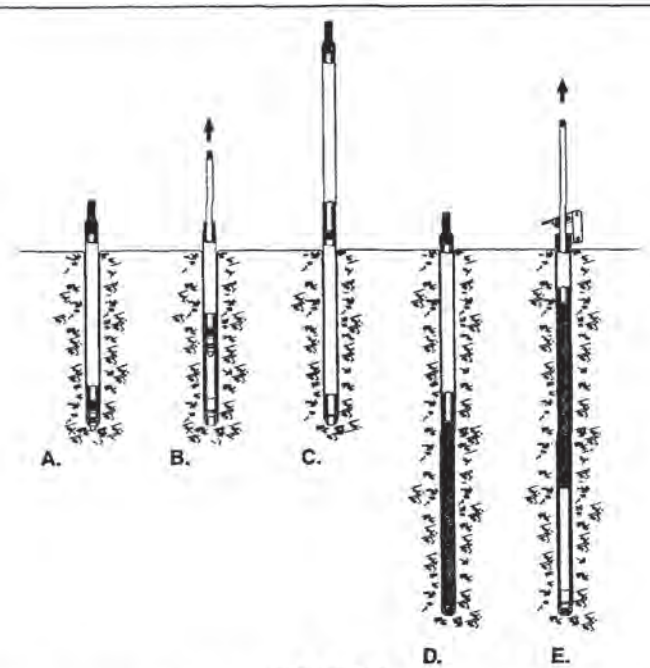


FIGURE 4.2
Outer Casing Driven Through Undisturbed Soil to Begin Sampling with DT21 System

4.3 Assembling and Driving the Outer Casing Using a DT21 Solid Drive Tip

No matter if sampling begins at the bottom of a pre-cored hole or under several feet of undisturbed soil, the outer casing of the DT21 Dual Tube System is always initially driven with a DT21 Solid Drive Tip installed in the leading end. The solid drive tip seals the outer casing as it is driven to the top of the sampling interval. Once this interval is reached, the solid drive tip is removed to begin sampling. This section describes assembling and driving the outer casing using the DT21 Solid Drive Tip.

1. If using a DT21 Large or Small Cutting Shoe (DT4030 or DT4035) install an O-Ring (AT2100R) at the base of the threads as shown in Figure 4.3. If using an expendable cutting shoe, install an AT2100R O-Ring on the DT21 Expendable Cutting Shoe Holder (DT4040) and two DT4045R O-Rings on the DT21 Expendable Cutting Shoe (DT4045) (Fig. 4.3).

2. Thread the DT21 Cutting Shoe or DT21 Expendable Point Holder into the leading end of a 2.125-inch OD Probe Rod (AT2136, AT2139, or AT2148). Completely tighten the cutting shoe or cutting shoe holder using a machine vise and MC Combination Wrench (AT8590) as shown in Figure 4.4.

3. Install an O-Ring (DT4070R) in both grooves of the DT21 Solid Drive Point (DT4070) (Fig.4.5).

4. Thread the solid drive point into the female end of a 1.0-inch OD probe rod of the same length as the 2.125-inch probe rod (outer casing).

5. Lubricate the O-rings on the solid drive point with a small amount of deionized water. Insert the point and probe rod into the outer casing until the point partially extends from the bottom of the cutting shoe.

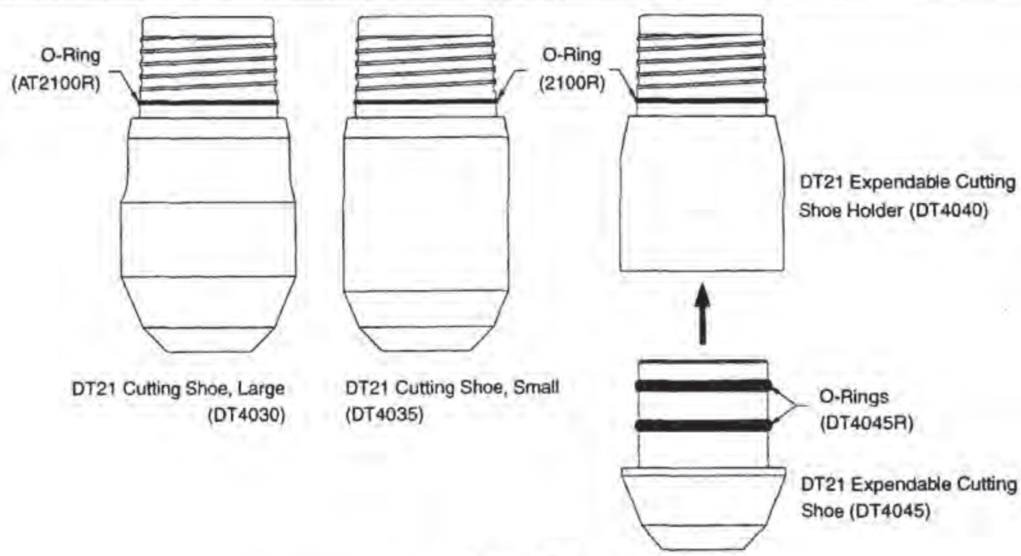


FIGURE 4.3
DT21 Cutting Shoes Utilize O-Ring Seals

Figure 4.4. Place probe rod (outer casing) in vise and tighten cutting shoe with MC Combination Wrench.

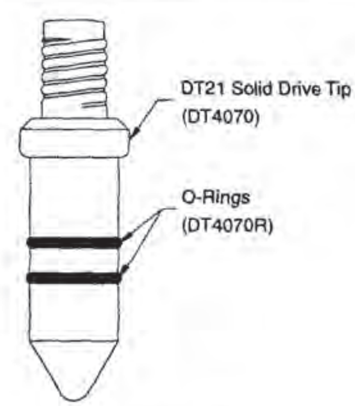


FIGURE 4.5
Solid Drive Point is Fitted with Two O-Rings

6. Place a DT21 Threadless Drive Cap (DT4020) on top of the inner rod (Fig. 4.6). This drive cap is threadless for quick installation/removal, yet still provides protection for the probe rod threads.

7. Thread a Drive Cap (AT2101) onto the 2.125-inch probe rod (outer casing) (Fig. 4.6).

   NOTE: Current AT2101 Drive Caps are manufactured using a drilling process that leaves an angled surface inside the cap (Fig. 4.7). This provides room for the Threadless Drive Cap (DT4020). Older AT2101 Drive Caps were manufactured using a boring process that leaves a flat surface inside the cap (Fig. 4.7). These older drive caps cannot be used with the DT21 Dual Tube System.

8. Place the assembled outer casing section under the probe unit for driving. Position the casing directly under the hammer with the cutting shoe centered between the toes of the probe foot.

9. Lower the hammer onto the drive cap and advance the outer casing into the subsurface.

10. Raise the hammer and remove the DT21 Threadless Drive Cap.

    If the first soil core was collected with a Macro-Core Open-Tube Sampler, the outer casing is now at the bottom of the pre-cored hole. Thread a 1.0-inch probe rod onto the inner rod string and remove the DT21 Solid Drive Point from the outer casing. Continue with Section 4.4 to begin sampling with the DT21 Dual Tube System.

    If the outer casing is to be driven deeper before sampling, continue with Step 11 of this section.

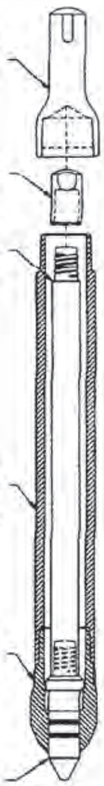


FIGURE 4.6
Outer Casing with Solid Drive Tip

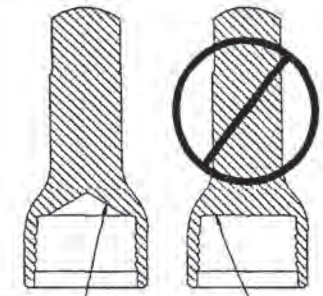


FIGURE 4.7
Comparison of AT2101 Drive Caps

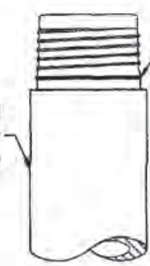


FIGURE 4.8
Outer Casing Joints are Sealed with O-Rings

11. Place an O-Ring (AT2100R) on the outer casing section that extends from the ground (Fig. 4.8).

12. Thread a 1.0-inch probe rod onto the inner rod string. Place a 2.125-inch probe rod over the inner rods and thread it onto the outer casing (Fig. 4.9). Completely tighten the outer casing using a pipe wrench.

13. Place the threadless drive cap on top of the inner rod. Thread the 2.125-inch drive cap over the threadless drive cap and onto the outer casing.

14. Lower the hammer onto the drive cap and advance the outer casing into the subsurface.

Repeat Steps 10-13 until the leading end of the outer casing is at the top of the proposed sampling interval. Continue with Step 15 to remove the DT21 Solid Drive Point for sampling.

15. Raise the hammer and retract the probe derrick to provide access to the top of the tool string.

16. Unthread the 2.125-inch drive cap and remove the threadless drive cap from the inner rods.

Figure 4.9. Place a 2.125-inch probe rod over the 1.0-inch rod and thread it onto the outer casing string.

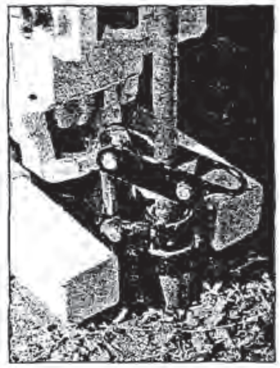


Figure 4.10. The DT21 Rod **Clamp Assembly holds the inner rod string while adding or removing 1.0-inch rods.**

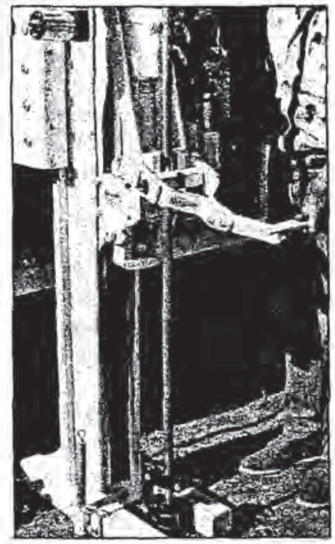


Figure 4.11. Raise the inner rod string using the probe hammer and a Rod Grip Pull Sytem if rods are too heavy to lift by hand.

17. Thread a 1.0-inch OD probe rod onto the inner rod string. Lift and remove the inner rods from the outer casing. The DT21 Solid Drive Point is removed from the leading end of the casing with the inner rods.

    NOTE: Hold the inner rod string with a DT21 Rod Clamp Assembly (DT 4060) while unthreading the retracted rods (4.10). Use the probe hammer and Rod Grip Pull System (GH3000K) to pull the inner rods if they are too heavy to lift comfortably by hand (Fig. 4.11).

The outer casing is now ready for sampling. Continue with Section 4.4 for more instructions.

4.4 Liner Drive Head Assembly

The main function of the DT21 Liner Drive Head Assembly (DT4050) is to connect a PETG liner to the leading end of the inner rod string. This enables the inner rods to hold the liner tight against the cutting shoe to fill the liner with soil as the outer casing is driven. The inner rods are then used to retrieve the full liner from within the outer casing.

The liner drive head assembly includes an internal check ball to improve sample recovery (Fig. 4.12) A considerable vacuum is created below the filled liner as it is lifted from the bottom of the outer casing. Because the inner rod string and liner drive head are hollow, air can rush through the rods and into the top of the liner. The check ball seals the liner drive head so that air does not push the soil sample out the bottom of the liner during retrieval. Then when a new liner is advanced back down the outer casing and when soil enters the liner during sampling, the check ball allows air to escape up through liner drive head and inner rod string.

Saturated conditions can also challenge sample recovery. Water enters the outer casing either from the saturated formation or is deliberately poured from the ground surface to keep flowing sands out of the casing. As with air in unsaturated formations, the check ball lets water pass through the liner drive head as a new liner is lowered to the bottom of the casing and during sampling as the liner is filled with soil. The check ball then seals the drive head during retrieval so that water draining from the inner rods does not wash the sample out the bottom of the liner. A drain hole located on the side of the liner drive head (Fig. 4.12) allows water to exit the inner rods and travel harmlessly along the outside of the liner.

The liner drive head assembly is made up of five parts as shown in Figure 4.13. The two 3/8-inch flat head socket cap screws are used to attach liners to the liner drive head. The longer 5/8-inch flat head socket cap screw holds the stainless steel check ball within the liner drive head. To disassemble the liner drive head for cleaning, simply unthread the 5/8-inch cap screw and remove the check ball.

Instructions for attaching a liner to the DT21 Liner Drive Head Assembly (DT4050) are given below.

1. Visually inspect the liner drive head assembly to ensure that the check ball moves freely within the drive head and the drain hole is unobstructed.

2. Place the liner drive head assembly in a machine vise so that either one of the 3/8-inch caps screws is on top as shown in Figure 4.14.

   NOTE: Only one 3/8-inch cap screw is used to attach a liner to the liner drive head assembly. Two 3/8-inch cap screws are included on the drive head to provide a backup in case one incurs thread damage. Either cap screw may be used to attach the liner.

3. Remove the 3/8-inch cap screw using a 3/32-inch hex key.

4. Place the open end of a DT21 Liner against the bottom of the liner drive head. Align the hole in the liner with the hole in the liner drive head as shown in Figure 4.15. Wiggle the free end of the liner back-and-forth while pushing the liner onto the drive head (Fig. 4.15).

   NOTE: Use the DT21 Liner that matches the length of your probe rods (36 inches, 1 meter, or 48 inches). The 24-inch DT21 Liners (DT4024K) are to be used with 48-inch probe rods only. One 1.0-inch x 24-inch probe rod (AT105B) is also required when using the DT4024K liners.

5. Thread the 3/8-inch cap screw through the liner and back into the liner drive head (Fig. 4.16). Tighten the cap screw with the 3/32-inch hex key.

   The DT21 Liner is now attached to the DT21 Liner Drive Head Assembly (Fig. 4.17).

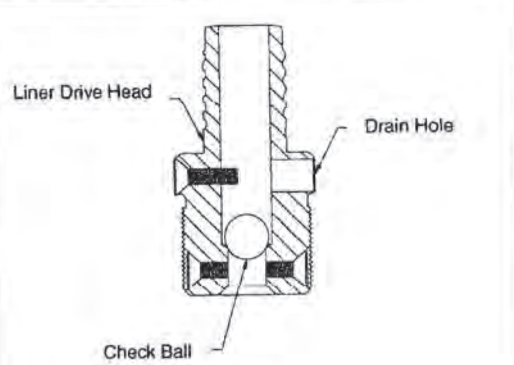


FIGURE 4.12
Cross-Section of Liner Drive Head

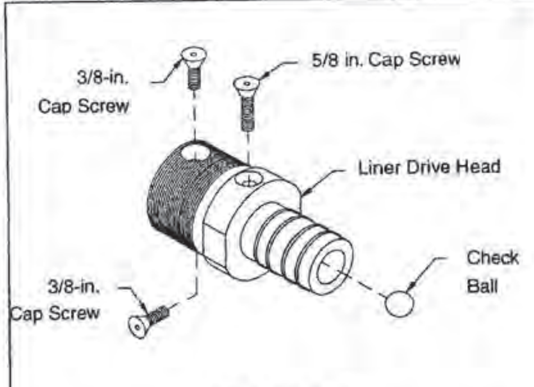


FIGURE 4.13
Liner Drive Head Assembly Components

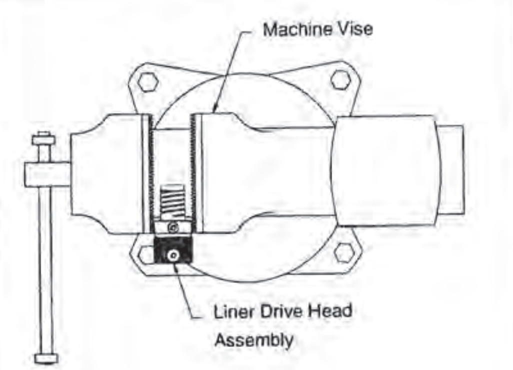


FIGURE 4.14
Place Liner Drive Head in Vise

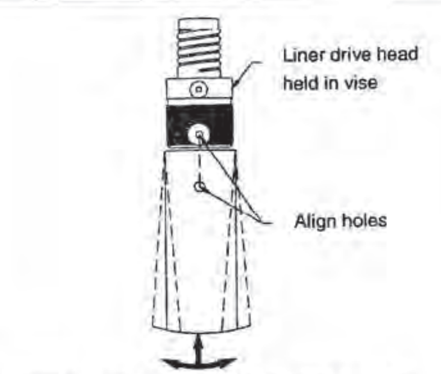


FIGURE 4.15
Push Liner Onto Liner Drive Head

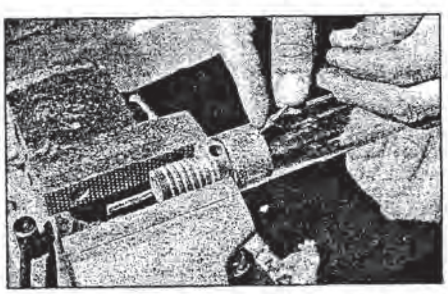


Figure 4.16. Thread cap screw into liner drive head to secure liner.

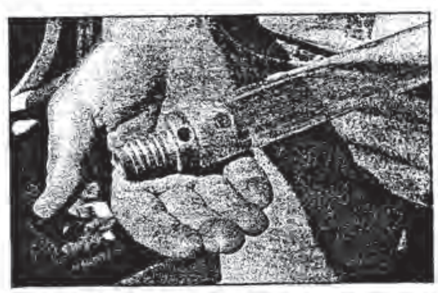


Figure 4.17. Liner attached to liner drive head and ready for sampling.

4.5 Soil Core Collection

This section describes the procedure for collecting continuous core samples from within the sealed outer casing of the DT21 Dual Tube Soil Sampling System. The procedure is to be performed after the outer casing is driven to the top of the sampling interval using a DT21 Solid Drive Tip.

1. Place an O-Ring (AT2100R) in the groove just below the male threads on the top section of the outer casing (Fig. 4.18).

2. Thread a 1.0-inch probe rod onto an assembled DT21 Liner Drive Head and DT21 Liner (Fig. 4.19).

   NOTE: A 1.0-inch x 24-inch Probe Rod (AT105B) is first threaded onto the DT21 Liner Drive Head Assembly (DT4050) if using a 24-inch DT21 Liner (DT4024K).

3. Insert the liner and probe rod into the outer casing (Fig. 4.20).

   The inner rod will extend past the top of the outer casing if only one section of casing was previously driven into the ground. If the casing was driven to a greater depth, continue adding 1.0-inch probe rods until the last rod extends from the casing. Use the DT21 Rod Clamp Assembly to hold the inner tool string while adding rods if desired.

4. Place a 2.125-inch probe rod over the inner rods and thread it onto the outer casing (Fig. 4.21). Completely tighten the outer casing using a pipe wrench.

5. Put a DT21 Drive Bumper (DT4010K) on top of the inner rod as shown in Figure 4.22.

6. Thread a Drive Cap (AT2101) onto the 2.125-inch probe rod (Fig. 4.22). Completely tighten the drive cap with a pipe wrench.

   NOTE: Current AT2101 Drive Caps are manufactured using a drilling process that leaves an angled surface inside the cap (Fig. 4.23). This provides room for a Drive Bumper (DT4010K). Older AT2101 Drive Caps were manufactured using a boring process that leaves a flat surface inside the cap (Fig. 4.23). These older caps do not leave room for a drive bumper and therefore cannot be used with the DT21 Dual Tube System.

7. Lower the hammer onto the drive cap and advance the outer casing one liner length into the subsurface to collect the first soil core. Apply hammer percussion to the tool string as this helps move soil through the cutting shoe and into the liner for increased sample recovery.

8. Raise the hammer and retract the probe derrick to provide access to the top of the tool string.

9. Unthread the Drive Cap (AT2101) and remove the DT21 Drive Bumper (DT4010K).

10. Thread a 1.0-inch OD probe rod onto the inner rod (Fig. 4.24). Rotate the inner rod string 2 or 3 revolutions to shear the soil core at the bottom of the liner. Raise the inner rods to retrieve the filled liner from the outer casing.

    NOTE: Hold the inner rod string with a DT21 Rod Clamp Assembly (DT 4060) while unthreading the retracted rods (Fig. 4.25). Use the probe hammer and Rod Grip Pull System (GH3000K) to pull the inner rods if they are too heavy to lift comfortably by hand (Fig. 4.26).

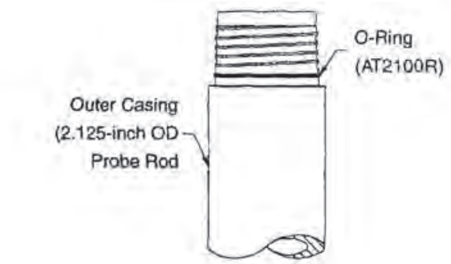


FIGURE 4.18
Outer Casing Joints are Sealed with O-Rings

Figure 4.19. Thread liner and liner drive head into 1.0-inch probe rod.

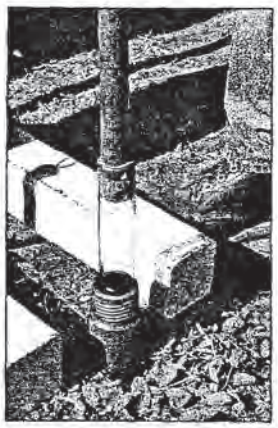


Figure 4.20. Lower liner to bottom of outer casing on leading end of inner rods.

Figure 4.21. Place a 2.125-inch probe rod over the 1.0-inch probe rod and thread it onto the outer casing string.

Figure 4.22. Place a drive bumper on top of the inner rods and thread a drive cap *onto the outer casing.*

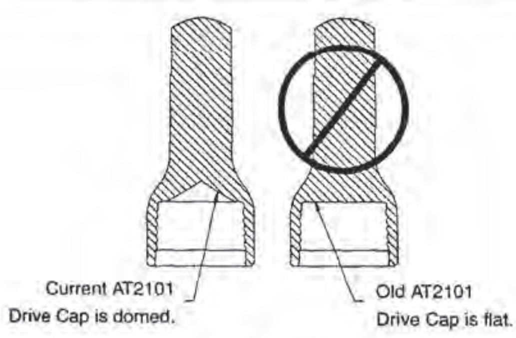


FIGURE 4.23
Comparison of AT2101 Drive Caps

Figure 4.24. Thread a 1.0-inch probe rod onto inner rod string to *retrieve filled liner.*

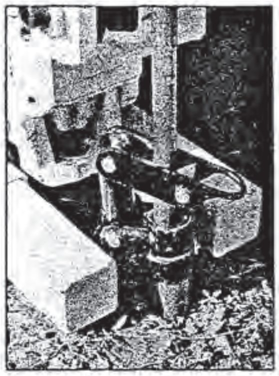


Figure 4.25. The DT21 Rod Clamp Assembly holds the inner rod string while adding or removing 1.0-inch rods.

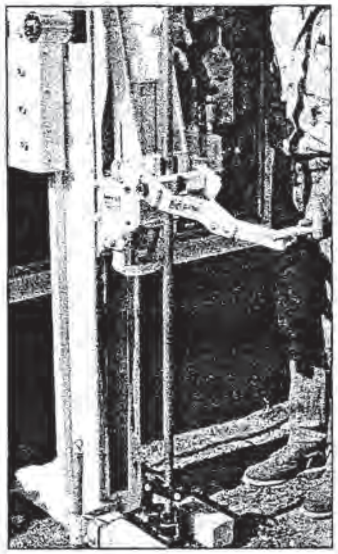


Figure 4.26. Raise the inner rod string using the probe hammer and a Rod Grip Pull Sytem if rods are too heavy to lift by hand.

Figure 4.27. Liner drive head attached to filled liner after retrieval from outer casing.

Figure 4.28. Score a line from top of liner to base of liner drive head using a utility knife.

Figure 4.29. Move free end of liner back-and-forth to split liner and free it from the liner drive head.

11. Unthread the last probe rod from the liner/drive head assembly. The DT21 Drive Head Assembly remains attached to the DT21 Liner (Fig. 4.27).

12. Place the liner drive head in a machine vise so that the 3/8-inch cap screw threaded through the liner is on top. Remove the cap screw with a 3/32-inch hex key.

13. Using a utility knife, score a line from the top of the liner to the bottom of the drive head (Fig. 4.28). Move the free end of the liner back-and-forth until the top of the liner splits and releases from the drive head (Fig. 4.29). The soil core is now prepared for storage or analysis according to project guidelines.

Repeat the procedure given in this section to collect consecutive soil core samples.

4.6 Dual Tube Soil Sampling Tips

Saturated sands are the hardest formations to sample with the DT21 system. Saturated conditions place a positive pressure on the soil outside of the outer casing. In saturated, noncohesive formations (e.g. sands) below the water table, it may be necessary to add water to the bore of the probe rods. Adding water to the probe rods puts a positive head on the system and may keep these materials from flowing into the rods as a sample is retracted. Additionally, the shorter 24-inch liners may be used to collect samples under these conditions. Collecting a shorter sample will minimize the vacuum created as the sample is retracted inside the rod bore. This may help minimize the heave of noncohesive materials into the rods. A shorter sample interval may also enhance sample recovery in sandy materials.

Some clay materials will expand as they are sampled. Under these conditions using a shorter sample interval (24-inch liners) may also improve sample recovery by minimizing the wall friction as the material is sampled.

4.7 Outer Casing Retrieval

The outer casing of the DT21 Dual Tube System may be retrieved in one of three ways:

1. Casing pulled then probe hole sealed from ground surface with granular bentonite.

   The outer casing may be pulled from the ground with the probe machine and a Pull Cap (AT2104) or a Rod Grip Pull System (GH3000K) if the probe hole is to be sealed with granular bentonite from the ground surface (Fig. 4.30). This method is used for shallow probe holes in stable formations only. Such conditions allow the entire probe hole to be sealed with granular bentonite.

2. Casing pulled with probe hole sealed from bottom-up during retrieval.

   Bottom-up grouting should be performed during casing retrieval in unstable formations where side slough is probable. Such conditions create void spaces in the probe hole if granular bentonite is installed from the ground surface.

   A GS500 or GS1000 Grout Machine is used to deliver a sealing material (high-solids bentonite slurry or neat cement grout) to the bottom of the outer casing through flexible tubing. The grout mix is pumped through the tubing to seal the void remaining as the outer casing is retrieved (Fig. 4.31). This is an advantage of the DT21 Dual Tube System as other soil samplers require a second set of tools to deliver grout to the bottom of the probe hole. Contact Geoprobe Systems for more information on bottom-up grouting with the GS500 and GS1000 Grout Machines.

3. Casing pulled with Geoprobe Prepacked Screen Well installed during retrieval.

   The final option is to install a Geoprobe Prepacked Screen Monitoring Well in the probe hole during retrieval of the outer casing. A DT21 Expendable Cutting Shoe Holder (DT4040) and a DT21 Expendable Cutting Shoe (DT4045) allow the operator to collect continuous soil cores as the outer casing is driven to depth. When sampling is complete, the outer rods are raised and the expendable cutting shoe is removed from the leading rod. This leaves an open casing through which a set of prepacked screens is lowered on the leading end of a PVC riser string (Fig. 4.32). The well is finished, complete with grout barrier, bentonite well seal, and a high-solids bentonite slurry/neat cement grout, during retrieval of the outer casing.

Refer to the Geoprobe Prepacked Screen Monitoring Well Standard Operating Procedure (Technical Bulletin No. 962000) for specific information on well installation.

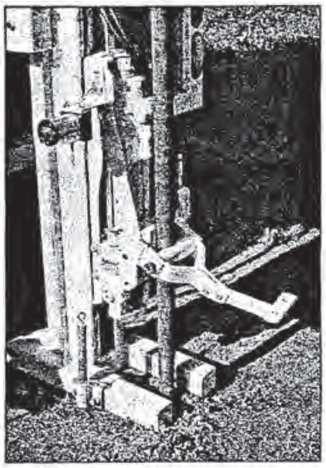


Figure 4.30 Outer casing may be retrieved with a pull cap or rod grip pull system if the probe hole is sealed with granular bentonite.

Figure 4.31. A grout machine and flexible tubing allow bottom-up grouting as the outer casing is retrieved.

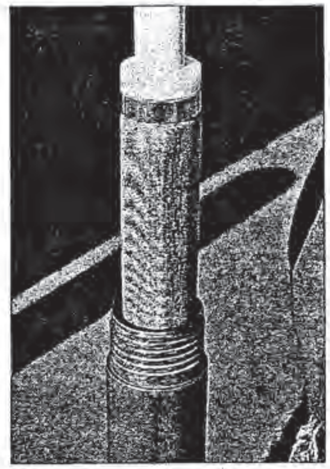


Figure 4.32. Geoprobe prepacked screens may be installed through the outer casing when an expendable cutting shoe is used.

5.0 REFERENCES

Geoprobe Systems, October, 1997, "1998-99 Tools and Equipment Catalog".

Geoprobe Systems, Macro-Core® Soil Sampler SOP, Technical Bulletin No. 958500, 1998

Geoprobe Systems, Prepacked Screen Monitoring Well SOP, Technical Bulletin No. 962000, 1998

Equipment and tool specifications, including weights, dimensions, materials, and operating specifications included in this brochure are subject to change without notice. Where specifications are critical to your application, please consult Geoprobe Systems.

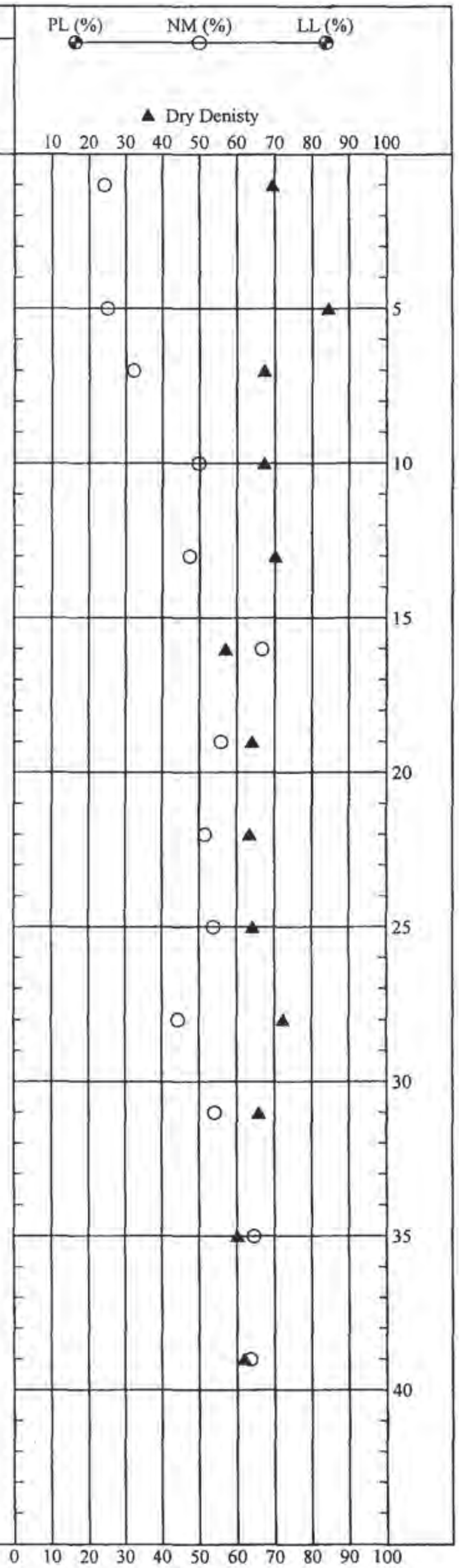
APPENDIX B

BORING LOGS

SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS	LEGEND	ELEV (ft)	SAMPLES: IDENT	TYPE	N-COUNT: 1st 6"	2nd 6"	3rd 6"
0	BLACK ASH, DRY							
9	SAND SIZED BLACK ASH, WET							
15	STIFF FINE SAND SIZED BLACK ASH SOFT, WET							
27	FIRM BLACK ASH, WET							
42	VERY STIFF (BELIEVE TO BE BOTTOM OF ASH)							
44	GEOPROBE TERMINATED AT 44.0'							



REMARKS:

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

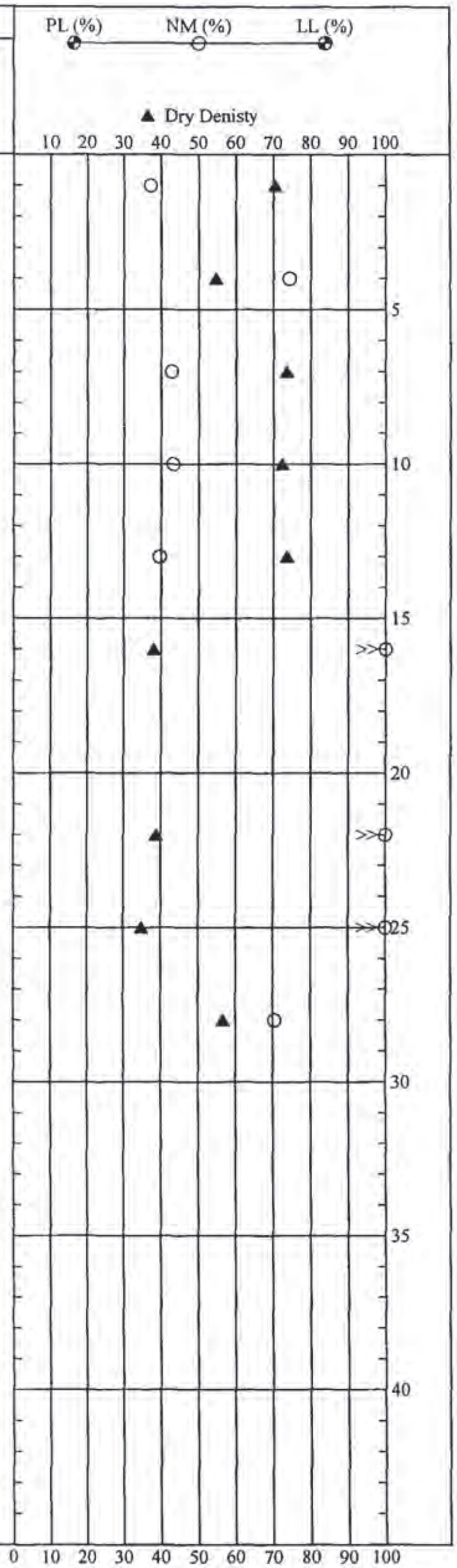
PROJECT: TVA - Johnsonville Fossil Plant

DRILLED: August 5, 2003 **BORING NO.:** B-1

PROJ. NO.: 3031032091/0001 **PAGE** 1 **OF** 1

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES: IDENT	TYPE	N-COUNT: 1st 6"	2nd 6"	3rd 6"
0	SILT SIZED BLACK ASH, DRY							
	SILT SIZED BLACK ASH, WET							
5								
10								
15								
	NO RECOVERY							
20								
	SILT SIZED BLACK ASH, WET							
	MOSTLY WATER							
25								
	SILT SIZED BLACK ASH, WET							
	REDDISH ORANGE, SILT SIZED CLAY							
	REFUSAL AT 29.0'							
30								
35								
40								
45								



SOIL-GEO-DRY-DEN 3031032091_01.GPJ LAW_GIBB.GDT 8/27/03

REMARKS:

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

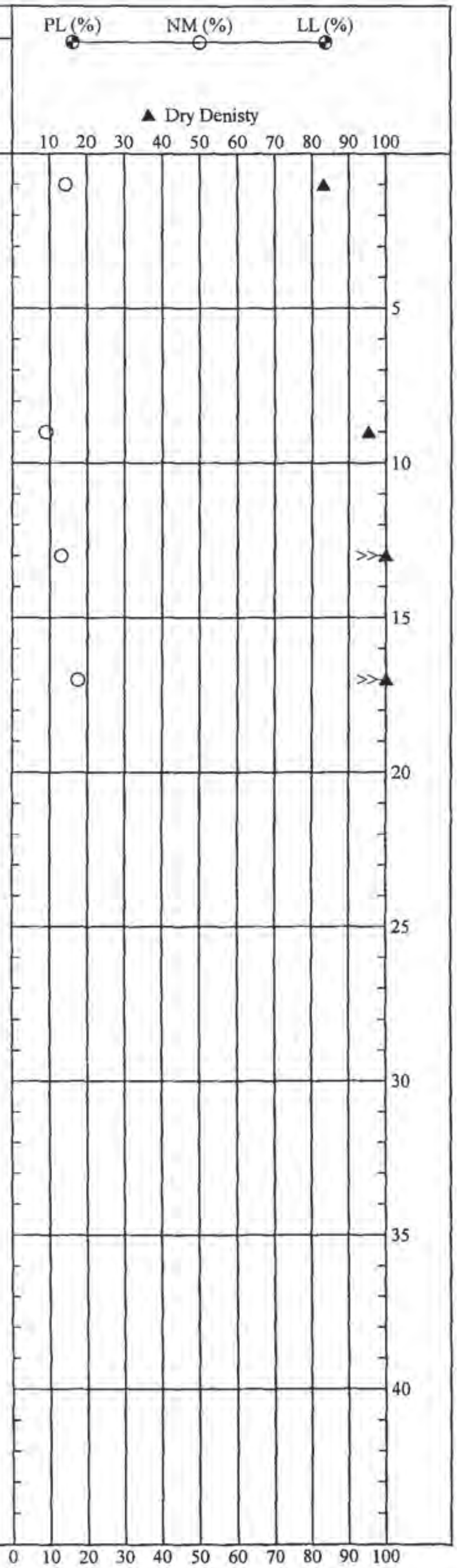
PROJECT: TVA - Johnsonville Fossil Plant

DRILLED: August 5, 2003 **BORING NO.:** B-2

PROJ. NO.: 3031032091/0001 **PAGE** 1 **OF** 1

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	N-COUNT 1st 6"	2nd 6"	3rd 6"
0	BLACK ASH							
	FILL MATERIAL							
	BLACK ASH							
14	BLACK ASH, WET							
18	REFUSAL AT 18.0'							



REMARKS:

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: TVA - Johnsonville Fossil Plant

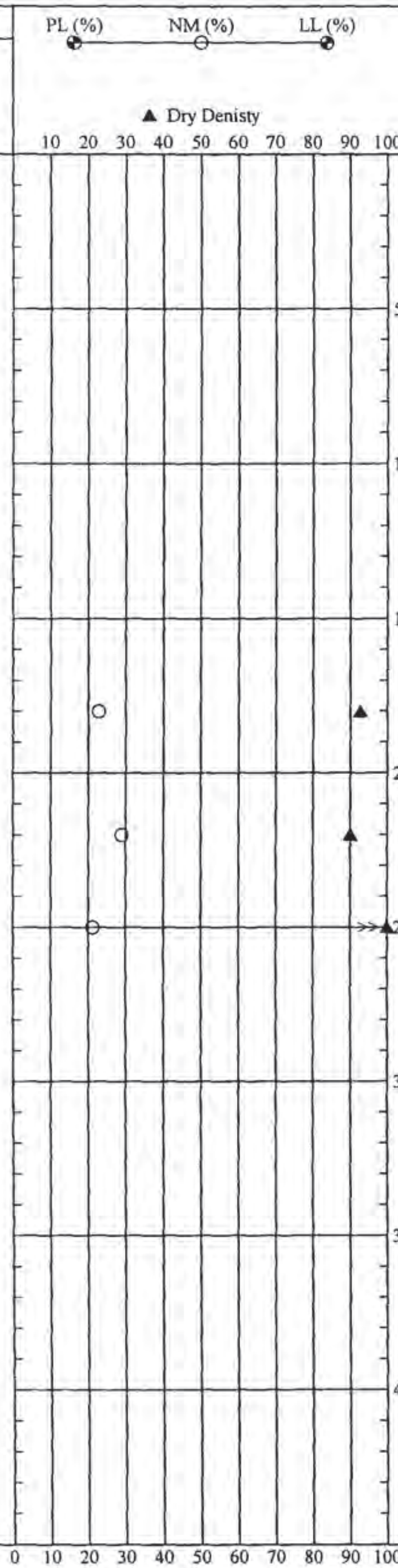
DRILLED: August 14, 2003 **BORING NO.:** B-3

PROJ. NO.: 3031032091/0001 **PAGE** 1 **OF** 1

MACTEC

SOIL-GEO-DRY-DEN 3031032091_01.GPJ LAW_GIBB.GDT 8/27/03

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	SAMPLES TYPE	N-COUNT 1st 6"	N-COUNT 2nd 6"	N-COUNT 3rd 6"
0	CLAY							
12	BLACK ASH							
24	SOFT BLACK ASH							
25	BLACK ASH							
27	REFUSAL AT 27.0'							



SOIL-GEO-DRY-DEN 3031032091_01.GPJ LAW_GIBB.GDT 8/27/03

REMARKS:

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

PROJECT: TVA - Johnsonville Fossil Plant

DRILLED: August 14, 2003 **BORING NO.:** B-4

PROJ. NO.: 3031032091/0001 **PAGE** 1 **OF** 1

MACTEC

APPENDIX M
BACKGROUND SOIL SAP

Background Soil
Sampling and Analysis Plan
Johnsonville Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Johnsonville Fossil Plant
New Johnsonville, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 10, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	July 24, 2017
1	Addresses October 19, 2017 TDEC Review Comments and Issued for TDEC Review	January 12, 2018
2	Addresses March 9, 2018 TDEC Review Comments and Issued for TDEC Review	May 11, 2018
3	Addresses June 11, 2018 TDEC Review Comments and Issued for TDEC Review	July 20, 2018
4	Addresses comments and revisions from other EIPs and issued for TDEC review.	December 10, 2018

BACKGROUND SOIL
SAMPLING AND ANALYSIS PLAN
JOHNSONVILLE FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Background Soil
Sampling and Analysis Plan
Johnsonville Fossil Plant
Tennessee Valley Authority
New Johnsonville, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 10, 2018 Revision 4, Final

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager	12/6/18 Date
TVA Investigation Field Lead	12/6/18 Date
Health, Safety, and Environmental (HSE) Manager	12/05/2018 Date
Investigation Project Manager	12/7/2018 Date
Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.12.03 11:52:10 -05'00' QA Oversight Manager	Date
Laboratory Project Manager	12-4-18 Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

Stantec

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LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order), to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Johnsonville Fossil Plant (JOF) on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management at JOF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC submitted a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 24, 2017, TVA submitted JOF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

TVA has developed this Background Soil Sampling and Analysis Plan (SAP) to provide procedures and methods necessary to characterize background soils in the vicinity of the JOF Plant (Plant).

2.0 OBJECTIVES

The objective of this Background Soil SAP is to characterize background soils on TVA property in the vicinity of the Plant. The approach in characterizing the background soils is to identify locations where naturally occurring, in place, native soils are present, yet unaffected by CCR material. Samples will be analyzed for CCR Parameters listed in 40 CFR Part 257, Appendices III and IV along with additional parameters required by the state groundwater monitoring program (copper, nickel, silver, vanadium, and zinc). These constituents will be hereafter referred to as "CCR Parameters." Additionally, the surficial soil at each location will be collected and analyzed for percent ash, to determine the presence or absence of windblown CCR.

This Background Soil SAP and the Plant-specific Quality Assurance Project Plan (QAPP) will provide the procedures necessary to conduct investigation activities associated with the sampling and analysis of background soils. Proposed field activities will include the following tasks:

- Verify and document proposed sampling locations using global positioning system (GPS) surveying
- Collect background soil samples from proposed locations
- Package and ship soil samples to laboratory for analysis of CCR Parameters

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and will document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLING LOCATIONS

A map of twelve-proposed background soil sampling locations is provided as Figure 1 (Attachment A). The locations were selected based on access, current hydrogeologic knowledge, and the sample location criteria set forth by TDEC. In addition, areas where known or suspected beneficial reuse of CCR has occurred were excluded from consideration as sampling locations. Additional considerations in selection of background soil boring locations included: relative elevation to the Plant, similar geologic units, and/or similar depositional environment (i.e., alluvial, or non-alluvial), and when feasible, proximity to existing background groundwater monitoring wells (proposed locations BG-05 and BG-06 are located adjacent to existing background groundwater monitoring wells B-9 and JOF-101; respectively).

Boring advancement through unconsolidated soils to refusal will be conducted at locations shown on Figures 1 & 2 within a one-mile radius of the Plant's historical CCR disposal footprint. Soil borings will be advanced using a direct-push technology (DPT) drill rig (typically equipped with five-foot long probe rods or dual tube samplers) or an equivalent technology. The rods will be decontaminated between sampling locations in accordance with Section 5.2.7. In addition to the soil data that will be collected from the proposed sampling locations, TVA will collect soil samples through the well screen interval at locations of proposed background groundwater monitoring wells.

Grab samples will be collected in five-foot intervals during boring advancement from the ground surface to the top of bedrock/partially weathered rock/weathered rock (refusal). Each boring will be logged by a Tennessee-licensed professional geologist.

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to prepare for field activities, advance soil borings, collect background soil samples, and assist in providing scientifically defensible results.

Background soil sample collection will adhere to applicable United States Environmental Protection Agency (EPA) and TVA Environmental Technical Instruction (TI) documents. A project field book and field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be planned in accordance with TVA TI ENV-TI-05.80.01 *Planning Sampling Events*, conducted according to TVA TI ENV-TI-05.80.50, *Soil and Sediment Sampling* and documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will:

- Designate a Safety Officer and a Tennessee-licensed professional geologist
- Review applicable reference documents, including (but not limited to), TVA TIs (Section 5.5) and Standard Operating Procedures (SOPs), QAPP (Appendix C), SAPs, and HASP.
- Complete required health and safety paperwork, field readiness checklist, and confirm field team members have completed required training
- Coordinate field activities with the Laboratory Coordinator to confirm that sample bottles and preservatives are ordered, coolers and analyte-free deionized water are obtained, and sampling and sample arrival dates are communicated to the laboratories
- Coordinate activities with the drilling subcontractor
- Clear Access – Proposed boring locations will be marked using a wooden stake or survey flag with the position surveyed using GPS. Suitability of each location will be evaluated for logistical issues including access, grubbing needs, overhead utility clearance, and proximity to Plant features. Access improvements, including clearing and grubbing or road building, will be completed prior to the investigation start date. If a proposed boring location is discovered to have accessibility restrictions related to agricultural, cultural, biological, or other such limiting factors, then a replacement boring will be proposed at a location that will meet the study's goals with approval from TDEC.

- Perform Environmental Review – As required by the National Environmental Policy Act (NEPA), an environmental review must be completed to document and mitigate any potential impact of the work described herein. The level of review required for this work is anticipated to be a categorical exclusion, which would be documented by TVA with a categorical exclusion checklist (CEC). A CEC has a number of signatories from TVA. It is understood that the environmental review is to be completed before implementation of the field work. Additionally, plant staff will not issue an excavation permit ahead of the completed environmental review.

- Complete Utility Locate(s) / Excavation Permit(s) - Prior to initiating subsurface activities, subsurface utility clearance will be sought via the plant engineering department and/or the TN 811 service. At locations within the Plant, engineering will provide primary utility clearance assurance in addition to TN 811 being notified. At all other drilling locations TVA or 3rd party underground locators will be engaged to clear boring locations. For drilling locations outside the plant (e.g., along public roads and rights-of-way), utility avoidance assurance will be supplemented by the TN 811 service and the TVA or 3rd party underground locators. An excavation permit is required prior to initiating any digging or boring at the Plant. A key component to the completion of the excavation permit is consensus on the drilling locations with pertinent TVA staff.

- Identify Water Source – During implementation of the EIP, a source of potable water will be required to complete several investigation tasks, including certain drilling methods and decontamination procedures.

- Obtain required functional and calibrated field instruments, including health and safety equipment

- Complete sample paperwork to the extent possible, including chain-of-custody forms and sample labels in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*

- Obtain ice daily prior to beginning work for sample preservation

5.2 SAMPLING METHODS AND PROTOCOL

Drilling activities performed at the Plant during implementation of this SAP will include advancing subsurface boreholes using DPT or other compatible technology based on field conditions and rig availability. Sampling activities will be conducted according to TVA TI ENV-TI-05.80.50, *Soil and Sediment Sampling.*

The following sections present drilling and soil sampling procedures required to complete the tasks presented.

5.2.1 Drilling, Logging, and Surveying

5.2.1.1 Background Borings

Probe advancement will be initiated using the static weight of the rig until encountering refusal. Percussion will be used to advance the probe rods further following maximum penetration under the static load. A new two-inch inside diameter one- time use clear, polyvinyl chloride (PVC) sample liner will be placed inside the sample rod before each push to collect continuous soil samples. After the sample rod is pushed to the appropriate depth, it will be retracted, and the liner and sample removed and placed on clean plastic sheeting. A new PVC liner will then be placed in the sampler and another rod will be added to the run. DPT sample rods will be driven and retracted in a continuous run until the desired soil boring depth is achieved.

A liner cutter will be used to open the liner for sample retrieval. Soils that are not considered part of the representative sample (e.g., slough as determined by visual inspection of the sample) will be managed in accordance with Section 5.2.8. The core length will be measured to calculate sample recovery. Soils obtained in each PVC liner will be logged by a Tennessee-licensed professional geologist. Samples will be collected in accordance with Section 5.2.4.

Once sample collection is complete at each boring, the boreholes will generally be filled with a bentonite-cement grout mixture using a tremie pipe to within approximately six inches of the surface. The top six inches will be restored to match the existing conditions.

5.2.1.2 Background Groundwater Monitoring Wells

During installation of proposed background monitoring wells, soil samples will be collected to provide additional background soil data. Soil samples collected during the installation of these monitoring wells will either be collected using the same method described above in Section 5.2.1.1 or by using split spoon samplers driven through the hollow stem augers used to advance the monitoring well boring. Soil samples from these monitoring well locations will be collected through the well screen interval.

5.2.1.3 Borehole Logging

During boring advancement, each borehole will be logged by a Tennessee-licensed professional geologist. At a minimum, the following information will be recorded in accordance with TVA TI ENV-TI-05.80.03, *Field Record Keeping* and *American Society of Testing and Materials (ASTM) Standard D2488* and entered on boring logs for each borehole and each distinct stratum described:

- Name of person completing boring log
- Boring identification and boring date
- Soil color and classification, using Munsell soil color charts and Modified Unified Soil Classification System (USCS) for unconsolidated materials
- Visual identification of CCR in soil cores, if present
- Moisture content (e.g. dry, moist, or wet)
- Soil consistency or density, size, shape, and angularity of particles (for fine to coarse grained soils)
- Soil pH as determined in the field using field pH test kits
- Depth interval represented by stratum observations
- Additional observations deemed relevant (e.g. presence of groundwater, fractures, GPS survey data, etc.)
- Field boring logs will be collected on field forms and then input to gINT for final production

5.2.1.4 Surveying

Once completed, borings will be surveyed for horizontal and vertical control by survey grade GPS. The final survey of each location will be conducted following completion and abandonment of each individual sampling location. The survey data will be added to the final boring logs once available.

5.2.2 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Field Team Leader, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP.

5.2.3 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.2.3.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.3.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks. Boring log forms will be used to document lithologic conditions and field observations at each boring location.

5.2.3.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COC forms will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality control (QC) check of samples in each cooler compared to sample IDs on the corresponding COC form. The Investigation Project Manager will staff the project with a field sample manager during sample collection activities. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.2.3.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.4 Collection of Samples

Sample collection for laboratory analysis at each location will be conducted in accordance with TVA TI ENV-TI-05.80.50, *Soil and Sediment Sampling* and will be initiated at the ground surface. An initial grab sample representing the surficial soils (i.e., top 6 inches) will be collected by hand auger and submitted for laboratory analysis of percent ash by polarized light microscopy (PLM) in addition to CCR Parameters. The additional analysis of percent ash by PLM on the surficial sample is to determine if there have been any windblown CCRs deposited at the boring location. Sampling will continue the length of the boring by collecting grab samples from the mid-point of each five-foot boring interval. The mid-point for grab samples will be the mid-point based on recovery. If soils are expected to be hard to recover during core retrieval, core catchers will be used to prevent loss of sample material. No composite samples are proposed. If a change in lithology, such as a change in residuum, colluvium, alluvium, etc. occurs within a core interval separate grab samples will be collected from the mid-point of both lithologies in the core. Each sample from the recovered core will be collected with a gloved hand, properly decontaminated sample scoop, or certified clean disposable sample scoop. Field samplers will wear a new pair of disposable nitrile gloves while handling each sample. The samples will be placed in a new, re-sealable bag and will be homogenized using a gloved hand or decontaminated sample scoop, certified clean disposable sample scoop and/or by kneading the material through the outside of the bag until the physical appearance is consistent over the entire sample.

After homogenization, the sample will be collected from the bag and placed in the appropriate laboratory-supplied sample containers. Each sample will be submitted to the laboratory for CCR Parameters (refer to Section 5.2.6).

5.2.5 Preservation and Handling

Prior to placing each soil sample into the laboratory supplied containers, an aliquot of the homogenized soil sample will be tested using a field pH test kit with the results recorded in the daily field notes. Once each sample container is filled, the rim and threads will be cleaned by wiping with a clean paper towel and capped. Each sample container will be checked to confirm that it is sealed, labeled legibly, and externally clean. Sample containers will be packaged in a manner to prevent breakage during shipment.

Coolers will be prepared for shipment in accordance with TVA TI ENV-05.80.06, *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright position. Small uniformly sized containers (such as 4-ounce or 8-ounce soil jars) will be stacked in an upright configuration and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory. Gel ice or loose ice will be placed around and among the sample containers to cool the samples to less than 6 degrees Celsius (°C) during shipment. The cooler will be filled with additional packing material to secure the containers.

The original COC form will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC form will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC form and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC form. If multiple coolers are required to ship samples contained on a single COC form, then the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e., strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC form. If there are discrepancies the Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Project Manager.

5.2.6 Sample Analyses

Samples will be submitted to the TVA-approved laboratory for analysis. These samples will be analyzed for concentrations of CCR Parameters in order to evaluate naturally occurring levels and establish a baseline in background soils. Tables 1-3 summarize the constituents requiring analysis. Analytical methods, preservation requirements, container size, and holding times for each chemical analysis is presented in Table 4. Additional sampling and laboratory-specific information are covered in more detail in the QAPP.

Table 1. 40 CFR Part 257 Appendix III Constituents

Appendix III Constituents
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids – Not Applicable

Table 2. 40 CFR Part 257 Appendix IV Constituents

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 Combined

Table 3. TN Rule 0400-11-01-.04, Appendix 1 Inorganic Constituents

TDEC Appendix 1 Constituents*
Copper
Nickel
Silver
Vanadium
Zinc

* Constituents not listed in CCR Appendices III and IV

Table 4. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Percent ash	PLM (RJ Lee SOP OPT23.02)	Not Applicable	4 oz. glass	Not Applicable
Metals	SW-846 6020A	Cool to <6° C	4 oz. glass	180 days
Mercury	SW-846 7471B	Cool to <6° C	4 oz. glass	28 days
Radium 226	SW-846 901.1	Cool to <6° C	One 16 oz. wide-mouth glass jar for both Ra 226 and 228 samples	180 days
Radium 228	SW-846 901.1	Cool to <6° C	See Ra 226 above.	180 days
Chloride	SW-846 9056A Modified	Cool to <6° C	4 oz. glass	28 days
Fluoride	SW-846 9056A Modified	Cool to <6° C	4 oz. glass	28 days

Table 4. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Sulfate	SW-846 9056A Modified	Cool to <6º C	4 oz. glass	28 days
pH	SW-846 9045D Modified	Cool to <6º C	4 oz. glass	Not Applicable*

*Holding time for soil pH samples is 15 minutes following creation of soil paste. Soil samples will be tested in the field using field pH test kits, 10% of the sample locations will have confirmation samples submitted for laboratory analysis of pH and will have paste prepared in the laboratory so that analysis can be completed within the holding time.

5.2.7 Equipment Decontamination Procedures

Documented decontamination will be performed for drilling equipment, tooling, and instruments in contact with subsurface materials in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination. Decontamination pads will be constructed for decontamination of large downhole tooling (augers, drill rods, etc.). Decontamination will be conducted using a high-pressure washer/steam cleaner.

Decontamination pads will be constructed at locations designated by TVA personnel using poly sheeting with sufficient berms to contain decontamination fluids and prevent potential runoff to uncontrolled areas. Following decontamination, fluids will be pumped into a drum for storage, transportation, and ultimately disposal in accordance with Section 5.2.8. Decontamination activities will be performed away from surface water bodies and areas of potential impacts. Decontamination of non-disposable sampling equipment or instruments can be performed using water and Liquinox® or other appropriate non-phosphatic detergent in 5-gallon buckets.

Decontamination of sampling equipment and instruments (e.g., water level meters, etc.) will be performed prior to use and between sampling locations. Decontamination activities will be documented in the logbook field notes. Additional information regarding equipment decontamination procedures is in the QAPP.

5.2.8 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Soil Cuttings
- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05 *Field Sampling Equipment Cleaning and Decontamination*, the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to background soil sampling and analysis.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to confirm that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Project Manager considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Four types of field QA/QC samples will be collected during sampling activities: field duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, equipment blanks, and field blanks. QA/QC samples will be collected in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control*. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below. A complete description of the QA requirements is provided in the QAPP.

Field Duplicate Samples – One field duplicate sample will be collected for every 20 soil samples or once per sampling event. Duplicates samples will be prepared as blind duplicates and will be collected by splitting the homogenized sample volume into two sets of identical, laboratory-prepared sample bottles. The primary and duplicate samples will be labeled according to procedure in Section 6.2.1. Sample identifier information will not be used to identify the duplicated samples. Actual sample identifiers for duplicate samples will be noted in the field logbook. The duplicate sample will be analyzed for the same parameters as the primary sample.

MS/MSD Samples – A sufficient volume of soil is already contained in the laboratory supplied soil sample jars for use as the MS/MSD. As such, MS/MSD samples will be collected by the laboratory from the sample containers submitted for standard analysis, allowing matrix spike samples to be run to assess the effects of matrix on the accuracy and precision of the analyses. One MS/MSD sample will be analyzed for every 20 soil samples collected. Additional sample volume intended for use as the MS/MSD must be identified in the comments field on the COC records and sample labels. The location of sample collection will be noted in the log book.

The MS/MSD sample will be analyzed for the same analytes as the primary sample, with the exception of parameters that are not amenable to MS/MSD.

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected for every 20 samples. The equipment blank will be collected at a soil boring location by pouring laboratory-provided deionized water into or over the decontaminated sampling equipment (e.g., decontaminated DPT cutting shoe, sample scoops, or other non-disposable decontaminated equipment), then into the appropriate sample containers. The time and location of collecting the equipment blank will be noted in the log book. The sample will be analyzed for the same analytes, with the exception of pH, as the sample collected from the soil boring location where the equipment blank is prepared.

Field Blanks: One field blank sample will be prepared per day using laboratory-supplied deionized water. The sample will be analyzed for the same analytes, with the exception of pH.

6.2.1 Sample Labels and Identification System

Sample IDs will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*. Each sample container will have a sample label affixed and secured with clear package tape as necessary to prevent label removal. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

PLM data will not be subjected to data validation due to the specialized training and equipment required to accurately visually quantitate ash. PLM data will be subjected to verification including a review of QC analyses and a reasonability assessment based on photomicrographs included in the data package.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 5. Preliminary Schedule for Background Soil SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Background Soil SAP Submittal		Completed
Prepare for Field Activities	25 Days	Following EIP Approval
Conduct Field Activities	35 Days	Following Field Preparation
Laboratory Analysis	50 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Plant-specific safety requirements are anticipated to include TVA specified training and attendance at a safety briefing. Only Field Team members and subcontractors performing work activities will be required to meet the above requirements.
- A dedicated Safety Officer will be present for this work.
- Assessment of suitability of areas and access to borings, including clearing and grubbing, will be provided by TVA, and will be completed prior to the Investigation start date.

9.0 REFERENCES

Environmental Protection Agency (EPA). 1995. "Engineering Forum Issue; Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Sites." December 1995.

Environmental Protection Agency (EPA). 2004. "National Functional Guidelines for Inorganic Data Review." October.

Environmental Protection Agency (EPA) Region 4. 2001. "Environmental Investigations Standard Operating Procedures and Quality Assurance Manual." November.

Tennessee Valley Authority (TVA). 2017a. "Planning Sampling Events." Technical Instruction ENV-TI-05.80.01, Revision 0000 March 31.

Tennessee Valley Authority (TVA). 2017b. "Sample Labeling and Custody." Technical Instruction ENV-TI-05.80.02, Revision 0001 March 31.

Tennessee Valley Authority (TVA). 2017c. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017d. "Field Sampling Quality Control." Technical Instruction ENV-TI-05.80.04, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017e. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017f. "Handling and Shipping of Samples." Technical Instruction ENV-TI-05.80.06, Revision 0000 March 31.

Tennessee Valley Authority (TVA). 2017g. "Soil and Sediment Sampling." Technical Instruction ENV-TI-05.80.50, Revision 0000 September 29.

ATTACHMENT A
FIGURES

Figure No.
1

Title
Proposed Soil Sampling Locations

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

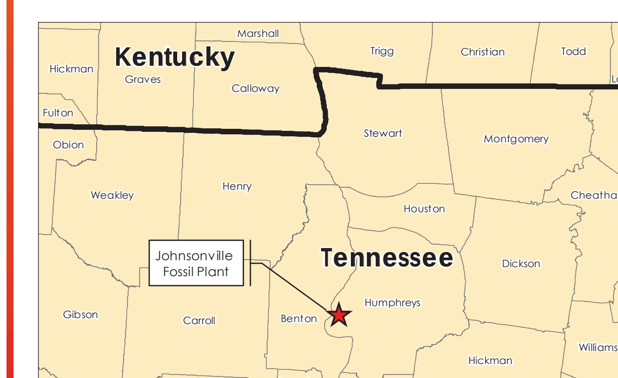
0 1,100 2,200 3,300 4,400 Feet
1:13,200 (At original document size of 22x34)

Legend

- Proposed Background Soil Sample Location
- Proposed Background Groundwater Monitoring Well
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TVA (2017) & ESRI Basemaps



Stantec TVA

U:\TVA-EP\175567296\gis\mxds\JOF_Proposed_Soil_Sampling.mxd Revised: 2018-12-06 By: mbough

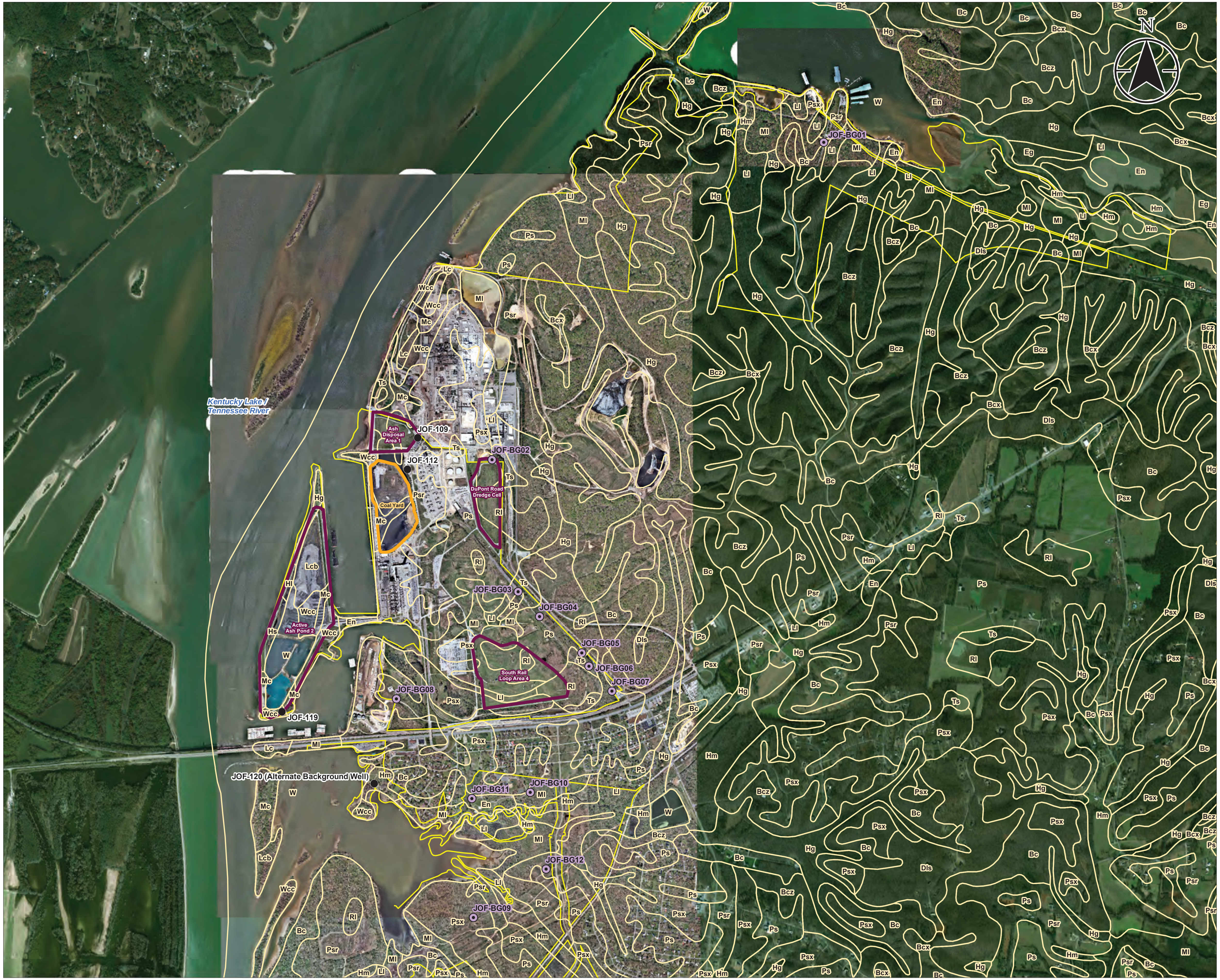


Figure No.
2

Title
Proposed Soil Sampling Locations

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

0 1,100 2,200 3,300 4,400 Feet
1:13,200 (At original document size of 22x34)

Legend

- Proposed Background Soil Sample Location
- Proposed Background Groundwater Monitoring Well
- CCR Unit Boundary (Approximate)
- Coal Yard
- Soil Map Unit
- TVA Property Boundary

Map Unit	Map Unit Name
Bc	Bodine gravelly silt loam, 12 to 20 percent slopes
Bcx	Bodine gravelly silt loam, 5 to 12 percent slopes
Bcz	Bodine gravelly silt loam, 20 to 40 percent slopes
Dls	Dickson silt loam, shallow
Eg	Ennis gravelly silt loam
En	Ennis silt loam
Hg	Humphreys gravelly silt loam, 2 to 5 percent slopes
Hl	Huntington silt loam
Hm	Humphreys silt loam
Hs	Huntington silty clay loam
Lc	Lindside silty clay loam
Lcb	Lindside silty clay loam, high-bottom
Ll	Lindside silt loam
Mc	Melvin silty clay loam
Ml	Melvin silt loam
Ps	Paden silt loam
Psr	Paden silt loam, eroded
Psx	Paden silt loam, slope
Rl	Robertsville silt loam
Ts	Taft silt loam, 0 to 2 percent slopes
W	Water
Wcc	Wolftever silty clay loam, compact

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TVA (2017) & ESRI Basemaps
3. Soils Data provided by US Department of Agriculture

ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Background Soil Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment[1]
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Photoionization detector (PID)
Water level indicator meter
Field pH Test Kits
***These items are detailed in associated planning documents to avoid redundancy.**
[1]Refer to the Exploratory Drilling SAP for drilling-specific field equipment

APPENDIX N
CCR MATERIAL CHARACTERISTICS SAP

CCR Material Characteristics Sampling and Analysis Plan Johnsonville Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Johnsonville Fossil Plant
New Johnsonville, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 10, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	July 24, 2017
1	Addresses October 19, 2017 TDEC Review Comments and Issued for TDEC Review	January 12, 2018
2	Addresses March 9, 2018 TDEC Review Comments and Issued for TDEC Review	May 11, 2018
3	Addresses June 11, 2018 TDEC Review Comments and Issued for TDEC Review	July 20, 2018
4	Addresses comments and revisions from other EIPs and issued for TDEC review.	December 10, 2018

CCR Material Characteristics
Sampling and Analysis Plan
Johnsonville Fossil Plant

TITLE AND REVIEW PAGE

Title of Plan: CCR Material Characteristics
Sampling and Analysis Plan
Johnsonville Fossil Plant
Tennessee Valley Authority
New Johnsonville, Tennessee

Prepared By: Stantec Consulting Services, Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 10, 2018 Revision 4, Final

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager — Date 12/6/18

TVA Investigation Field Lead — Date 12/6/18

Health, Safety, and Environmental (HSE) Manager — Date 12/05/2018

Investigation Project Manager — Date 12/7/2018

Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.12.03 11:52:28 -05'00'

QA Oversight Manager — Date

Laboratory Project Manager — Date 12-4-18

Charles L. Head
TDEC Senior Advisor — Date

Robert Wilkinson
TDEC CCR Technical Manager — Date

Stantec

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LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order), to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Johnsonville Fossil Plant (JOF) on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management at JOF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC submitted a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 24, 2017, TVA submitted JOF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

TDEC's comments included a request for a sampling plan to determine the leachability of CCR constituents (listed in 40 CFR Part 257, Appendix III and IV of the CCR Rule) from material in surface impoundments, landfills, and non-registered CCR units at the JOF Plant (Plant). TDEC's comments also included a request for a Pore Water Sampling and Analysis Plan (SAP) for the Plant. The submittal of this CCR Material Characteristics SAP addresses both requests.

2.0 OBJECTIVES

The objective of this CCR Material Characteristics SAP is to characterize the leachability of CCR constituents from material in a CCR unit, in response to the TDEC Order. The approach is to collect and analyze pore water and CCR material from the locations identified in Section 4.0

This CCR Material Characteristics SAP will provide procedures necessary to conduct the sampling and analysis of pore water and CCR material in the CCR units, and to characterize them for the CCR Parameters.

Proposed activities will include the following major tasks:

- Verify proposed sampling locations using the global positioning system (GPS)
- Develop temporary wells in the ash disposal area (drilling and installation procedures of the temporary wells are outlined in the Exploratory Drilling SAP)
- Collect pore water and CCR material samples from the temporary well locations
- Conduct laboratory testing and analyses

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLING LOCATIONS

The Study Area for this CCR Material Characteristics SAP consists of Active Ash Pond 2, Ash Disposal Area 1, Coal Yard, Dupont Road Dredge Cell, and the South Rail Loop Area 4. Each proposed sampling location in the Study Area will accommodate sampling for pore water and CCR material. Pore water will be collected as filtered and unfiltered samples, while CCR material will be collected as unsaturated and saturated samples (as conditions allow). Sixteen sample locations were selected based on TDEC's request to characterize the leachability of constituents from the material in the Study Area. All samples will be taken from temporary wells placed in the CCR units, which will also be used to determine the water level in those units.

During construction and installation of the temporary wells (i.e., sampling locations), a CCR material grab sample will be taken from each 5-foot core boring, from the top of the unit to its base. This will result in the collection of CCR material samples from both the phreatic zone (for saturated samples) and non-phreatic zone (for unsaturated samples). Samples shall not be taken from active ponds; they shall only be taken from former ponds once they have been dewatered and stabilized. After the temporary wells have been installed, pore water samples will be taken at the base of the units in the ash.

A map showing proposed pore water/CCR material sampling locations is provided as Figures 1-3 in Attachment A. Installation and construction specifications for the temporary wells are provided in the JOF Exploratory Drilling SAP. The proposed temporary well locations are subject to change based on ongoing site operations and conditions. TDEC will be notified of any changes in well locations.

Table 1. Proposed Sample Locations

Sample Location ID	Description
TW01	Active Ash Pond 2 (north section) – northern-most TW*
TW02	Active Ash Pond 2 (north section) – between TW01 & TW03
TW03	Active Ash Pond 2 (north section) – south of TW02
TW04	Active Ash Pond 2 (south section) – north of TW05
TW05	Active Ash Pond 2 (south section) – southern-most TW*
TW06	Ash Disposal Area 1 – northern TW*
TW07	Ash Disposal Area 1 – southern TW*
TW08	Coal Yard - northern TW*
TW09	Coal Yard – western TW*
TW10	Coal Yard – southeastern TW*
TW11	DuPont Road Dredge Cell - northern TW*
TW12	DuPont Road Dredge Cell – middle TW*
TW13	DuPont Road Dredge Cell - southern TW*
TW14	South Rail Loop Area 4 - northern TW*
TW15	South Rail Loop Area 4 - southern TW*
TW16	South Rail Loop Area 4 – southeastern TW*

*Temporary well

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to collect samples, document field activities, and assist in providing scientifically defensible results.

Pore water and CCR material sampling will adhere to applicable EPA and TVA Environmental Technical Instruction (TI) documents. A project field book and field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be planned in accordance with TVA TI ENV-TI-05.80.01 *Planning Sampling Events*, conducted according to TVA TI ENV-TI-05.80.50, *Soil and Sediment Sampling* and documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will conduct the following:

- Designate a Safety Officer
- Review applicable reference documents, including (but not limited to), TVA TIs (Section 5.5) and Standard Operating Procedures (SOPs), Quality Assurance Project Plan (QAPP; Appendix C), SAPs, and HASP.
- Complete required health and safety paperwork, field readiness checklist, and confirm field team members have completed required training
- Coordinate field activities with the Laboratory Coordinator to confirm that sample bottles and preservatives are ordered, coolers and analyte-free deionized (DI) water are obtained, and sampling and sample arrival dates are communicated to the laboratories
- Obtain required calibrated field instruments, including health and safety equipment, water level meters, and equipment needed for measuring parameters that define stability during well purging
- Discuss project objectives and potential hazards with project personnel
- Complete sample paperwork to the extent possible prior to deploying to the field, including chain-of-custody (COC) forms and sample labels
- Obtain ice prior to sample collection for sample preservation

5.2 SAMPLING METHODS AND PROTOCOL

Sampling and collection methods will be conducted in accordance with applicable TVA Technical Instructions (TIs), including:

- ENV-TI-05.80.01 *Planning Sampling Events*
- ENV-TI-05.80.02 *Sample Labeling and Custody*
- ENV-TI-05.80.03 *Field Record Keeping*
- ENV-TI-05.80.04 *Field Sampling Quality Control*
- ENV-TI-05.80.05 *Field Sampling Equipment Cleaning and Decontamination*
- ENV-TI-05.80.06 *Handling and Shipping of Samples*
- ENV-TI-05.80.42 *Groundwater Sampling*
- ENV-TI-05.80.44 *Groundwater Level and Well Depth Measurement*
- ENV-TI-05.80.46 *Field Measurement Using a Multiparameter Sonde*
- ENV-TI-05.80.50, *Soil and Sediment Sampling*

5.2.1 Pore Water and CCR Material Collection and Analysis

Pore water samples will be collected from the phreatic zone at the base of a unit, and above any applicable drainage layer, in order to obtain in-situ leaching information for the material. The analyses of actual pore water samples will provide real-time measurements of any constituents that may be leaching from the material.

Samples of CCR material will be collected from the borings advanced for the temporary wells, constructed specifically to obtain pore water samples, from both saturated and unsaturated zones in the CCR unit. These samples will be analyzed for the parameters described below, both for total concentrations and leachability, after being subjected to the most applicable leaching method based on emerging science in the industry, which could include the Synthetic Precipitation Leaching Procedure (SPLP).

The pore water and CCR material samples will be analyzed for the constituents listed in 40 CFR Part 257, Appendices III and IV, and the five inorganic constituents listed in Appendix 1 of TN Rule 0400-11-01-.04 (i.e., TDEC regulations) which include copper, nickel, silver, vanadium, and zinc. The combined Appendices III and IV constituents, and TDEC Appendix 1 inorganic constituents, will hereafter be referred to collectively as the "CCR Parameters." Total organic carbon (TOC), iron, and manganese have been added to the CCR Parameters list as specific parameters of interest under this SAP.

5.2.1.1 Water Level Measurements

Prior to sampling, each temporary well and staff gauge will be inspected for damage or indications that the well integrity has been compromised. If field observations indicate the need for well or staff gauge maintenance or repairs, the Field Team Leader will notify TVA.

After the temporary well and staff gauge integrity inspection is completed, the water level in each well and at each staff gauge will be measured in relation to a surveyed reference point (e.g., top of well casing) using an electronic water level indicator.

Pore water elevation data will be measured and recorded in accordance with TVA TI ENV-TI-05.80.44, *Groundwater Level and Well Depth Measurement*. The elevation will be recorded to the nearest 0.01 foot. To the extent possible, the field team will minimize the length of time between collection of the first and last water level measurement for the monitoring well network and staff gauges. At a minimum, measurements will be made within the same day. In addition, barometric pressure readings will be recorded daily. TVA plans to use a multi-parameter sensor equipped with a National Institute of Science & Technology (NIST) certified temperature sensor.

The water level indicator will be decontaminated between each well by following the decontamination procedures provided below in Section 5.2.7.

5.2.1.2 Well Purging

Following the measurement of water levels, monitoring wells will be purged using a dedicated pump for pore water sampling. Purging will continue until field measurements of water quality parameters stabilize during three consecutive readings at 3 to 5-minute intervals per the criteria listed in TVA TI ENV-TI-05.80.42, *Groundwater Sampling*. The stabilization criteria follow:

- pH - ±0.1;
- Specific conductivity - ±5% microSiemens per centimeter (µS/cm);
- Dissolved oxygen (DO) - ±10% for > 0.5 milligrams per Liter (mg/L) or <0.5 mg/L; and
- Turbidity - below 10 Nephelometric Turbidity Unit (NTU) or ±10% for values above 10 NTUs.

Field measurements, including pH, specific conductivity, turbidity, oxidation/reduction potential, and temperature, will be collected during purging using a flow-through cell. Once the field parameters have stabilized, samples will be collected. For low yield wells, field parameters will be measured at the time of sample collection in an open sample container using a multi-parameter probe. A final turbidity measurement will be made after each sample is collected.

If after 2 hours of purging field parameters have not stabilized, then groundwater samples will be collected and the efforts to stabilize parameters will be recorded in the field log book and field data sheet.

Purging beginning and end times, pumping rates, water quality parameter readings, and groundwater levels will be recorded throughout the purging operation on field sampling forms. The total volume purged at each well may vary based on recharge rates and stabilization of water quality parameters.

Low-flow purging techniques will be used to collect a representative sample from the water bearing unit unless the wells do not yield sufficient water. If pump settings are unknown, purging will begin at a minimum pumping rate of 0.1 liter per minute (L/min) and will be slowly increased to a setting that induces little or no drawdown, if possible. Pumping rates will not exceed 0.5 L/min. If drawdown exceeds 0.3 feet, but reaches stability, purging of the well will continue and the current flow rate, drawdown, and time will be recorded on the field data sheet by the sampler.

Low yield wells will be purged until standing water is removed. Groundwater samples will be collected with a low-flow pump, as soon as water levels return to 80% within the well bore, but no later than 24 hours after the well purge.

5.2.2 Field Equipment Description, Testing/Inspection, Calibration and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Field Team Leader, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP (Appendix C).

5.2.3 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks, and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVA TIs.

5.2.3.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.3.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks. Field logbooks will be used to record daily activities, including sample collection and tracking information.

5.2.3.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COC forms will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality control (QC) check of samples in each cooler compared to sample IDs on the corresponding COC form. The Investigation Project Manager will staff the project with a field sample manager during sample collection activities. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.2.3.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.4 Collection of Samples

5.2.4.1 Pore Water Sampling

Pore water sample collection will adhere to the TVA TI, ENV-TI-05.80.42, *Groundwater Sampling*. The sampling team leader will maintain a project field book and field forms to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

Filtered and unfiltered pore water samples will be collected once from each of the temporary well locations in appropriate, laboratory provided, pre-preserved sample containers. Samples will be collected directly from the pump discharge line.

A final reading of water quality parameters will be conducted and documented on field sampling forms at the time of sample collection, but these measurements will not be from the sample itself. Unfiltered pore water samples will be collected in appropriate, laboratory provided, pre-preserved sample containers.

The sampler will wear clean nitrile (or equivalent) gloves when handling sample containers and will not touch the interior of containers or container caps. New gloves will be used when handling each sample. When filling sample bottles, care will be taken to minimize sample aeration (i.e., water will be directed down the inner walls of the sample bottle) and avoid overfilling and diluting preservatives. Each sample bottle will be capped before filling the next bottle.

It will be necessary to collect filtered (dissolved) inorganic constituent samples, in addition to unfiltered (total) inorganic constituent samples. Dissolved sample collection will be accomplished in accordance with TVA TI ENV-TI- 05.80.42.

Issues that could affect the quality of samples will be recorded on the field data sheet or in the log book along with the action(s) taken to resolve the issue. These could include observations such as clogged sampling tubes, highly turbid samples or defective materials or equipment.

5.2.4.2 CCR Material Sampling

Boring advancement through the CCR material to the base of the unit will be in concurrence with the Plant Exploratory Drilling SAP, with CCR material collected using 3-inch diameter split-spoon samplers. Sample collection will be conducted in accordance with TVA TI ENV-TI-08.80.50, *Soil and Sediment Sampling*. Continuous sampling will be conducted until the base of the CCR unit has been reached. Split-spoons will be decontaminated between sampling locations in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*.

During construction and installation of the temporary wells (i.e., sampling locations), a CCR material grab sample will be taken from each 5-foot core boring, from the top of the unit to its base. No composite samples are proposed. Each sample will be collected with a gloved hand, properly decontaminated sample scoop, or certified clean disposable sample scoop. Field samplers will wear a new pair of disposable nitrile gloves (or equivalent) while handling each sample. The samples will be placed in a new, re-sealable bag and will be homogenized using a gloved hand or decontaminated sample scoop, certified clean disposable sample scoop and/or by kneading the material through the outside of the bag until the physical appearance is consistent over the entire sample. After homogenization, the sample will be collected from the bag and placed in the appropriate laboratory-supplied sample containers. Each sample will be submitted to the laboratory for analytical testing (refer to Section 5.2.6).

5.2.5 Preservation and Handling

Prior to placing each CCR material sample into the laboratory supplied containers, an aliquot of the homogenized sample will be tested using a field pH test kit with the results recorded in the daily field notes. Sample containers will be labeled in accordance with TVA TI ENV-05.80.02, *Sample Labeling and Custody.* Once each sample container is filled, the rim and threads will be cleaned by wiping with a clean paper towel and capped, and a signed and dated custody seal will be applied.

Each sample container will be checked to confirm that it is sealed, labeled legibly, and externally clean. Sample containers will be packaged in a manner to prevent breakage during shipment.

Coolers will be prepared for shipment in accordance with TVA ENV-TI-05.80.06, *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright position. Small uniformly sized containers will be stacked in an upright configuration and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory.

Loose ice will be placed around and among the sample containers to cool the samples to less than 6 degrees Celsius (°C) during shipment. The cooler will be filled with additional packing material to secure the containers.

The original COC form will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC form will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC form and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC form. If multiple coolers are required to ship samples contained on a single COC form, then the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e., strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC form. If there are discrepancies the Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team

Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Project Manager.

5.2.6 Sample Analyses

Pore water and CCR material samples will be submitted to the TVA-approved laboratory for analysis. Pore water samples will consist of filtered and unfiltered samples and analyzed for the CCR Parameters and additional parameters of interest. CCR material samples (both saturated and unsaturated) will be analyzed for total CCR Parameters, as well as leachability, after being subjected to the most applicable leaching method based on emerging science in the industry, which could include the SPLP, prior to an analysis for the CCR Parameters and additional parameters of interest.

All samples will be analyzed for the CCR related constituents listed in Title 40 of the Code of Federal Regulations Part 257 (40 CFR 257), Appendices III and IV. In addition, five inorganic constituents listed in Appendix 1 of TN Rule 0400-11-01-.04 (i.e., TDEC regulations), and not included in the 40 CFR 257 Appendices III and IV, will be analyzed to maintain continuity with TDEC environmental programs. The additional constituents listed in TDEC Appendix 1 include the following metals: copper, nickel, silver, vanadium, and zinc. The combined federal CCR Appendices III and IV constituents, and TDEC Appendix 1 inorganic constituents, are referred to collectively as “CCR Parameters.” Total organic carbon (TOC), manganese, and iron will be analyzed as additional parameters of interest.

Tables 2 through 5 summarize the constituents requiring analysis. Analytical methods, preservation requirements, container size, and holding times for each chemical analysis are presented in Table 6. Additional sampling and laboratory-specific information is covered in more detail in the QAPP.

Table 2. 40 CFR Part 257 Appendix III Constituents

Appendix III Constituents
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids

Table 3. 40 CFR Part 257 Appendix IV Constituents

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 Combined

Table 4. TN Rule 0400-11-01-.04, Appendix 1 Inorganic Constituents

TDEC Appendix 1 Constituents*
Copper
Nickel
Silver
Vanadium
Zinc

* Constituents not listed in CCR Appendices III and IV

Table 5. Additional Parameters of Interest

Parameters of Interest*
Total Organic Carbon (TOC)
Iron
Manganese

* Constituents not included in the CCR Parameters

Table 6. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Metals, dissolved	SW-846 6020A	HNO3 to pH < 2 & Cool to <6°C	250-mL HDPE	180 days
Metals, total	Liquid & Solid - SW-846 6020A	HNO3 to pH < 2 & Cool to <6°C; Cool to <6°C	250-mL HDPE; 4-oz glass (CCR)	180 days
Mercury, dissolved	SW-846 7470A	HNO3 to pH < 2 & Cool to <6°C	250-mL HDPE	28 days
Mercury, total	Liquid - SW-846 7470A; Solid - SW-846 7471B	HNO3 to pH < 2 & Cool to <6°C; Cool to <6°C	250-mL HDPE; 4-oz glass (CCR)	28 days
Radium 226	Liquid - SW-846 903.0; Solid - SW-846 901.1	HNO3 to pH < 2 & Cool to <6°C; Cool to <6°C	1 L glass or Plastic; One 16-oz widemouth glass jar (CCR) for both Ra 226 and 228 samples	180 days
Radium 228	Liquid - SW-846 904.0; Solid - SW-846 901.1	HNO3 to pH < 2 & Cool to <6°C; Cool to <6°C	2 L glass or plastic; See Ra 226 above for CCR	180 days
CCR Parameters	SPLP Leachability Method	Cool at <6°C	2 16-ounce glass (CCR)	28 days
Chloride	Liquid - SW-846 9056A; Solid - SW-846 9056A Modified	Cool to <6°C; Cool to <6°C	250-mL HDPE; 4-oz glass (CCR)	28 days

Table 6. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Fluoride	Liquid - SW-846 9056A; Solid - SW-846 9056A Modified	Cool to <6°C; Cool to <6°C	250-mL HDPE; 4-oz glass (CCR)	28 days
Sulfate	Liquid - SW-846 9056A; Solid - SW-846 9056A Modified	Cool to <6°C; Cool to <6°C	125-mL HDPE; 4-oz glass (CCR)	28 days
pH	Liquid - SW-846 9040C (field measurement); Solid - SW-846 9045D	NA	NA (liquids); 4-oz glass (CCR)	NA*
Total Dissolved Solids (TDS)	SM2540C	Cool to <6°C	250-mL HDPE	7 days
Total Organic Carbon (TOC)	Liquid - SM5310C; Solid - SW-846 9060A	H_2SO_4 to pH<2 & Cool to <6°C; Cool to <6°C	250-mL amber glass; 4-oz glass (CCR)	28 days

*The pH of pore water samples will be measured in the field. Holding time for CCR material pH samples is 15 minutes following creation of sample paste. CCR material samples will be tested in the field using field pH test kits, 10% of the sample locations will have confirmation samples submitted for laboratory analysis of pH and will have paste prepared in the laboratory so that analysis can be completed within the holding time.

5.2.7 Equipment Decontamination Procedures

Documented decontamination will be performed for non-dedicated sampling equipment in contact with groundwater or surface water, and drilling equipment, tooling, and instruments in contact with subsurface materials, in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination. Pumps dedicated to a specific well do not need to be decontaminated.

Decontamination activities will be performed away from surface water bodies and areas of potential impacts. Decontamination of non-disposable sampling equipment or instruments can be performed using water and Liquinox ® or other appropriate non-phosphatic detergent in 5-gallon buckets. Following decontamination, fluids will be disposed of in accordance with Section 5.2.8.

Decontamination of sampling equipment and instruments (i.e., water level meters, etc.) will be performed prior to use and between sampling locations. Decontamination activities will be documented in the logbook field notes. Additional information regarding equipment decontamination procedures is in the QAPP.

5.2.8 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- CCR material cuttings
- Purge Water
- Personnel Protection Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05. *Field Sampling Equipment Cleaning and Decontamination*, the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to pore water and CCR material sampling and analysis.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to confirm that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Project Manager considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Five types of field QA/QC samples will be collected during sampling activities: field duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, equipment blanks, field blanks, and filter blanks. QA/QC samples will be collected in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control*. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below. A complete description of the QA requirements is provided in the QAPP.

Field Duplicate Samples – One duplicate sample will be collected for every 20 samples or once per sampling event. Duplicates samples will be prepared as blind duplicates and will be collected in two sets of identical, laboratory-prepared sample bottles. The primary and duplicate samples will be labeled according to procedure in Section 6.2.1. Sample identifier information will not be used to identify the duplicated samples. Actual sample identifiers for duplicate samples will be noted in the field logbook. The duplicate sample will be analyzed for the same parameters as the primary sample.

MS/MSD Samples – A sufficient volume of sample will be collected for use as the MS/MSD. MS/MSD samples will be collected to allow matrix spike samples to be run to assess the effects of matrix on the accuracy and precision of the analyses. One MS/MSD sample will be analyzed for every 20 samples collected or once per sampling event. MS/MSD samples will be collected by filling bottles alternately by thirds in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control* into three sets of identical, laboratory-prepared sample bottles.

Additional sample volume intended for use as the MS/MSD must be identified in the comments field on the COC records and sample labels. The location of sample collection will be noted in the log book. The MS/MSD sample will be analyzed for the same analytes as the primary sample, with exception of parameters that are not amenable to MS/MSD. For parameters such as Total Suspended Solids and radium that are not amenable to the MS/MSD procedure, additional sample volume will be collected for laboratory duplicate analysis per the QAPP.

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected for every 20 samples or once per sampling event. The equipment blank will be collected at a sampling location by pouring laboratory-provided deionized water into or over the decontaminated sampling equipment, then into the appropriate sample containers. The time and location of collecting the equipment blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the equipment blank is prepared. If the tubing used to collect the filter blank is not certified clean tubing, then a tubing blank will be collected at a frequency of blank per lot.

Field Blanks – One field blank sample will be prepared per day using laboratory-supplied deionized water. The sample will be analyzed for the same analytes, with the exception of pH.

Filter Blanks – One filter blank will be collected during each day of the sampling activities when dissolved parameters are collected for analysis. The filter blank will be collected at a sampling location by passing laboratory-supplied deionized water through in-line filters used in the collection of dissolved metals, (or other analytes), then into the appropriate sample containers. The time and location of collecting the filter blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the filter blank is prepared. In addition, one filter blank will be collected per lot of filters used. The filter lot check is to be performed one per lot of filters used and scheduled in a manner to allow for laboratory to report data prior to investigative sample collection.

6.2.1 Sample Labels and Identification System

Sample IDs will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*. Each sample container will have a sample label affixed and secured with clear package tape as necessary to prevent label removal. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 7. Preliminary Schedule for CCR Material Characteristics SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
CCR Material Characteristics SAP Submittal		Completed
Prepare for Field Activities	25 Days	Following EIP Approval
Conduct Field Activities (CCR sampling, then pore water sampling)	40 Days (CCR) 20 Days (pore water)	Following Field Preparation
Laboratory Analysis	50 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Approved sampling methods and protocols may have to be substituted in the EIP based on changing field conditions.
- The proposed temporary well locations are subject to change based on ongoing site operations and conditions.
- Plant-specific safety requirements are anticipated to include TVA specified training and attendance at a safety briefing. Only Field Team members and subcontractors performing work activities will be required to meet the above requirements.
- A dedicated Safety Officer will be present for this work.
- Assessment of suitability of areas and access to sample locations, including clearing and grubbing, will be provided by TVA, and will be completed prior to the Investigation start date.

9.0 REFERENCES

Tennessee Valley Authority (TVA). 2017a. "Planning Sampling Events." Technical Instruction ENV-TI-05.80.01, Revision 0000 March 31.

Tennessee Valley Authority (TVA). 2017b. "Sample Labeling and Custody." Technical Instruction ENV-TI-05.80.02, Revision 0001 March 31.

Tennessee Valley Authority (TVA). 2017c. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017d. "Field Sampling Quality Control." Technical Instruction ENV-TI-05.80.04, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017e. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017f. "Handling and Shipping of Samples." Technical Instruction ENV-TI-05.80.06, Revision 0000 March 31.

Tennessee Valley Authority (TVA). 2017g. "Groundwater Sampling." Technical Instruction ENV-TI-05.80.42, Revision 0001. March 31.

Tennessee Valley Authority (TVA). 2017h. "Groundwater Level and Well Depth Measurement." Technical Instruction ENV-TI-05.80.44, Revision 0000. March 31

Tennessee Valley Authority (TVA). 2017i. "Field Measurement Using a Multi-Parameter Sonde." Technical Instruction ENV-TI-05.80.46, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017j. "Soil and Sediment Sampling." Technical Instruction ENV-TI-05.80.50, Revision 0000 September 29.

ATTACHMENT A
FIGURES

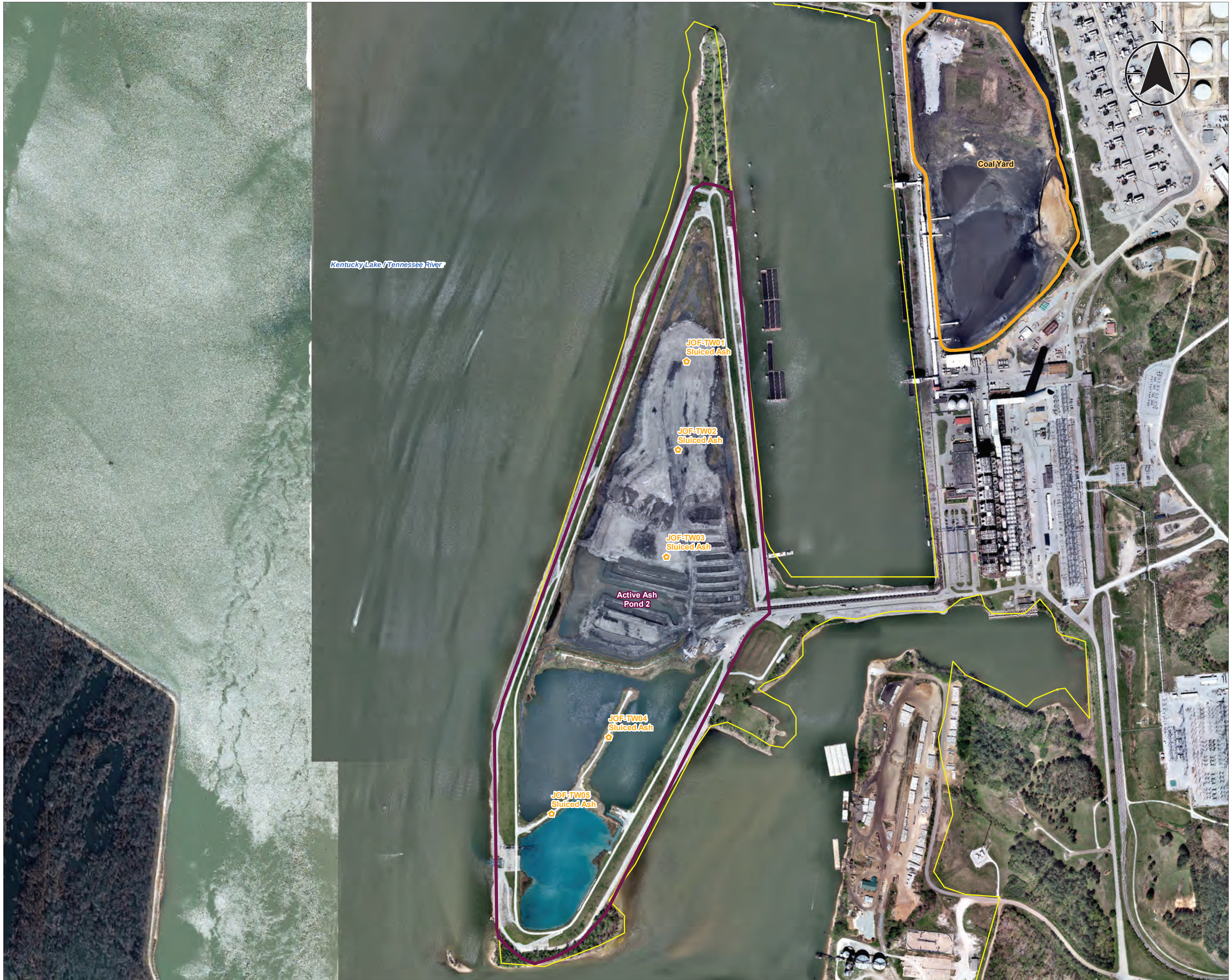

Figure No.
1

Title

Proposed Temporary Wells Active Ash Pond 2

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Proposed Temporary Well (Screened Interval)
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)

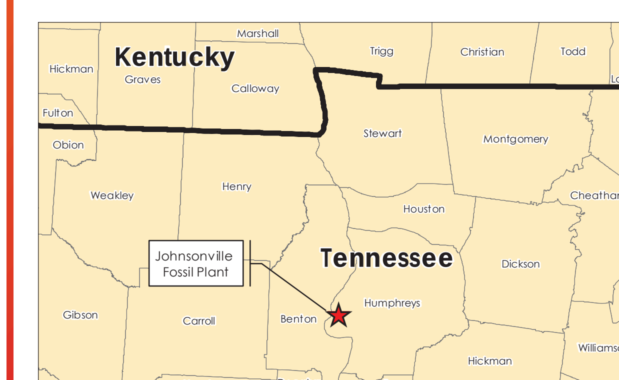

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Figure No.

2

Title **Proposed Temporary Wells Ash Disposal Area 1, Coal Yard, & DuPont Road Dredge Cell**

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296

Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Proposed Boring with Piezometer Vibrating Wire
- Proposed Temporary Well (Screened Interval)
- Existing Piezometer Open Standpipe
- Existing Piezometer Vibrating Wire
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)

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Figure No.
3

Title

Proposed Borings
South Rail Loop Area 4

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-12-06
Technical Review by ZW on 2018-12-06

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Proposed Boring with Piezometer Vibrating Wire
- Proposed Temporary Well (Screened Interval)
- Existing Piezometer Open Standpipe
- Existing Piezometer Vibrating Wire
- Unit Boundary (Approximate)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)

Stantec

TVA

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ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
CCR Material Characteristics Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment[1]
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Water level indicator meter
Peristaltic pump
Tubing
Multi-parameter Sonde
***These items are detailed in associated planning documents to avoid redundancy.**
[1]Refer to the Exploratory Drilling SAP for drilling-specific field equipment

APPENDIX O
WATER USE SURVEY SAP

Water Use Survey
Sampling and Analysis Plan
Johnsonville Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Johnsonville Fossil Plant
New Johnsonville, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 10, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	July 24, 2017
1	Addresses October 19, 2017 TDEC Review Comments and Issued for TDEC Review	January 12, 2018
2	Addresses March 9, 2018 TDEC Review Comments and Issued for TDEC Review	May 11, 2018
3	Addresses June 11, 2018 TDEC Review Comments and Issued for TDEC Review	July 20, 2018
4	Addresses comments and revisions from other EIPs and issued for TDEC review.	December 10, 2018

WATER USE SURVEY
SAMPLING AND ANALYSIS PLAN
JOHNSONVILLE FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Water Use Survey
Sampling and Analysis Plan
Johnsonville Fossil Plant
Tennessee Valley Authority
New Johnsonville, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 10, 2018 Revision 4, Final

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager — Date 12/6/18

TVA Investigation Field Lead — Date 12/6/18

Health, Safety, and Environmental (HSE) Manager — Date 12/05/2018

Investigation Project Manager — Date 12/7/2018

Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.12.03 11:52:48 -05'00'

QA Oversight Manager — Date

Laboratory Project Manager — Date 12-4-18

Charles L. Head
TDEC Senior Advisor — Date

Robert Wilkinson
TDEC CCR Technical Manager — Date

Stantec

Table of Contents

LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order), to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Johnsonville Fossil Plant (JOF) on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management at JOF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC submitted a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 24, 2017, TVA submitted JOF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

In response to TDEC's comments, TVA has developed this Water Use Survey Sampling and Analysis Plan (SAP) to conduct a water use survey and sampling of groundwater and surface water supplies within ½ mile of the boundary of the JOF Plant (Plant). This plan includes a schedule and procedures for identifying the locations and owner of each water source, soliciting permission to collect groundwater or surface water samples, sampling of water sources, and reviewing and reporting the gathered information.

2.0 OBJECTIVES

The objectives of this Water Use Survey SAP are to establish procedures for identifying and sampling existing usable water supply wells and surface water sources being used for domestic purposes located within the Survey Area (defined in Section 4.0). Sampling will assist in the evaluation of constituents that may be related to coal ash in water supply wells or surface water supplies within the survey area. TVA defines a usable water well to be one that will house a pump (even if a pump is not currently present) and does not contain an obstruction or defective construction that would prevent the insertion or operation of a pump.

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLE LOCATIONS

TVA will conduct a survey of water supplies within a ½ mile radius of the boundary of the site. The water supplies will be sampled if access is granted and if accessible for sampling. A map showing properties within ½ mile of the site boundary is provided in Attachment A. A final map displaying surveyed and sampled water supplies will be provided in the Environmental Assessment Report (EAR).

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to prepare for field activities, identify locations of domestic water supply, collect water samples, and assist in providing scientifically defensible results.

Sample collection will adhere to applicable United States Environmental Protection Agency (EPA) and TVA Environmental Technical Instruction (TI) documents. A project field book and field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will:

- Designate a Safety Officer
- Review applicable reference documents, including (but not limited to), TVA (Section 5.5) and Standard Operating Procedures (SOPs), Quality Assurance Project Plan (QAPP; Appendix C), SAPs, and HASP.
- Complete required health and safety paperwork, field readiness checklist, and confirm field team members have completed required training
- Coordinate field activities with the Laboratory Coordinator to confirm that sample bottles and preservatives are ordered, coolers and analyte-free deionized water are obtained, and sampling and sample arrival dates are communicated to the laboratories
- Obtain required functional and calibrated field instruments, including health and safety equipment
- Complete sample paperwork to the extent possible, including chain-of-custody forms and sample labels in accordance with TVA TI ENV-TI-05.80.03, *Field Record Keeping* and TVA TI ENV-TI-05.80.02, *Sample Labeling and Custody*
- Obtain ice daily prior to beginning work for sample preservation

5.2 PROPERTY AND OWNER IDENTIFICATION

Sources of information on the potential presence of private water supplies in the survey area include:

- Existing information related to the water survey area provided by TVA;
- Public and private utilities water service maps on file;
- County water well inventory records on file with TDEC; and
- Existing reports with information regarding water well and surface water supply locations.

TVA will compile information from county tax maps on properties and cross-reference sources of information to create a map of potential water supplies within the survey boundary. This map will be used to guide door-to-door surveys that seek to confirm ownership and locations of groundwater supply wells or surface water supplies used for domestic or business purposes, identify previously unknown water sources, and evaluate whether the water source is now or in the future could be used as a source of water supply.

A template for the properties identified through this data comparison process is provided as Table 1 in Attachment B. This master table will list potential properties identified via this survey where a private water supply is present and whether the supply is located within the survey area. Each property will be assigned an identification number to preserve the owner's privacy. The identification numbers will begin with "Plant specific three letter acronym-PV-00#" (or similar designation) and will be assigned sequentially as the property appears on the list, beginning with "-001". Key data relating to each property identification number (i.e. property owner, resident name, and address) will be stored and managed on a secure server.

5.3 DOOR-TO-DOOR SURVEY

This section provides a generic access agreement letter (Attachment C), example survey form (Attachment D), and procedure to be used by TVA to conduct the survey.

5.3.1 Survey Description

This survey will allow TVA to identify persons either currently using groundwater or surface water as a drinking water source or if persons have usable water wells. The updated list of survey properties will be visited by TVA personnel or their contractors to gather information using the same or similar questions to those in the example survey form (Attachment D). The door-to-door survey will be conducted between the hours of 8 am and 8 pm (to be staggered to cover a general 8-hour work day each day) to increase the likelihood that someone will be present. Locations where contact is not made will be revisited as needed, including weekend contact attempts if necessary.

TVA or their contractors will discuss the access agreement letter with each property owner to determine if access will be granted to allow sampling of their well or water supply source at a later date. In the event that access is not initially granted, TDEC will be contacted to assist in gaining access. Two copies of the access agreement letter (example in Attachment C) will be left with the property owner, one for the owner's records, and one to be signed and returned to TVA if an immediate signature is not obtained during the initial visit. If the occupant is not the property owner, then TVA will work with the occupant to contact the property owner for access.

Contact information for appropriate TVA personnel will be provided in the access agreement letter.

The survey team will consist of at least two people. To the extent possible, at least one member will be a TVA employee.

5.3.2 Well Owner Questionnaire

The personnel conducting the door-to-door survey will complete a Water Supply Well Survey Form (Attachment D) for each property owner. If necessary, the information will be supplemented with the following information if it is known by the owner:

- Well construction information, including construction material and date drilled
- Septic system type and location (if present) relative to well location
- Which taps receive treated vs untreated water
- Typical use of water (irrigation, residential water source, etc.)
- Determine if the well or source has ever gone dry or if water supply is a concern
- Water quality concerns or complaints, if any
- Number of occupants living at the location

5.3.3 Survey Information Management

Information forms will be compiled in an electronic format, such as Microsoft Excel and key data relating to each property (i.e. property owner, resident name, and address) will be stored and managed on a secure server. The information will be used to finalize a map showing homes and businesses within the survey area that TVA contacted, wells within the survey area, and locations of water sources that are used as a drinking water source or have usable water wells. The final map will indicate one of the following for each property:

- Water supply well or surface water source used as primary drinking water source
- Water supply well present and usable, is not used as primary drinking water source, but is used for other activities (e.g., irrigation)
- Water supply well present and usable, but is not currently being used
- Water supply well present but not in a usable condition (e.g., no pump is present, and the field team is unable to sample the well with field pumps)
- No water supply well or surface water supply present
- Information not available

This map will be provided to TDEC and will be used to prepare for a water supply sampling event.

5.4 SAMPLE LOCATIONS

TVA will collect samples from locations identified during the door-to-door survey that are using groundwater or surface water as a drinking water source or have usable wells and where permission has been obtained for sample collection from the owner/operator.

If sampling reveals CCR constituents present above maximum contaminant levels (MCLs) within the initial survey boundary, TVA will promptly report the information to TDEC. In the event of an emergency related to elevated CCR constituents in groundwater associated with Plant operations, TVA will work with TDEC to implement a contingency plan. As part of the contingency plan, TVA will work with TDEC to notify appropriate parties, implement necessary safety measures, and provide an alternative source of potable water.

5.5 SAMPLING METHODS AND PROTOCOL

Water supply sample collection will adhere to applicable EPA (EPA 2001) and TVA TI documents. The related TVA TIs follow:

- ENV-GAF-PW.01 *Potable Water Sampling*
- ENV-TI-05.80.01 *Planning Sample Events*
- ENV-TI-05.80.02 *Sample Labeling and Custody*
- ENV-TI-05.80.03 *Field Record Keeping*
- ENV-TI-05.80.04 *Field Sampling Quality Control*
- ENV-TI-05.80.05 *Field Sampling Equipment Cleaning and Decontamination*
- ENV-TI-05.80.06 *Handling and Shipping of Samples*
- ENV-TI-05.80.46 *Field Measurement Using a Multi-Parameter Sonde*

5.5.1 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment E. A final list of equipment will be prepared by the Field Team Leader, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by the Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP.

5.5.2 Field Documentation

Field documentation will be maintained in accordance with TVA TI *ENV-05.80.03, Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/global positioning system (GPS) documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.5.2.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.5.2.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks.

5.5.2.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COC forms will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality control (QC) check of samples in each cooler compared to sample IDs on the corresponding COC form. The Investigation Project Manager will staff the project with a field sample manager during sample collection activities. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.5.2.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.5.3 Collection of Samples

5.5.3.1 GENERAL SAMPLING PROCEDURES

Prior to sampling, a multi-parameter meter will be used to record conventional water parameters at the tap. Water quality measurement instrumentation will be calibrated and used in accordance with the QAPP. Conventional field parameters to be measured include:

- Dissolved Oxygen, (milligrams per Liter; mg/L)
- Oxidation Reduction Potential (milliVolts; mV)
- pH (Standard units)
- Specific Conductance (microSiemens per centimeter [µS/cm] in accordance with ENV-TI-05.80.42)
- Temperature (degrees Celsius; C°)
- Turbidity (Nephelometric turbidity units; NTU)

The sampling point will be selected from within the system as close to the well head as possible but prior to the addition of water softeners, filters, and treatment systems when possible. If a sample cannot be collected prior to a water treatment device, then the type of treatment device will be documented in the field logbook. Aerators and screens/fixtures attached to the faucet will be removed prior to sampling, if possible. The system will be purged by allowing cold water to run for at least 15 minutes. If there is an inline tank prior to the sampling tap, enough water will be purged to complete a full exchange of water in the tank after the 15-minute purge has been completed. During purging, field parameters will be measured every 3-5 minutes to assess stability. If water quality parameters have not stabilized after purging for 15 minutes, then TVA will note that they have not stabilized, record the final field parameter values, and collect a sample.

5.5.3.2 WATER SUPPLY SAMPLING FROM A TAP

TVA and its contractors will collect samples in accordance with the procedures provided in the QAPP. Water samples will be collected directly from a faucet or pipe valve (with any screens/fixtures removed, if possible) into laboratory-supplied bottleware or will be collected from the screenless/fixtureless faucet into laboratory-supplied bottleware utilizing new, clean sample tubing connected to the tap/faucet after completion of system purging. The tubing will be connected to the tap/faucet via a properly decontaminated adapter with a ribbed nipple that will be screwed on the faucet outlet. The tubing will be flushed for at least three minutes prior to sampling. The sample will be collected at the indoor or outdoor tap closest to the wellhead, prior to any water treatment devices. If a sample cannot be collected prior to a water treatment device, then the type of treatment device will be documented in the field logbook.

5.5.3.3 WATER SUPPLY WELL SAMPLING WHERE THERE IS NO TAP

Water supply wells that do not have a tap will be sampled in a manner that allows collection of samples that will be representative of ambient groundwater quality. This typically requires that the well is purged to remove stagnant water prior to sample collection. For wells that have existing pumps, purging will be conducted in a manner to minimize disturbance of water in the well bore by pumping at low rates. If wells without functioning pumps installed are identified during the initial sampling event, then a second visit to the property may be required for sample collection. Available information regarding the condition of the well and the equipment needed to collect a sample will be recorded in the field logbook during the initial visit to the property.

The methods to be used for sample collection are provided in the TIs and ENV-GAF-PW.01, *Potable Water Sampling* which describes use of bailers, peristaltic, or submersible pumps for sample collection at wells where there is no tap or existing pump. Water samples will be collected directly from a pump discharge point directly into laboratory-supplied bottleware or will be collected from the pump into laboratory-supplied bottleware following completion of system purging utilizing new, clean sample tubing which has been connected to the pump and flushed for three minutes.

5.5.4 Preservation and Handling

Sample containers will be labeled in accordance with TVA TI ENV-05.80.02, *Sample Labeling and Custody.* Once each sample container is filled, the rim and threads will be cleaned by wiping with a clean paper towel and capped, and a signed and dated custody seal will be applied. Each sample container will be checked to confirm that it is sealed, labeled legibly, and externally clean. Sample containers will be packaged in a manner to prevent breakage during shipment.

Coolers will be prepared for shipment in accordance with TVA TI ENV-05.80.06, *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright position. Small uniformly sized containers will be stacked in an upright configuration and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory. Gel ice or loose ice will be placed around and among the sample containers to cool the samples to less than 6 degrees Celsius (°C) during shipment. The cooler will be filled with additional packing material to secure the containers.

The original COC form will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC form will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC form and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC form.

If multiple coolers are required to ship samples contained on a single COC form the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e., strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC form. If there are discrepancies the Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Project Manager.

5.5.5 Sample Analyses

Samples will be submitted to the TVA-approved laboratory for analysis. Samples will be analyzed for the CCR related constituents listed in Title 40 of the Code of Federal Regulations Part 257 (40 CFR 257), Appendices III and IV. In addition, five inorganic constituents listed in Appendix 1 of TN Rule 0400-11-01-.04 (i.e., TDEC regulations), and not included in the 40 CFR 257 Appendices III and IV, will be analyzed to maintain continuity with TDEC environmental programs. The additional constituents listed in TDEC Appendix 1 include the following metals: copper, nickel, silver, vanadium, and zinc. The combined federal CCR Appendices III and IV constituents, and TDEC Appendix 1 inorganic constituents, will hereafter be referred to collectively as “CCR Parameters.”

For geochemical evaluation, major cations/anions not included in the CCR Parameters are included in the analyses for this SAP. The additional geochemical parameters include magnesium, potassium, sodium, carbonate, and bicarbonate.

Tables 1 through 4 summarize the constituents requiring analysis. Analytical methods, preservation requirements, container size, and holding times for each chemical analysis are presented in Table 5. Additional sampling and laboratory specific information is covered in more detail in the QAPP.

Table 1. 40 CFR Part 257, Appendix III Constituents

Appendix III Constituents
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids

Table 2. 40 CFR Part 257, Appendix IV Constituents

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 Combined

Table 3. TN Rule 0400-11-01-.04, Appendix 1 Inorganic Constituents*

TDEC Appendix 1 Constituents*
Copper
Nickel
Silver
Vanadium
Zinc

* Constituents not listed in CCR Appendices III and IV

Table 4. Additional Geochemical Parameters

Major Cations/Anions
Bicarbonate
Carbonate
Magnesium
Potassium
Sodium

* Constituents not included in the CCR Parameters

Table 5. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Metals, dissolved	EPA 200.8	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Metals, total	EPA 200.8	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Mercury, dissolved	EPA 245.1	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Mercury, total	EPA 245.1	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Radium 226	EPA 903.0	HNO3 to pH < 2 Cool to <6°C	1 L glass or Plastic	180 days
Radium 228	EPA 904.0	HNO3 to pH < 2 Cool to <6°C	2 L glass or plastic	180 days
Chloride	EPA 300.0	Cool to <6°C	250-mL HDPE	28 days
Fluoride	EPA 300.0	Cool to <6°C	250-mL HDPE	28 days
Sulfate	EPA 300.0	Cool to <6°C	250-mL HDPE	28 days
pH	SW-846 9040C (field measurement)	NA	NA	15 minutes
Total Dissolved Solids	SM2540C	Cool to <6°C	250-mL HDPE	7 days
Alkalinity (Total, Carbonate, and Bicarbonate)	SM2320B	Cool to <6°C	250-mL HDPE	14 days

The pH of groundwater samples will be measured in the field.

5.5.6 Equipment Decontamination Procedures

Documented decontamination will be performed for non-dedicated sampling equipment and instruments that in contact with groundwater or surface water in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination.

Decontamination activities will be performed away from surface water bodies and areas of potential impacts. Decontamination of non-disposable sampling equipment or instruments can be performed using water and Liquinox® or other appropriate non-phosphatic detergent in 5-gallon buckets. Following decontamination, fluids will be disposed in accordance with Section 5.5.7

Decontamination of sampling equipment and instruments (i.e., water level meters, etc.) will be performed prior to use and between sampling locations. Decontamination activities will be documented in the logbook field notes. Additional information regarding equipment decontamination procedures is located in the QAPP.

5.5.7 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*, the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to the Water Use Survey SAP.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to confirm that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Project Manager considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Five types of field QA/QC samples will be collected during sampling activities: field duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, equipment blanks, field blanks, and filter blanks. QA/QC samples will be collected in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control*. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below. A complete description of the QA requirements is provided in the QAPP.

Field Duplicate Samples – One field duplicate sample will be collected for every 20 samples or once per sampling event. Duplicates samples will be prepared as blind duplicates and will be collected in two sets of identical, laboratory-prepared sample bottles. The primary and duplicate samples will be labeled according to procedure in Section 6.2.1. Sample identifier information will not be used to identify the duplicated samples. Actual sample identifiers for duplicate samples will be noted in the field logbook. The duplicate sample will be analyzed for the same parameters as the primary sample.

MS/MSD Samples – A sufficient volume of sample will be collected for use as the MS/MSD. MS/MSD samples will be collected to allow matrix spike samples to be run to assess the effects of matrix on the accuracy and precision of the analyses. One MS/MSD sample will be analyzed for every 20 samples collected or once per sampling event. MS/MSD samples will be collected filling bottles alternately by thirds in accordance with ENV-TI-05.80.04, *Field Sampling Quality Control* into three sets of identical, laboratory-prepared sample bottles. Additional sample volume intended for use as the MS/MSD must be identified in the comments field on the COC records and sample labels.

The location of sample collection will be noted in the log book. The MS/MSD sample will be analyzed for the same analytes as the primary sample, with exception of parameters that are not amenable to MS/MSD. For parameters such as Total Suspended Solids and radium that are not amenable to the MS/MSD procedure, additional sample volume will be collected for laboratory duplicate analysis per the QAPP.

For parameters such as Total Suspended Solids and radium that are not amenable to the MS/MSD procedure, additional sample volume will be collected for laboratory duplicate analysis per the QAPP.

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected for each sampling event. The equipment blank will be collected at a sampling location by pouring laboratory-provided deionized water into or over the decontaminated sampling equipment, then into the appropriate sample containers. The time and location of collecting the equipment blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the equipment blank is prepared. If the tubing used to collect the filter blank is not certified clean tubing, then a tubing blank will be collected at a frequency of blank per lot.

Field Blanks: One field blank sample will be prepared per day using laboratory-supplied deionized water. The sample will be analyzed for the same analytes, with the exception of pH.

Filter Blanks – One filter blank will be collected during each day of the sampling activities when dissolved parameters are collected for analysis. The filter blank will be collected at a sampling location by passing laboratory-supplied deionized water through in-line filters used in the collection of dissolved metals, (or other analytes), then into the appropriate sample containers. The time and location of collecting the filter blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the filter blank is prepared. In addition, one filter blank will be collected per lot of filters used. The filter lot check is to be performed one per lot of filters used and scheduled in a manner to allow for laboratory to report data prior to investigative sample collection.

6.2.1 Sample Labels and Identification System

Sample IDs will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*. Each sample container will have a sample label affixed and secured with clear package tape as necessary to prevent label removal. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of the water use survey and sampling are summarized in Table 6 below. This schedule is preliminary and subject to change based on approval of this SAP, site conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 6. Preliminary Schedule for Water Use Survey Activities

Project Schedule		
Task	**Duration**	**Notes**
Water Use Survey SAP Submittal		Completed
Field Activities Preparation	90 Days	Following EIP Approval
Field Activities Implementation	65 Days	Following Field Preparation
Lab Analysis	50 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Private water sources will only be sampled and measured when access is granted. The Field Team Leader will record the address and information provided by the owner when access is not granted.
- This scope of work does not include the repair of wells or pumps. Wells or pumps in a condition that will not allow sampling will be noted in the field logbook.

9.0 REFERENCES

Environmental Protection Agency (EPA) Region 4. 2001. "Environmental Investigations Standard Operating Procedures and Quality Assurance Manual." November.

Tennessee Valley Authority (TVA). 2016. "Potable Water Sampling." Technical Instruction ENV-GAF-PW.01, Revision 0. August 29.

Tennessee Valley Authority (TVA). 2017a. "Planning Sampling Events." Technical Instruction ENV-TI-05.80.01, Revision 0001 March 31.

Tennessee Valley Authority (TVA). 2017b. "Sample Labeling and Custody." Technical Instruction ENV-TI-05.80.02, Revision 0001. March 31.

Tennessee Valley Authority (TVA). 2017c. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017d. "Field Sampling Quality Control." Technical Instruction ENV-TI-05.80.04, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017e. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017f. "Handling and Shipping of Samples." Technical Instruction ENV-TI-05.80.06, Revision 0000 March 31.

Tennessee Valley Authority (TVA). 2017g. "Field Measurement Using a Multi-Parameter Sonde." Technical Instruction ENV-TI-05.80.46, Revision 0000. March 31.

ATTACHMENT A
½ MILE RADIUS MAP

Figure No.
1

Title

JOF ½ Mile Radius Map

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

Humphreys County, Tennessee

175567296

Prepared by TR on 2017-06-09
Technical Review by ZW on 2017-06-09

0 800 1,600 2,400 3,200 Feet

1:9,600 (At original document size of 22x34)

Legend

Approximate TVA Property

TVA Property 1/2 Mile Buffer

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TVA (April, 2016) & ESRI Basemaps
3. TVA property boundary is referenced from TVA Drawing 421K 563 R2 Johnsonville Steam Plant Area (March 1952).

Stantec

TVA

ATTACHMENT B
PRIVATE WATER WELL LIST TEMPLATE

Stantec

Table 1
Water Supply Survey List
Template

KIF ID No.	KIFPV-001	KIFPV-002	KIFPV-003
Owners Name			
Property Address			
Alt. Property Address			
Mailng Address			
Stewart County Tax Assessor's Map No.			
Dwelling/Building Present? Y/N			
Data Source			
Municiple Water at This Location? Y/N			
Door-to- Door Survey? Y/N			
Comments			

ATTACHMENT C
GENERIC ACCESS AGREEMENT LETTER

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

Date: ____________________

Address:

____
____
____

SUBJECT: Access for Water Supply Survey

Dear Well Owner,

The Tennessee Valley Authority (TVA) is working with the Tennessee Department of Environment and Conservation (TDEC) to evaluate environmental conditions in and around the Kingston Fossil Plant. One of these activities is to conduct sampling of private well water. TVA would like to sample your well, and to do so, we need your written permission.

The purpose of this letter is to ask your permission, as the property owner, to allow TVA, its contractor, and their respective subcontractors and agents to conduct a water supply survey at your property located at [insert address]. A signed access agreement will allow TVA and its contractor to survey your well. An access agreement is provided at the end of this letter. If you are renting or leasing the property and/or are not the legal property owner, please let TVA know and we will work to contact the owner for this permission.

TVA would coordinate the timing of this work with you to minimize any inconvenience. The work would be conducted on weekdays, during normal business hours, and you would need to be present. However, we will work with you to schedule the work for a day when you are available. We hope to complete this work during June or July 2017 or as soon as we can schedule it with you; additional sampling may be requested for later dates, and this access agreement is also meant to cover future sampling.

The field staff will ask you about the location of the water supply entering your home and if your home has a water treatment system. Should water sampling be necessary they will try to collect a sample between the water well and the water treatment system, if you have one. Otherwise they will try to sample closest to the water entry point. In many cases, this will be a tap on the exterior of your home. The sampling activity involves filling sample bottles with tap water and will take approximately 30 minutes.

All TVA and contractor field staff would be identifiable by bright yellow safety vests and/or identification badges. No work would be performed at your property without your permission. Our field staff may need to go into your home, and they will be instructed to provide you with an

ID and a phone number should you wish to confirm with TVA that they are authorized personnel. The field staff would be available to answer any questions you may have during the well sampling.

You can also contact the following person if you have any questions:

If you agree to allow TVA, its contractor, and their respective subcontractors and agents access to your property to survey and/or sample your well water as described above, we ask that you sign this letter where indicated below and return it to TVA. So that you may also keep a copy for your records, we have provided a duplicate of this letter.

Thank you for considering participation in this well sampling program. Yours

sincerely,

CC:

As the owner(s) of the property located at, __________________ I/we hereby agree to allow TVA its contractor, and their subcontractors and agents the access described above.

Owner(s) Signature: ____

Owner(s) Printed Name: ____

Date(s) Signed by Owner(s): ____

Contact Phone Number: ____
(To be used only to coordinate sampling activities)

Contact email: ____

ATTACHMENT D
EXAMPLE DOOR-TO-DOOR SURVEY

Survey Team No.	Property Identification No.
	KIF-SW-

GPS Coordinates: ____________________

Date: ___________________

Name:
Property Address:
Mailing Address:
E-mail Address:
Telephone Number:
1 Is there a well or surface water supply on the property?
2 If any, how many wells or surface water supplies are on the property?
3 Is this a drinking water or irrigation water supply (circle one)?
4 When was the last time water from the water supply was used?
5 Does the water supply on the property have a pump and is it operational?
6 How deep is the well or wells?
7 Do you have a septic system on the property?
8 Do you have municipal water and/or sewer? (circle all that apply)
9 Have any odors from the water been detected?
10 Has any discoloration in the water or staining in the sinks, tubs, ect. been observed?
11 Where on the property is the water supply located?
12 Can we walk over and see the well or surface water supply?
13 Can we return and take a sample of your water supply?
14 Do you treat your well or surface water supply water? Do you use a treatment system such as reverse osmosis system, filtration, or water softening unit?
15 Was Access Agreement provided to the water supply owner?
16 Was Access Agreement signed by water supply owner and provided to survey team?
Key Observations for Surveyor to Note: -Mark the well(s)/surface water supply and/or septic system location on the property map, or draw a diagram of these locations relative to the dwelling and other buildings. -Describe the location(s) where the water supply can be accessed for sampling. Make sure you note if there is a sampling location located up flow of (before) any water treatment unit (if present). -Is there a spigot at the wellhead that can be used for sampling? -Provide a business card with TVA contact information for follow-up questions from the property owner.
Survey Complete (Circle One) Y N
General Notes or Drawing:

ATTACHMENT E
FIELD EQUIPMENT LIST

Field Equipment List
Water Use Survey

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
Field Equipment[1]
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Flow measurement supplies (for example: graduated cylinder and stop watch)
Multiparameter Sonde with flow-through cell
Turbidity meter
***These items are detailed in associated planning documents to avoid redundancy.**
[1]Refer to the Exploratory Drilling SAP for other drilling-specific field equipment

APPENDIX P
GROUNDWATER MONITORING DATA

Figure No.

1

Title

Existing and Closed Wells Johnsonville Fossil Plant

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296

Prepared by LMB on 2018-04-11
Technical Review by ZW on 2018-04-11

0 700 1,400 2,100 2,800 Feet

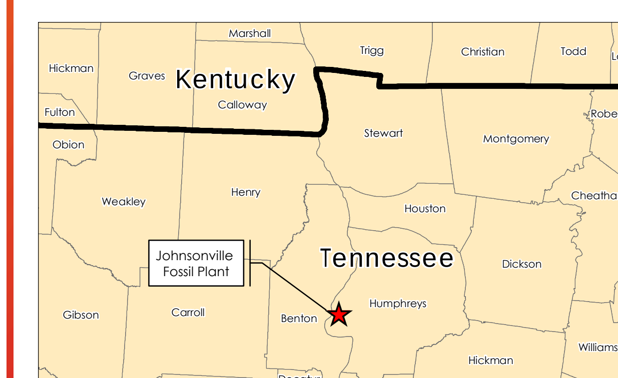
1:8,400 (At original document size of 22x34)

Legend

- Closed Well
- CCR Well
- CCR/State Monitoring Well
- State Compliance Monitoring Well
- Observation Well
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TVA (2017) & ESRI Basemaps



Stantec

TVA

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Table 1A

Groundwater Chemical Data

Well ID	Historical Well ID Ref.	Date	Inorganics																															Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	**TDEC**	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**-**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**100**	**10^**	**-**	**50**	**-**	**100**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
		EPA	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**1300~**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**-**	**1^^**	**-**	**50**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
JOF-10-AP1	10-AP1	03/16/11	420	<1	4.4	44	<2	6300	<0.5	98	<2	21	<2	2900	<1	--	17	3500	<0.2	<5	27	--	1.3	<1	--	<1	360	22	<1	--	--	<10	15	21	0.16	300
		09/14/11	<100	<1	4.8	44	<2	8100	<0.5	110	<2	11	<2	2500	<1	--	18	2300	<0.2	6.6	30	--	1.2	2.8	--	<1	400	20	<1	--	--	<10	21	21	0.14	320
		03/21/12	120	<1	3.6	35	<2	7500	<0.5	110	<2	<10	<2	2200	<1	--	18	1500	<0.2	<5	29	--	0.92	<1	--	<1	380	18	<1	--	--	<10	18	22	0.13	340
		09/19/12	--	<1	3.5	35	<1	--	<0.5	--	<2	--	--	--	<1	--	--	--	<0.2	--	36	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	0.18	--
		03/20/13	--	<1	2.4	37	<1	--	<0.5	--	<2	--	--	--	<1	--	--	--	<0.2	--	36	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	0.16	--
		09/25/13	--	<1	2	33.8	<1	--	<1	--	1	--	--	--	<1	--	--	--	<0.2	--	29.4	<0.25	--	<1	--	<0.5	--	--	<1	--	--	--	--	--	<0.4	--
		03/12/14	--	<1	2.1	33.5	<1	--	<1	--	<1	--	--	--	<1	--	--	--	<0.2	--	32.7	<0.25	--	<1	--	<0.5	--	--	<1	--	--	--	--	--	<0.4	--
		09/09/14	--	<1	1.6	34	<5	--	0.5	--	<2	--	--	--	<1	--	--	--	<0.2	--	39	<0.1	--	3.6	--	<1	--	--	<1	--	--	--	--	--	0.16	--
		09/23/15	--	<2	2.17	28.6	<2	--	<1	--	<2	5	<5	--	<2	--	--	--	<0.2	--	31.8	<0.1	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	0.125	--
		03/22/16	--	<2	<2	29.9	<2	--	<1	--	<2	4.51	<5	--	<2	--	--	--	<0.2	--	32.4	<0.1	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	0.177	--
		09/21/16	--	<2	<2	29.5	<2	7620	<1	107	<2	3.73	<5	--	<2	<15	--	--	<0.2	<5	32.1	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	22.3	0.108	345
JOF-10-AP2	10-AP2	03/16/11	230	<1	4.9	71	<2	<200	<0.5	140	<2	58	<2	4100	<1	--	14	13000	<0.2	<5	36	--	0.94	<1	--	<1	280	77	<1	--	--	<10	16	23	0.15	820
		09/14/11	<100	<1	3.2	41	<2	<200	0.83	130	<2	34	<2	2800	<1	--	14	8300	<0.2	7.3	35	--	0.94	1	--	<1	260	80	<1	--	--	<10	18	24	0.13	440
		03/21/12	180	<1	2.3	33	<2	<200	2.2	170	<2	15	<2	2700	<1	--	18	4900	<0.2	9	39	--	0.73	1	--	<1	320	93	<1	--	--	<10	24	32	0.12	610
		09/19/12	--	<1	2.6	41	<1	--	1.1	--	14	--	--	--	<1	--	--	--	<0.2	--	52	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	0.12	--
		03/20/13	--	<1	1.8	31	<1	--	2.8	--	2.1	--	--	--	<1	--	--	--	<0.2	--	48	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	0.17	--
		09/25/13	--	<1	1.8	25.8	<1	--	2.1	--	1.3	--	--	--	<1	--	--	--	<0.2	--	39.2	<0.25	--	<1	--	<0.5	--	--	<1	--	--	--	--	--	<0.4	--
		03/12/14	--	<1	1.6	25.2	<1	--	2.7	--	<1	--	--	--	<1	--	--	--	<0.2	--	43.1	<0.25	--	<1	--	<0.5	--	--	<1	--	--	--	--	--	<0.4	--
		09/09/14	--	<1	1.6	27	<1	--	2.7	--	<2	--	--	--	<1	--	--	--	<0.2	--	52	<0.1	--	2	--	<1	--	--	<1	--	--	--	--	--	0.16	--
		09/23/15	--	<2	<2	19.8	<2	--	2.56	--	<2	13.9	<5	--	<2	--	--	--	<0.2	--	40.6	<0.1	--	<2	--	<2	--	--	<2	--	--	<5	31.6	--	0.115	--
JOF-10-AP3	10-AP3	03/16/11	1300	<1	<1	26	<2	5300	4	250	<2	55	<2	1100	<1	--	26	20000	<0.2	<5	**110**	--	5.6	<1	--	<1	630	34	<1	--	--	<10	75	36	<0.1	780
		04/21/11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	84	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		09/14/11	210	<1	1.2	21	<2	5700	4	240	<2	47	3	750	<1	--	23	17000	<0.2	8.6	**110**	--	5.4	1.2	--	<1	590	36	<1	--	--	<10	68	32	<0.1	730
		03/21/12	710	<1	1.4	21	<2	6300	3.7	240	<2	46	<2	1900	<1	--	23	16000	<0.2	6.3	93	--	5.2	1.1	--	<1	580	38	<1	--	--	<10	56	32	<0.1	730
		09/19/12	--	<1	1.6	21	<1	--	4.7	--	<2	--	--	--	<1	--	--	--	<0.2	--	**120**	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	<0.1	--
		03/20/13	--	<1	<1	20	<1	--	**5.8**	--	<2	--	--	--	<1	--	--	--	<0.2	--	**120**	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	<0.1	--
		09/25/13	--	<1	<2	19.6	<1	--	**5.1**	--	1.2	--	--	--	<1	--	--	--	<0.2	--	**104**	<0.25	--	<2	--	<1	--	--	<1	--	--	--	--	--	<0.4	--
		03/12/14	--	<1	<2	18.7	<1	--	**5.1**	--	1.3	--	--	--	<1	--	--	--	<0.2	--	**104**	<0.25	--	<2	--	<1	--	--	<1	--	--	--	--	--	<0.4	--
		09/09/14	--	<1	1.3	22	<1	--	**5.9**	--	<2	--	--	--	<1	--	--	--	<0.2	--	**120**	<0.1	--	3	--	<1	--	--	<1	--	--	--	--	--	<0.1	--
		09/23/15	--	<2	<2	16.8	<2	--	**5.1**	--	<2	40.1	<5	--	<2	--	--	--	<0.2	--	**101**	<0.1	--	<2	--	<2	--	--	<2	--	--	<5	77	--	<0.1	--
		03/22/16	--	<2	<2	17.5	<2	--	**5.87**	--	<2	38.9	<5	--	<2	--	--	--	<0.2	--	**101**	<0.1	--	<2	--	<2	--	--	<1	--	--	<5	74.9	--	<0.1	--
		09/22/16	--	<2	<2	15.8	<2	6130	**5.02**	218	<2	36.8	<5	--	<2	<15	--	--	<0.2	<5	94.4	--	--	<2	--	<2	--	--	<1	--	--	<5	66.8	30.4	<0.1	752
JOF-A1	A-1	02/11/82	<50	<2	<1	2	<0.5	<500	0.1	14	2	--	9	81	<1	--	1.1	14	<0.2	--	10	<0.01	--	<1	--	<10	--	2.1	<50	--	--	--	21	2	--	33
		03/24/82	--	<2	1	<100	--	--	<0.1	17	<1	--	40	250	<1	--	1.3	20	<0.2	--	7	--	--	<1	--	<10	--	2.2	--	--	--	--	20	--	--	5
		04/13/82	--	--	<1	<100	--	--	<0.1	18	<1	--	30	240	<1	--	1.4	50	<0.2	--	2	--	--	1	--	<10	--	2.1	--	--	--	--	20	--	--	5
		05/25/82	--	--	<1	<100	--	--	<0.1	18	2	--	20	350	8	--	1.4	40	<0.2	--	1	--	--	<1	--	<10	--	2	--	--	--	--	<10	--	--	5
		08/11/88	160	--	<1	<10	--	<500	<0.1	20	<1	<1	40	3900	9	<10	1.8	100	--	<20	7	--	2.8	<1	--	<10	<50	2.1	--	<50	--	<10	40	1	--	8
		06/20/90	12000	2	<1	190	--	7500	**23**	220	10	--	10	100000	320	<10	72	24000	--	<20	**290**	--	19	<1	12000	--	570	200	--	--	--	60	580	120	--	1000
		09/04/90	<50	<1	<1	40	--	<500	0.2	18	<1	--	20	2500	2	<10	1.2	130	--	<20	2	--	2.4	<1	3300	--	80	2.5	--	--	--	<10	40	2	--	7
		09/04/90	<50	<1	<1	<10	--	<500	0.2	18	<1	--	20	2500	4	<10	1.1	110	--	<20	4	--	2.3	<1	3200	--	70	2.5	--	--	--	<10	20	2	--	5
		12/11/90	<50	<1	<1	<10	--	<500	<0.1	19	<1	--	<10	4300	2	<10	1.1	120	--	<20	2	--	2.2	3	5100	--	60	2.4	--	--	--	<10	<10	2	--	88
		12/11/90	<50	<1	<1	<10	--	<500	<0.1	19	<1	--	<10	4500	2	<10	1.2	110	--	<20	1	--	2.1	<1	4600	--	<50	3.1	--	--	--	<10	<10	2	--	<1
		03/05/91	190	<1	<1	200	--	<500	0.5	50	2	--	<10	220	3	<10	3.6	<5	--	<20	7	--	0.42	<1	4800	--	370	2.7	--	--	--	<10	<10	3	--	<1
		06/25/91	240	<1	2	<10	--	<500	0.3	19	1	--	<10	14000	2	<10	1.5	110	--	<20	14	--	2.4	<1	4400	--	<50	2.6	--	--	--	<10	780	3	--	2
		09/24/91	70	<1	<1	40	--	<500	<0.1	19	<1	--	10	9700	1	<10	1.5	150	--	<20	4	--	2.2	1	1700	--	<50	2.3	--	--	--	<10	<10	3	--	3
		09/24/91	60	<1	<1	30	--	<500	3	18	<1	--	10	10000	1	<10	1.5	190	--	<20	4	--	2.1	2	1700	--	<50	2.3	--	--	--	<10	<10	2	--	3
		12/04/91	<50	--	<1	<10	--	<500	<0.1	20	26	--	80	15000	1	<10	1.8	290	--	--	4	--	2.1	<1	2200	--	140	2.3	--	--	--	<10	70	2	--	<1
		03/17/92	110	--	<1	<10	--	<500	0.2	17	<1	--	<10	11000	2	<10	0.3	140	--	<20	3	--	2.1	<1	6100	--	<80	1.7	--	--	--	<10	70	1	--	2

Well ID	Historical Well ID Ref.	Date	Inorganics																															Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	TDEC	-	6	10	2000	4	-	5	-	100	-	-	-	15~	-	-	-	2	-	100	10^	-	50	-	100	-	-	2	-	-	-	-	-	4	-
		EPA	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
JOF-A1 (cont.)	A-1	03/17/92	70	--	<1	20	--	<500	0.1	16	<1	--	<10	9900	2	<10	0.2	130	--	<20	<1	--	2.1	<1	5600	--	<80	1.7	--	--	--	<10	30	1	--	1
		06/10/92	<50	--	<1	<10	--	<500	0.2	16	<1	--	<10	2600	<1	10	1.2	72	--	--	4	--	2.1	--	4900	--	<80	2	--	--	--	--	<10	1	--	120
		09/01/92	60	--	<1	<10	--	<500	0.1	17	<1	--	<10	4100	<1	<10	1.2	110	--	--	6	--	2.2	--	5100	--	<50	2	--	--	--	--	<10	2	--	3
		12/14/92	70	<1	1	<10	--	<500	0.2	17	<1	--	<10	6500	2	<10	1.2	140	--	<20	6	--	2.3	<1	--	--	<50	2.3	--	--	--	<10	<10	2	--	2
		06/07/93	250	<1	<1	<10	--	<500	<0.1	16	<1	--	<10	930	<1	<10	1.2	95	--	<20	6	--	2.1	--	--	--	<50	1.8	--	--	--	--	20	2	--	7
		06/07/93	190	<1	1	<10	--	<500	<0.1	16	<1	--	<10	1600	<1	<10	1.2	130	--	<20	5	--	2.2	--	--	--	<50	2	--	--	--	--	20	2	--	7
		03/07/94	210	<1	<1	<10	--	<500	0.1	17	1	--	<10	8000	5	<10	1.2	140	--	<20	12	--	2.2	--	--	--	<50	2	--	--	--	--	60	2	--	<2
		09/20/94	50	<1	<1	<10	--	<500	<0.1	16	<1	--	<10	640	<1	<10	1.2	100	--	<20	8	--	2.1	--	--	--	<50	1.9	--	--	--	--	40	2	--	5
		03/19/98	620	<1	<1	<10	<1	<500	<0.1	15	7	<1	<10	3200	3	--	1.3	47	0.2	--	12	--	2.6	<1	--	<10	<50	2	<2	--	--	<10	60	2	0.3	4
		03/19/98	170	<1	<1	<10	<1	<500	<0.1	15	<1	<1	<10	1400	<1	--	1.2	41	<0.2	--	5	--	2	<1	--	<10	<50	1.8	<2	--	--	<10	10	2	0.3	5
		09/15/98	160	<1	1	<10	<1	<200	<0.1	16	8	4	10	4000	2	--	1.1	130	<0.2	--	12	--	2	<1	--	<10	<50	2.1	<2	--	--	<10	40	2	0.5	4
		09/15/98	<50	<1	<1	<10	<1	<200	<0.1	14	1	1	<10	1300	<1	--	1.1	42	<0.2	--	5	--	1.9	<1	--	<10	<50	1.7	<2	--	--	<10	10	2	0.4	6
		03/10/99	220	1	1	10	1	200	0.1	16	12	6	20	6000	5	--	1.3	75	0.2	--	67	--	2.1	1	--	10	50	2.1	2	--	--	10	120	2	0.3	2
		03/10/99	50	1	1	10	1	200	0.1	14	5	1	10	1700	4	--	1.2	48	0.2	--	5	--	2	1	--	10	50	2	2	--	--	10	10	2	0.4	8
		09/10/99	50	1	1	10	1	200	0.1	16	12	17	10	4000	1	--	1.2	83	0.2	--	21	--	2.1	1	--	10	50	2	2	--	--	10	50	2	0.3	8
		03/07/00	50	1	1	23	1	200	0.1	15	6.8	15	10	1800	1	--	1	84	0.2	<20	6.8	--	2.3	1	3700	10	50	2.1	2	50	5	10	23	3	0.4	14
		09/19/00	8900	<1	<1	11	1	<200	0.4	16	8.2	4.4	<10	6600	9.6	--	1.5	320	<0.2	--	15	--	2.2	<1	--	<10	<50	1.8	<2	170	27	<10	100	2	0.4	9
		03/20/01	<50	<1	<1	<10	<1	<200	<0.1	16	<1	<1	<10	5300	<1	--	1.3	70	<0.2	<20	<1	--	1.8	<1	4500	<10	<50	1.6	<2	<50	<5	<10	<10	2.3	0.34	7
JOF-A2	A-2	02/11/82	<50	<2	<1	7	<0.5	<500	<0.1	18	7	--	7	1300	1	--	1.2	280	<0.2	--	42	<0.01	--	<1	--	<10	--	2.2	<50	--	--	--	19	1	--	11
		03/24/82	--	<2	1	<100	--	--	<0.1	23	1	--	50	1600	<1	--	1.6	290	<0.2	--	7	--	--	<1	--	<10	--	2.2	--	--	--	--	20	--	--	9
		04/13/82	--	--	<1	<100	--	--	<0.1	22	<1	--	30	1400	<1	--	1.6	300	<0.2	--	4	--	--	<1	--	<10	--	2	--	--	--	--	20	--	--	9
		05/25/82	--	--	<1	<100	--	--	0.1	22	2	--	40	1400	16	--	1.5	300	<0.2	--	9	--	--	<1	--	<10	--	2	--	--	--	--	<10	--	--	9
		08/11/88	2100	--	8	20	--	<500	<0.1	30	10	13	90	25000	490	<10	2.1	410	--	<20	72	--	4.6	<1	--	<10	70	2	--	<50	--	10	960	1	--	10
		03/18/92	<50	--	1	<10	--	<500	0.5	19	<1	--	<10	15000	27	<10	0.3	210	--	<20	4	--	2.8	<1	3500	--	<80	1.5	--	--	--	<10	60	<1	--	1
		03/18/92	<50	--	2	<10	--	<500	0.1	8.5	<1	--	<10	31000	8	<10	0.3	1100	--	<20	14	--	1.6	<1	5300	--	<80	1.6	--	--	--	<10	350	<1	--	4
		06/09/92	<50	--	1	<10	--	<500	0.2	20	3	--	<10	6100	2	10	1.5	260	--	--	6	--	2.5	--	3900	--	<80	1.8	--	--	--	--	<10	1	--	15
		06/09/92	<50	--	1	<10	--	<500	<0.1	20	<1	--	<10	6200	2	20	1.4	250	--	--	5	--	2.6	--	3800	--	<80	1.9	--	--	--	--	<10	<1	--	5
		09/01/92	<50	--	<1	<10	--	<500	0.1	20	<1	--	<10	14000	27	<10	1.3	320	--	--	4	--	3	--	3200	--	<50	1.9	--	--	--	--	50	<1	--	2
		12/14/92	<50	<1	3	<10	--	<500	0.1	22	<1	--	<10	20000	30	<10	1.3	340	--	<20	5	--	2.9	<1	--	--	<50	2	--	--	--	<10	80	1	--	2
		03/16/93	<50	<1	2	<10	--	<500	0.1	23	<1	--	<10	17000	25	10	1.4	350	--	<20	5	--	2.8	<1	--	--	<50	20	--	--	--	<10	100	1	--	3
		03/16/93	<50	<1	1	<10	--	<500	0.1	24	3	--	<10	13000	20	10	1.4	340	--	<20	6	--	2.9	<1	--	--	<50	2	--	--	--	<10	90	2	--	3
		06/09/93	260	<1	2	<10	--	<500	<0.1	18	<1	--	<10	7400	7	<10	1.3	280	--	<20	9	--	2.6	--	--	--	<50	1.8	--	--	--	--	30	1	--	7
		09/21/93	80	<1	1	<10	--	<500	<0.1	20	<1	--	<10	8300	22	<10	1.6	300	--	<20	3	--	2.5	--	--	--	<50	2	--	--	--	--	70	1	--	7
		09/21/93	<50	<1	1	<10	--	<500	0.1	22	<1	--	<10	8200	17	<10	1.6	300	--	<20	4	--	2.5	--	--	--	<50	2	--	--	--	--	60	1	--	8
		03/08/94	80	<1	<1	<10	--	<500	<0.1	22	<1	--	<10	14000	6	<10	1.5	320	--	<20	4	--	2.8	--	--	--	<50	1.9	--	--	--	--	30	1	--	4
		03/08/94	60	<1	1	<10	--	<500	<0.1	23	<1	--	<10	14000	7	<10	1.5	330	--	<20	3	--	2.7	--	--	--	<50	2	--	--	--	--	30	1	--	5
		09/20/94	<50	<1	1	10	--	<500	<0.1	20	<1	--	<10	3000	<1	<10	1.5	290	--	<20	6	--	2.6	--	--	--	30	2	--	--	--	--	80	1	--	8
		03/22/95	<50	--	<1	<10	<1	<500	<0.1	20	<1	--	<10	7000	8	--	1.6	280	--	--	5	--	2.6	--	--	--	<50	1.9	--	--	--	--	<10	1	--	6
		03/22/95	<50	--	<1	<10	<1	<500	<0.1	21	<1	--	<10	7000	10	--	1.6	290	--	--	5	--	2.6	--	--	--	<50	1.8	--	--	--	--	<10	1	--	6
		09/06/95	<50	--	2	<10	<1	<500	<0.1	20	<1	--	<10	5400	2	--	1.6	310	--	--	8	--	2.5	<1	--	--	<50	1.8	--	--	--	--	10	1	--	35
		03/21/96	<50	--	4	<10	<1	<500	<0.1	19	<1	--	<10	7600	6	--	1.8	280	--	--	5	--	3.2	--	--	--	<50	1.8	--	--	--	--	10	2	--	<2
		09/24/96	<50	--	2	<10	<1	<500	<0.1	19	<1	--	<10	8200	<1	--	1.5	320	--	--	4	--	2.5	--	--	--	<50	2	--	--	--	--	<10	1	--	5
		03/26/97	<50	--	<1	<10	<1	<500	<0.1	22	<1	--	<10	6900	<1	--	1.7	340	--	--	8	--	2.5	--	--	--	<50	1.9	--	--	--	--	<10	<1	--	8
		09/09/97	<50	--	<1	<10	<1	<500	<0.1	19	<1	--	<10	7500	<1	--	1.5	310	--	--	4	--	2.4	--	--	--	<50	1.8	--	--	--	--	<10	1	--	7
		03/18/98	<50	<1	2	<10	<1	<500	<0.1	20	<1	<1	<10	9200	2	--	1.5	320	<0.2	--	4	--	2.5	<1	--	<10	<50	1.8	<2	--	--	<10	10	1	0.2	5
		09/15/98	<50	<1	<1	<10	<1	<200	<0.1	19	<1	<1	<10	9400	<1	--	1.4	310	<0.2	--	6	--	2.5	<1	--	<10	<50	1.8	<2	--	--	<10	10	1	0.2	6
		03/09/99	50	1	1	10	1	200	1.4	18	2	2	10	7500	1	--	1.6	320	0.2	--	7	--	2.5	1	--	10	50	2	2	--	--	10	10	1	0.2	9
		09/13/99	90	1	3	10	1	200	0.1	20	6	12	10	29000	27	--	1.4	360	0.2	--	40	--	2.6	1	--	10	50	2	2	--	--	10	150	1	0.2	5

Well ID	Historical Well ID Ref.	Date	Inorganics																																Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	**TDEC**	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**-**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**100**	**10^**	**-**	**50**	**-**	**100**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
		EPA	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**1300~**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**-**	**1^^**	**-**	**50**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
JOF-A2 (cont.)	A-2	03/07/00	510	1	2.3	20	1	230	0.1	20	8.4	15	10	20000	32	--	1.6	360	0.2	<20	31	--	2.9	1	4900	10	50	1.9	2	50	20	10	120	2	0.2	16
		09/20/00	190	<1	2	<10	1	<200	<0.1	19	2.3	3.6	<10	15000	<1	--	1.5	320	<0.2	--	20	--	2.8	<1	--	<10	<50	1.8	<2	200	<5	<10	48	1	0.2	7
		03/20/01	5000	<1	3	23	<1	<200	<0.1	20	11	3.4	<10	19000	30	--	2	350	<0.2	<20	23	--	2.9	<1	12000	<10	<50	1.5	<2	<50	64	10	96	1.2	0.17	6
JOF-A3	A-3	02/11/82	50	<2	3	3	<0.5	<500	<0.1	9.6	1	--	7	14000	<1	--	1.3	1200	<0.2	--	20	<0.01	--	<1	--	<10	--	2.2	<50	--	--	--	14	2	--	3
		03/24/82	--	<2	4	<100	--	--	<0.1	10	<1	--	50	15000	1	--	1.4	1200	<0.2	--	13	--	--	<1	--	<10	--	2.3	--	--	--	--	20	--	--	2
		04/13/82	--	--	<1	<100	--	--	<0.1	10	<1	--	30	15000	<1	--	1.4	1100	<0.2	--	9	--	--	<1	--	<10	--	2.2	--	--	--	--	20	--	--	<1
		05/25/82	--	--	<1	<100	--	--	<0.1	10	2	--	30	14000	12	--	1.3	1200	<0.2	--	16	--	--	<1	--	<10	--	2.2	--	--	--	--	<10	--	--	2
		06/08/92	<50	--	3	<10	--	<500	0.2	9.8	2	--	<10	17000	4	<10	1.4	1100	--	--	17	--	1.7	--	4200	--	<80	2.1	--	--	--	--	120	1	--	27
		09/01/92	80	--	4	<10	--	<500	0.1	8.4	<1	--	<10	29000	5	<10	1.2	1100	--	--	48	--	1.8	--	4200	--	<50	2.2	--	--	--	--	390	1	--	2
		09/01/92	70	--	4	<10	--	<500	0.1	8.3	<1	--	<10	28000	5	<10	1.2	1100	--	--	48	--	1.8	--	4000	--	<50	2.2	--	--	--	--	390	1	--	3
		03/15/93	<50	<1	3	<10	--	<500	0.1	10	1	--	<10	14000	4	20	1.2	1200	--	<20	32	--	1.6	<1	--	--	<50	40	--	--	--	<10	150	2	--	4
		09/21/93	<50	<1	<1	<10	--	<500	<0.1	9.9	<1	--	<10	12000	2	<10	1.5	1200	--	<20	15	--	1.5	--	--	--	<50	2	--	--	--	--	50	1	--	4
		03/07/94	<50	<1	<1	<10	--	<500	0.3	10	1	--	<10	17000	2	10	1.4	1200	--	<20	17	--	1.8	--	--	--	<50	2.2	--	--	--	--	150	2	--	4
		09/20/94	<50	2	1	10	--	<500	<0.1	9.6	<1	--	<10	10000	<1	<10	1.3	1200	--	<20	18	--	1.8	--	--	--	<50	2.2	--	--	--	--	60	2	--	4
JOF-B1	B-1	03/12/90	880000	<1	**690**	**2900**	--	16000	**29**	280	**1800**	--	2100	3900000	800	160	100	60000	--	200	**4200**	--	31	3	44000	--	9600	200	--	--	--	2600	8300	110	--	900
		06/19/90	90	<1	2	10	--	<500	3	19	5	--	<10	2700	44	<10	1.3	120	--	<20	5	--	2.5	<1	4500	--	80	2.3	--	--	--	20	50	2	--	5
		09/04/90	6100	<1	4	150	--	4400	**29**	200	5	--	10	78000	30	20	68	21000	--	100	**210**	--	19	1	12000	--	550	270	--	--	--	<10	530	88	--	910
		12/10/90	6200	<1	<1	100	--	7200	5	200	2	--	10	72000	2	10	70	21000	--	<20	**280**	--	21	2	12000	--	490	210	--	--	--	20	490	100	--	77
		03/06/91	14000	4	4	130	--	6700	**8**	210	7	--	100	98000	8	<10	68	20000	--	<20	**350**	--	21	2	7800	--	280	210	--	--	--	40	590	120	--	900
		06/25/91	34000	<1	3	400	--	8000	0.7	210	20	--	20	180000	2	40	64	19000	--	<20	**390**	--	32	2	36000	--	700	210	--	--	--	80	2200	110	--	1100
		09/23/91	7000	<1	2	150	--	7100	4	210	7	--	40	110000	<1	10	68	19000	--	<20	**290**	--	23	4	5800	--	430	180	--	--	--	40	560	120	--	1200
		12/04/91	63000	--	6	520	--	7300	**6**	170	57	--	130	140000	6	<10	64	18000	--	--	**790**	--	23	2	50000	--	770	220	--	--	--	110	720	120	--	1400
		03/17/92	39000	--	**20**	400	--	6100	**16**	170	<1	--	60	140000	33	<10	11	16000	--	<20	**460**	--	20	<1	810	--	560	210	--	--	--	70	650	122	--	600
		06/09/92	13000	--	4	140	--	7500	**7**	200	14	--	<10	100000	3	20	64	18000	--	--	**350**	--	20	--	20000	--	440	190	--	--	--	--	490	120	--	1200
		09/02/92	21000	--	4	250	--	6700	5	190	12	--	20	120000	2	20	59	16000	--	--	**330**	--	22	--	29000	--	440	210	--	--	--	--	540	50	--	1200
		12/15/92	3500	<1	2	30	--	7500	4	210	3	--	<10	85000	2	<10	68	19000	--	<20	**320**	--	20	<1	--	--	510	210	--	--	--	<10	480	120	--	1200
		03/17/93	5400	<1	3	60	--	5900	**12**	200	8	--	<10	81000	<1	20	60	17000	--	<20	**370**	--	21	<1	--	--	440	190	--	--	--	<10	460	140	--	970
		06/08/93	4500	<1	<1	50	--	3200	4	200	1	--	<10	77000	<1	<10	59	17000	--	<20	**330**	--	22	--	--	--	460	190	--	--	--	--	470	120	--	1100
		09/21/93	850	<1	<1	<10	--	6000	4	220	<1	--	<10	74000	<1	<10	66	18000	--	<20	**380**	--	19	--	--	--	500	190	--	--	--	--	490	110	--	1100
		03/08/94	1300	<1	<1	20	--	2300	1	200	2	--	<10	77000	<1	10	61	17000	--	<20	**330**	--	20	--	--	--	490	180	--	--	--	--	470	130	--	930
		09/20/94	3200	<1	5	50	--	6500	2	200	<1	--	<10	81000	<1	<10	61	17000	--	<20	**160**	--	20	--	--	--	460	180	--	--	--	--	960	120	--	1100
		03/20/95	1100	--	<1	<10	<1	6900	4	230	<1	--	<10	86000	<1	--	73	20000	--	--	**310**	--	20	--	--	--	270	190	--	--	--	--	520	140	--	1300
		09/05/95	1400	--	2	10	1	5400	4	210	<1	--	<10	76000	3	--	68	16000	--	--	**300**	--	17	4	--	--	480	190	--	--	--	--	480	120	--	960
		03/21/96	2900	--	4	20	<1	5000	3	220	**140**	--	10	99000	<1	--	75	19000	--	--	**340**	--	21	--	--	--	500	180	--	--	--	--	530	180	--	1100
		09/23/96	4400	--	2	60	<1	5000	3	230	5	--	<10	110000	<1	--	75	18000	--	--	**330**	--	19	--	--	--	510	190	--	--	--	--	530	150	--	970
		03/26/97	1100	--	2	10	<1	5500	3	220	<1	--	<10	100000	<1	--	76	19000	--	--	**400**	--	20	--	--	--	470	170	--	--	--	--	530	170	--	1100
		09/09/97	1300	--	<1	10	<1	4400	3	220	<1	--	<10	110000	<1	--	76	19000	--	--	**310**	--	22	--	--	--	530	190	--	--	--	--	510	180	--	1000
JOF-B10	89-B10	03/12/90	2100	<1	2	10	--	<500	2	5.5	<1	--	<10	4400	3	20	1.5	370	--	<20	16	--	0.92	<1	6800	--	<50	4	--	--	--	<10	70	6	--	5
		06/19/90	190000	1	<1	1300	--	1700	**6**	36	100	--	180	540000	10	40	11	2200	--	<20	**130**	--	2.4	<1	13000	--	1600	3.4	--	--	--	600	1100	3	--	2
		09/04/90	60000	<1	2	470	--	860	2	16	27	--	70	200000	10	30	4.8	780	--	60	50	--	1.1	<1	36000	--	440	4.3	--	--	--	240	480	6	--	3
		12/12/90	44000	<1	<1	270	--	<500	2	10	19	--	30	96000	9	10	4.1	410	--	<20	39	--	1	<1	45000	--	260	4.1	--	--	--	110	250	7	--	77
		03/05/91	100000	5	6	820	--	930	3	24	52	--	130	260000	13	<10	7.7	1600	--	<20	**190**	--	1.9	<1	4500	--	670	3.6	--	--	--	350	880	6	--	3
		06/26/91	120000	**94**	5	720	--	520	2	19	71	--	80	190000	21	180	5.5	640	--	<20	91	--	46	<1	62000	--	620	4.1	--	--	--	240	480	5	--	2
		09/24/91	39000	<1	1	390	--	<500	1	13	41	--	120	130000	8	<10	3.6	520	--	40	39	--	1.3	<1	18000	--	80	4.1	--	--	--	140	310	9	--	<1
		12/04/91	53000	--	1	250	--	<500	<0.1	8.4	31	--	110	56000	13	<10	5.2	350	--	--	43	--	0.87	2	64000	--	140	4.5	--	--	--	100	250	11	--	<1
		03/17/92	4100	--	**14**	150	--	<500	0.5	5.6	50	--	40	41000	25	<10	0.6	150	--	<20	41	--	0.7	<1	4500	--	100	3.6	--	--	--	80	170	6	--	1
		06/10/92	30000	--	9	170	--	<500	0.3	8.2	46	--	<10	58000	13	30	2.6	160	--	--	34	--	3.5	--	34000	--	120	3.6	--	--	--	--	90	5	--	5
		12/14/92	24000	<1	**20**	140	--	<500	0.7	8.8	4	--	30	53000	19	<10	2	220	<0.2	<20	38	0.15	1	2	--	<10	140	4.2	--	--	--	50	190	8	--	1

Well ID	Historical Well ID Ref.	Date	Inorganics																																Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	TDEC	-	6	10	2000	4	-	5	-	100	-	-	-	15~	-	-	-	2	-	100	10^	-	50	-	100	-	-	2	-	-	-	-	-	4	-
		EPA	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
JOF-B10 (cont.)	89-B10	03/15/93	14000	<1	**14**	100	--	<500	0.6	7.7	20	--	<10	41000	10	<10	1.6	250	0.3	<20	22	0.14	0.8	<1	--	<10	70	3.9	--	--	--	50	110	8	--	31
		09/21/93	64000	<1	**30**	320	--	<500	0.7	10	64	--	30	120000	36	<10	4.9	420	--	<20	70	0.11	0.8	--	--	--	300	4.5	--	--	--	--	280	9	--	<2
		03/09/94	25000	<1	6	140	--	<500	0.6	6.7	20	8	<10	41000	11	<10	2.7	160	0.2	<20	1	0.23	0.8	<1	--	<10	120	3.6	<50	--	--	50	120	6	<0.1	<2
		05/16/94	--	--	--	--	<1	--	--	--	--	27	--	--	--	--	--	--	0.6	--	--	--	--	<1	--	<10	--	--	<50	--	--	<10	--	--	0.1	--
		07/20/94	--	--	--	--	<1	--	--	--	--	<1	--	--	--	--	--	--	<0.2	--	--	--	--	<1	--	<10	--	--	<50	--	--	10	--	--	<0.1	--
		09/20/94	24000	<1	**16**	170	2	<500	0.4	7.4	37	1	<10	49000	24	<10	2.6	160	<0.2	<20	29	0.11	0.9	<1	--	<10	110	4.6	**3**	--	--	60	120	10	<0.1	3
		03/21/95	3600	<1	<1	<10	<1	<500	0.2	4.2	3	<1	<10	5100	2	--	1.4	13	<0.2	--	7	--	0.9	<1	--	<10	<50	4.4	<2	--	--	<10	<10	9	<0.1	2
		09/06/95	6000	<1	3	30	<1	<500	0.1	5.4	10	2	<10	11000	4	--	1.6	41	<0.2	20	10	--	0.8	1	--	<10	<50	4.9	<2	--	--	<10	30	11	0.1	<2
		03/26/96	550	2	<1	<10	<1	<500	0.1	4.4	4	1	<10	2000	1	--	1.2	6	<0.2	<20	2	--	0.7	<1	--	<10	<50	4.2	<1	--	--	<10	10	9	0.1	<2
		09/24/96	2600	<1	3	20	<1	<500	<0.1	4.7	5	<1	<10	6300	3	--	1.4	21	<0.2	<20	6	--	0.8	<1	--	<10	<50	5	<2	--	--	<10	10	12	<0.1	<2
		03/26/97	1100	<1	<1	10	<1	<500	<0.1	5.1	<1	<1	<10	2300	5	--	1.4	<5	<0.2	--	9	--	0.8	4	--	<10	<50	5.4	<2	--	--	<10	<10	1	<0.1	4
		09/10/97	5500	<1	2	20	<1	<500	0.7	5.3	6	<1	<10	12000	4	--	1.7	27	<0.2	--	14	--	0.8	<1	--	<10	<50	6.3	<2	--	--	10	20	14	<0.1	5
		09/10/97	5800	<1	2	20	<1	<500	<0.1	5.2	6	<1	<10	11000	4	--	1.7	27	<0.2	--	14	--	0.9	<1	--	<10	<50	6.4	<2	--	--	10	20	15	<0.1	5
		03/19/98	12000	<1	5	80	1	<500	0.4	6.2	28	7	<10	23000	8	--	1.9	85	<0.2	--	27	--	0.9	<1	--	<10	<50	3.4	<2	--	--	20	50	7	<0.1	<2
		03/19/98	660	<1	<1	<10	<1	<500	0.2	4.7	5	<1	<10	930	<1	--	1.2	<5	<0.2	--	9	--	0.8	<1	--	<10	<50	4.6	<2	--	--	<10	<10	11	<0.1	<2
		09/15/98	28000	<1	**14**	170	<1	<200	0.6	7.1	86	12	<10	56000	5	--	2.8	160	<0.2	--	48	--	0.9	<1	--	<10	80	4.2	<2	--	--	50	130	8	<0.1	2
		09/15/98	3400	<1	3	20	<1	<200	0.2	5.1	7	<1	<10	6000	3	--	1.5	22	<0.2	--	10	--	0.9	<1	--	<10	50	6.2	<2	--	--	<10	30	15	<0.1	10
		03/10/99	20000	1	**12**	110	1	200	0.6	5.7	83	10	10	35000	18	--	2.2	120	0.2	--	51	--	0.8	1	--	10	50	3.5	2	--	--	40	90	7	0.1	1
		03/10/99	4000	1	3	20	1	200	0.2	4.4	16	1	10	7100	3	--	1.4	24	0.2	--	13	--	0.8	1	--	10	50	4.6	2	--	--	10	20	9	0.1	1
		03/10/99	4000	1	3	20	1	200	0.1	4.6	17	1	10	7200	3	--	1.4	23	0.2	--	17	--	0.8	1	--	10	50	4.5	2	--	--	10	20	9	0.1	1
		09/10/99	3300	1	3	20	1	200	0.2	5.2	15	7	10	5200	2	--	1.4	31	0.2	--	18	--	0.7	1	--	10	50	4	2	--	--	10	20	5	0.1	8
		03/07/00	5400	1	3.1	40	1	270	0.15	4.9	11	9.7	10	6300	4.1	--	1.5	33	0.2	<20	20	--	0.84	1	9200	10	50	3.7	2	50	90	13	24	9	0.2	3
		09/19/00	48000	2.3	**33**	270	**5.6**	210	1.4	8.3	69	6.7	49	74000	54	--	4	320	0.4	--	62	--	1.1	2	--	<10	170	3.2	**2.1**	250	470	110	200	7	<0.1	3
		11/28/00	800	1.6	<1	<10	<1	<200	<0.1	4.4	<1	<1	<10	600	<1	--	1.2	40	<0.2	<20	11	--	0.85	<1	--	<10	<50	4.1	<2	--	23	<10	17	10	<0.1	3
		03/20/01	1700	<1	<1	12	<1	<200	<0.1	4.5	6	<1	<10	2300	<1	--	1.3	11	<0.2	<20	10	--	0.89	<1	6600	<10	<50	4.5	<2	<50	23	<10	15	11	<0.1	5
		09/18/01	4500	<1	<1	30	<1	<200	0.3	5.6	5	<1	<10	7200	6.7	--	1.8	30	<0.1	<20	7.8	--	0.94	<1	9600	<10	<50	4.7	<2	<50	49	11	19	15	<0.1	5
		03/12/02	5400	<1	<1	30	<1	410	0.18	5.6	<1	<1	<10	9200	4.3	--	1.9	30	<0.1	<20	3.2	--	0.48	<1	--	<10	<50	4.7	<2	<50	67	10	20	14	<0.1	1.2
		09/10/02	17000	<1	5	80	<1	<200	0.48	6.3	9.6	1.6	<10	20000	7.7	--	2.6	66	0.1	<20	14	--	2.2	<1	--	<10	<50	6.7	<2	<50	340	40	90	16	<0.1	<1
		09/10/02	17000	<1	4	70	<1	<200	0.34	6.2	8.2	<1	<10	20000	8.7	--	2.6	64	0.1	<20	18	--	1.3	<1	--	<10	<50	6.8	<2	<50	330	40	90	16	<0.1	<1
		03/11/03	11000	<1	9	60	<1	200	0.3	6.1	16	<1	<10	17000	10	--	2.2	54	<0.1	<20	24	--	1.8	<1	20000	<10	<50	6.3	<2	480	120	20	80	27	<0.1	15
		09/09/03	6000	<0.1	3	30	<1	<200	0.29	5.5	3.3	1.6	<10	8800	5.8	--	1.8	29	0.1	--	13.7	--	0.7	18.7	--	<10	<50	7.7	<0.1	--	--	10	20	17	<0.1	7.3
		03/09/04	3300	<0.6	2.1	20	<1	<200	0.34	5.1	5.5	1	<10	6100	2.8	--	1.5	21	<0.1	<20	8.7	--	1.1	0.2	--	<10	<50	6.4	<0.1	--	--	<10	20	15	<0.1	19
		09/14/04	9900	<3	7	50	<1	<200	0.3	5.7	13	2	<10	16000	5	--	1.9	52	<0.1	<20	18	--	1.4	<1	--	<10	<50	9.3	<2	<50	110	10	40	25	<0.1	58
		03/08/05	3500	<3	1	20	<1	<200	0.2	5.2	8	1	<10	4800	<1	--	1.5	20	<0.1	<20	8	--	2.4	<1	--	<10	<50	6.1	<2	<50	50	<10	20	15	<0.1	2
		09/07/05	5100	<3	2	30	<1	<200	0.1	5.2	5	<1	<10	5300	2	--	1.6	24	<0.1	<20	7	--	1.1	<1	--	<10	<50	9.2	<2	--	--	<10	10	19	<0.1	3.3
		03/22/06	580	<3	<1	10	<1	<200	0.1	4.7	4	<1	<10	840	<1	--	1.2	11	<0.1	<20	5	--	0.9	<1	--	<10	<50	6.2	<2	--	--	<10	10	11	<0.1	1
		09/19/06	2400	<3	1	20	<1	<200	0.1	4.8	6	1	<10	2900	1	--	1.4	16	<0.1	<20	7	--	1.5	<1	--	<10	<50	8	<2	--	--	<10	30	13	<0.1	3.9
		09/19/06	2700	<3	1	20	<1	<200	0.1	4.8	6	1	<10	3300	1	--	1.4	17	<0.1	<20	8	--	1.6	<1	--	<10	<50	7.7	<2	--	--	<10	30	14	<0.1	3.9
		03/06/07	1900	<1	<1	17	<2	<200	<0.5	5	5.1	<1	2.3	2000	1.4	--	1.4	22	<0.2	<5	6.4	--	1	1.5	--	<0.5	14	6.7	<1	--	--	<10	12	9	<0.1	<5
		09/19/07	750	<1	4.5	16	<2	<200	<0.5	5.1	18	<10	4.9	710	5.1	--	1.4	13	<0.2	<5	16	--	0.71	1.3	--	<0.5	<10	7.3	<1	--	--	<10	36	10	<0.1	<5
		03/12/08	14000	<1	5.2	81	<2	<200	<0.5	5.9	28	<10	6.2	14000	8.1	--	2.3	49	<0.2	<5	29	--	3.2	5.5	--	<0.5	41	6	<1	--	--	28	59	9.5	<0.1	<5
		09/16/08	510	<1	2.1	12	<2	<200	<0.5	5.3	2.9	<10	1.5	1000	<1	--	1.4	<10	<0.2	<5	5.5	--	0.9	<1	--	<0.5	<10	8.1	<1	--	--	<10	12	12	<0.1	<5
		03/10/09	1500	<1	1	16	<2	<200	<0.5	5.1	4.6	<10	1.6	1500	<1	--	1.4	<10	<0.2	<5	6	--	1	<1	--	<0.5	<10	6.6	<1	--	--	<10	11	11	<0.1	<5
		09/15/09	1400	<1	1	18	<2	<200	<0.5	6.1	4.2	<10	<2	1400	<1	--	1.8	12	<0.2	<5	6.1	--	0.94	<1	--	<1	11	9.8	<1	--	--	<10	12	16	<0.1	<5
		09/15/09	1300	<1	1.1	17	<2	<200	2	6.5	4.2	<10	<2	1300	1.8	--	1.7	16	<0.2	<5	6.4	--	1	<1	--	<1	12	7.7	<1	--	--	<10	22	15	<0.1	<5
		03/10/10	960	<1	<1	12	<2	<200	<0.5	5.3	2.9	<10	<2	1200	<1	--	1.5	<10	<0.2	<5	4.6	--	1	<1	--	<1	<10	7.3	<1	--	--	2.5	<10	13	0.1	<5
		09/14/10	1400	<1	<1	19	<2	<200	<0.5	6.4	3.8	<10	<2	1400	<1	--	1.9	12	<0.2	<5	5.4	--	1.1	<1	--	<1	12	9.5	<1	--	--	<2	11	18	<0.1	5.2
		03/15/11	190	<1	<1	12	<2	<200	<0.5	5.5	2.4	<10	<2	560	<1	--	1.5	<10	<0.2	<5	4.4	--	0.94	<1	--	<1	<10	6.7	<1	--	--	<10	<10	13	<0.1	<5

Stantec

Table 1A

Groundwater Chemical Data

Well ID	Historical Well ID Ref.	Date	Inorganics																																	Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	**TDEC**	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**-**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**100**	**10^**	**-**	**50**	**-**	**100**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
		EPA	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**1300~**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**-**	**1^^**	**-**	**50**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
JOF-B10 (cont.)	89B-10	09/13/11	330	<1	1	12	<2	<200	<0.5	6.6	<2	<10	<2	530	<1	--	1.8	15	<0.2	<5	3.5	--	1.2	<1	--	<1	12	9.4	<1	--	--	<10	<10	16	<0.1	5.6
		03/20/12	140	<1	<1	9.4	<2	<200	<0.5	5.6	<2	<10	<2	190	<1	--	1.5	<10	<0.2	<5	3.2	--	0.74	1.3	--	<1	<10	6.8	<1	--	--	<10	<10	13	<0.1	<5
		09/18/12	--	<1	<1	11	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	2.7	--	--	<1	--	<1	--	--	<1	--	--	<2	<10	--	<0.1	--
		03/19/13	100	<1	<1	10	<1	<200	<0.5	5.1	2.2	1.1	<2	110	<1	--	1.4	6.2	<0.2	<2	4	0.18	0.95	<1	--	<1	<10	6.5	<1	--	--	<2	<10	12	<0.1	<5
		09/24/13	--	<1	<1	11.5	<1	--	<1	--	3.7	<1	<1	--	<1	--	--	--	<0.2	--	5.3	--	--	<1	--	<0.5	--	--	<1	--	--	<1	<10	--	<0.4	--
		03/11/14	<250	<1	<1	10.7	<1	21.6	<1	5.84	1.3	<5	<1	<250	<1	--	1.59	9.7	<0.2	<1	3.5	--	0.933	<1	--	<0.5	8.5	7.64	<1	--	--	<10	<10	12.5	<0.4	5.5
		09/08/14	--	<1	<1	14	<1	--	<0.5	--	19	<1	3.8	--	<1	--	--	--	<0.2	--	16	--	--	<1	--	<1	--	--	<1	--	--	<2	<10	--	<0.1	--
		03/17/15	--	<2	<2	11	<2	--	<1	--	9.1	<2	<5	--	<2	--	--	--	<0.2	--	5.4	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		09/22/15	--	<2	<2	20.6	<2	--	<1	--	2.47	<2	<5	--	<2	--	--	--	<0.2	--	4.93	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		03/21/16	--	<2	<2	14	<2	--	<1	--	3.46	<2	<5	--	<2	--	--	--	<0.2	--	6.3	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		03/21/16	--	<2	<2	14.9	<2	--	<1	--	3.86	<2	<5	--	<2	--	--	--	<0.2	--	6.52	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		09/20/16	--	<2	<2	19.2	<2	<200	<1	7.57	<2	<2	<5	--	<2	<15	--	--	<0.2	<5	3.68	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	24.3	<0.1	6.85
JOF-B11	B-11	03/13/90	13000	<1	<1	460	--	<500	0.5	37	30	--	40	80000	5	20	3.8	760	--	<20	27	--	7.9	<1	14000	--	580	8.8	--	--	--	70	150	16	--	20
		06/19/90	140000	4	<1	1500	--	1500	**6**	16	67	--	120	380000	18	<10	12	1500	--	<20	36	--	1.9	<1	20000	--	1300	7	--	--	--	380	570	20	--	<1
		09/04/90	34000	<1	<1	600	--	640	**14**	13	22	--	60	170000	14	10	6.3	780	--	50	13	--	1.4	<1	26000	--	420	7.2	--	--	--	160	180	19	--	12
		12/12/90	30000	<1	<1	480	--	<500	0.4	11	10	--	20	79000	4	<10	5.8	500	--	<20	12	--	1.3	2	34000	--	320	7.6	--	--	--	70	110	22	--	89
		03/06/91	73000	4	3	960	--	670	0.3	14	35	--	110	220000	4	<10	7.6	860	--	<20	19	--	1.6	<1	2200	--	450	8.1	--	--	--	220	350	22	--	13
		06/25/91	36000	<1	3	440	--	<500	0.4	12	21	--	30	94000	5	50	5.7	310	--	<20	18	--	17	<1	41000	--	400	7.2	--	--	--	80	360	16	--	14
		09/23/91	16000	<1	1	300	--	<500	0.4	9.9	12	--	48	63000	2	<10	4.1	340	--	<20	12	--	1.3	<1	8700	--	<50	6.3	--	--	--	60	87	20	--	14
		12/04/91	68000	--	3	590	--	<500	<0.1	10	52	--	110	89000	12	<10	8.4	450	--	--	23	--	1.3	<1	94000	--	420	7.2	--	--	--	140	240	22	--	<1
		03/18/92	4100	--	**27**	440	--	<500	0.4	9.3	84	--	30	7700	29	<10	1	230	--	<20	41	--	1.1	<1	3300	--	270	7.4	--	--	--	90	180	21	--	14
		06/09/92	25000	--	6	320	--	<500	0.9	8.8	24	--	<10	63000	10	10	4.5	210	--	--	14	--	2.8	--	29000	--	190	7.1	--	--	--	--	60	21	--	2
		09/02/92	31000	--	4	400	--	<500	0.4	8.3	21	--	10	82000	4	<10	4.8	300	--	--	14	--	1.4	--	37000	--	250	7.6	--	--	--	--	130	24	--	4
		03/17/93	32000	<1	**34**	470	--	<500	0.8	13	70	--	30	130000	23	<10	5	440	0.3	<20	32	0.23	1.4	<1	--	<10	280	8.4	--	--	--	100	230	29	--	13
		09/22/93	98000	<1	**70**	1100	--	<500	0.6	16	**190**	--	70	250000	100	<10	9.6	860	0.2	<20	92	0.27	1.6	6	--	<10	910	7.6	--	--	--	--	440	29	--	13
		03/08/94	6600	<1	6	200	--	<500	0.1	11	10	2	<20	17000	5	<10	4.6	96	<0.2	<20	10	0.25	1.2	<1	--	<10	150	8.2	<50	--	--	20	20	27	<0.1	12
		05/16/94	--	--	--	--	<1	--	--	--	--	<1	--	--	--	--	--	--	0.2	--	--	--	--	1	--	<10	--	--	<50	--	--	<10	--	--	<0.1	--
		07/20/94	--	--	--	--	<1	--	--	--	--	2	--	--	--	--	--	--	<0.2	--	--	--	--	<1	--	<10	--	--	<50	--	--	10	--	--	<0.1	--
		09/20/94	4900	<1	<1	130	<1	<500	<0.1	8.7	3	<1	<10	10000	1	<10	4.2	80	<0.2	<20	4	0.19	1.2	<1	--	<10	90	7.8	<2	--	--	20	20	26	<0.1	23
		03/22/95	4200	<1	2	100	<1	<500	<0.1	9.1	4	<1	<10	7200	2	--	4.7	46	<0.2	--	6	--	1.3	<1	--	<10	<50	8	<2	--	--	<10	<10	27	<0.1	15
		09/06/95	1200	<1	<1	140	<1	<500	0.2	12	10	<1	<10	2800	2	--	4.5	55	<0.2	<20	4	--	1.1	<1	--	<10	140	7.6	<2	--	--	<10	10	25	<0.1	38
		03/21/96	1800	<1	<1	130	<1	<500	<0.1	9.4	4	1	<10	5400	<1	--	4.6	24	<0.2	<20	2	--	1.1	<1	--	<10	60	8.6	<1	--	--	<10	<10	29	<0.1	16
		09/23/96	410	<1	1	130	<1	<500	<0.1	9.2	2	<1	<10	1000	<1	--	4.6	36	<0.2	<20	3	--	1.1	<1	--	<10	100	7.9	<2	--	--	<10	<10	32	<0.1	14
		03/26/97	320	<1	<1	120	<1	<500	<0.1	11	2	<1	<10	880	<1	--	4.6	29	<0.2	--	8	--	1.1	<1	--	<10	80	8.1	<2	--	--	<10	<10	25	<0.1	17
		09/09/97	890	<1	<1	130	<1	<500	<0.1	9.5	2	<1	<10	2200	<1	--	4.8	34	<0.2	--	5	--	1.1	<1	--	<10	100	7.9	<2	--	--	<10	<10	31	<0.1	14
		03/19/98	970	<1	<1	150	<1	<500	<0.1	12	3	<1	<10	2000	<1	--	5.4	41	<0.2	--	7	--	1.2	<1	--	<10	110	8.3	<2	--	--	10	<10	34	<0.1	18
		03/19/98	960	<1	<1	150	<1	<500	0.1	11	2	<1	<10	1900	<1	--	5.4	43	<0.2	--	16	--	1.2	<1	--	<10	90	8.4	<2	--	--	<10	10	34	<0.1	18
		09/16/98	1800	<1	2	150	<1	<200	0.1	10	5	<1	<10	4000	1	--	5.1	54	<0.2	--	7	--	1.2	<1	--	<10	110	9	<2	--	--	<10	20	36	<0.1	16
		03/09/99	2000	1	3	180	1	200	0.1	12	13	9	10	4800	2	--	6	76	0.2	--	10	--	1.2	1	--	10	100	9.8	2	--	--	10	10	39	0.1	11
		09/14/99	3100	1	3	190	1	200	0.2	13	13	1	10	6000	1	--	6.3	80	0.2	--	11	--	1.2	1	--	10	160	10	2	--	--	10	20	38	0.1	26
		09/14/99	2600	1	3	180	1	200	0.2	13	15	1	10	5500	1	--	6.4	78	0.2	--	10	--	1.2	1	--	10	150	10	2	--	--	10	20	37	0.1	31
		03/08/00	1500	1	1	430	1	300	0.27	28	4	3.6	10	2300	1	--	14	140	0.2	<20	8.1	--	2.8	1	5600	10	320	29	2	50	31	10	24	140	0.2	14
		09/20/00	2500	<1	2	370	1.4	<200	0.71	21	4.1	1.9	<10	3900	3.7	--	9.6	160	<0.2	--	12	--	4.1	<1	--	<10	240	64	<2	280	34	<10	11	180	<0.1	27
		03/21/01	3100	<1	3	730	<1	<200	<0.1	43	12	<1	<10	4800	2.3	--	19	270	<0.2	22	21	--	4.9	<1	8400	<10	460	120	<2	<50	44	12	37	340	<0.1	15
		09/19/01	1800	<1	<1	970	<1	<200	2.3	51	4	2	<10	4000	<1	--	22	440	<0.1	<20	16	--	4	<1	6800	<10	620	310	<2	<50	23	<10	51	560	<0.1	16
		03/12/02	640	<1	<1	1100	<1	<200	0.6	57	<1	<1	10	860	<1	--	24	610	<0.1	<20	13	--	5.8	<1	--	<10	700	380	<2	<50	<5	<10	30	720	<0.1	16
		09/11/02	1400	<1	<1	650	<1	<200	0.59	33	2	<1	<10	1600	<1	--	14	400	<0.1	<20	8.8	--	3	<1	--	<10	430	260	<2	<50	49	<10	30	490	<0.1	16
		03/12/03	3700	<1	3	580	<1	300	0.6	32	3	<1	<10	6100	4	--	12	440	<0.1	<20	11	--	4.9	<1	9700	<10	390	230	<2	450	43	<10	40	440	<0.1	20

Well ID	Historical Well ID Ref.	Date	Inorganics																															Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	TDEC	-	6	10	2000	4	-	5	-	100	-	-	-	15~	-	-	-	2	-	100	10^	-	50	-	100	-	-	2	-	-	-	-	-	4	-
		EPA	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
JOF-B11 (cont.)	B-11	03/12/03	3700	<1	3	590	<1	200	0.7	32	2	<1	<10	6100	2	--	12	440	<0.1	<20	13	--	4.9	<1	9800	<10	400	230	<2	460	43	<10	40	470	<0.1	24
		09/09/03	950	<0.1	0.4	420	<1	<200	0.15	24	<1	1.4	<10	1700	0.8	--	10	360	<0.1	--	11.1	--	2.9	<0.2	--	<10	300	170	<0.1	--	--	<10	10	330	<0.1	19
		03/09/04	1900	<0.6	1.4	320	<1	<200	0.17	19	4.9	1.4	<10	4000	2.1	--	7.6	270	<0.1	<20	8.7	--	2.4	0.2	--	<10	230	128	<0.1	--	--	<10	20	410	<0.1	20
		09/14/04	1400	<3	1	290	<1	<200	0.3	20	5	<1	<10	1900	<1	--	7.9	280	<0.1	<20	8	--	1.7	<1	--	<10	240	110	<2	<50	34	<10	10	210	<0.1	27
		03/08/05	1500	<3	<1	280	<1	290	0.3	19	9	1	<10	2200	<1	--	7.9	250	<0.1	<20	9	--	3.3	<1	--	<10	200	110	<2	<50	24	<10	10	210	<0.1	23
		09/07/05	2000	<3	1	300	<1	<200	0.2	23	4	<1	<10	2100	1	--	9.8	290	<0.1	<20	9	--	2.2	<1	--	<10	250	83	<2	--	--	<10	10	200	<0.1	16
		03/22/06	1100	<3	1	320	<1	300	0.3	24	7	<1	<10	1800	1	--	10	290	<0.1	<20	12	--	2.1	<1	--	<10	250	100	<2	--	--	<10	20	230	<0.1	16
		09/19/06	1500	<3	<1	370	<1	300	0.3	28	6	1	<10	2300	1	--	13	340	<0.1	<20	13	--	3.2	<1	--	<10	310	110	<2	--	--	<10	40	250	<0.1	18
		03/06/07	990	<1	<1	380	<2	270	0.62	30	4.6	1.3	1.2	820	<1	--	13	370	<0.2	<5	9.7	--	2.4	1.5	--	<0.5	290	130	<1	--	--	<10	33	250	<0.1	16
		03/06/07	850	<1	<1	390	<2	270	0.58	30	4.8	1.3	1.4	830	<1	--	13	370	<0.2	<5	10	--	2.4	<1	--	<0.5	300	130	<1	--	--	<10	32	260	<0.1	16
		09/19/07	710	<1	1.4	350	<2	240	<0.5	29	10	<10	2.4	640	1.2	--	13	370	<0.2	<5	13	--	2.2	2.2	--	<0.5	310	120	<1	--	--	<10	42	270	<0.1	17
		03/12/08	1500	<1	2.9	370	<2	280	<0.5	30	6.4	<10	1.2	1600	<1	--	13	440	<0.2	<5	12	--	2.6	2.5	--	<0.5	290	150	<1	--	--	<10	34	300	<0.1	19
		09/16/08	510	<1	2.3	250	<2	300	<0.5	20	2.6	<10	1.1	910	<1	--	9.8	350	<0.2	20	9	--	1.9	2.4	--	<0.5	200	95	<1	--	--	<10	18	200	<0.1	21
		03/10/09	2100	<1	1.3	390	<2	270	0.63	31	9.4	<10	2.4	2300	<1	--	14	500	<0.2	<5	14	--	2.7	1.7	--	<0.5	290	150	<1	--	--	<10	36	330	<0.1	20
		09/15/09	3500	<1	1.5	430	<2	410	0.7	34	9.7	<10	<2	3500	1.3	--	16	580	<0.2	<5	14	--	2.8	1.4	--	<1	310	160	<1	--	--	<10	39	310	<0.1	22
		03/10/10	1500	<1	<1	260	<2	430	<0.5	22	6	<10	<2	2000	<1	--	10	380	<0.2	<5	8.8	--	2.2	1.1	--	<1	190	120	<1	--	--	4.1	25	230	<0.1	26
		03/10/10	1300	<1	<1	250	<2	410	<0.5	22	3.9	<10	<2	1800	<1	--	10	380	<0.2	<5	6.9	--	2.2	1.5	--	<1	200	120	<1	--	--	3.9	21	220	<0.1	26
		09/14/10	2100	<1	<1	290	<2	450	<0.5	27	5	<10	<2	2200	<1	--	13	450	<0.2	<5	8.9	--	2.4	<1	--	<1	240	110	<1	--	--	2.3	29	230	<0.1	26
		03/15/11	530	<1	<1	430	<2	540	<0.5	41	3.4	<10	<2	1400	<1	--	18	600	<0.2	<5	11	--	2.6	2.4	--	<1	330	160	<1	--	--	<10	29	370	<0.1	22
		09/13/11	370	<1	<1	420	<2	330	<0.5	36	2.5	<10	<2	550	3	--	17	600	<0.2	<5	8.9	--	2.8	<1	--	<1	320	200	<1	--	--	<10	18	400	<0.1	24
		03/20/12	120	<1	<1	310	<2	380	<0.5	27	2.5	<10	<2	150	<1	--	13	530	<0.2	<5	7	--	2	2.7	--	<1	240	170	<1	--	--	<10	13	320	<0.1	31
		09/18/12	--	<1	<1	520	<1	--	<0.5	--	2	<1	<2	--	<1	--	--	--	<0.2	--	11	--	--	1.3	--	<1	--	--	<1	--	--	<2	20	--	<0.1	--
		03/19/13	<100	<1	<1	450	<1	450	<0.5	33	<2	1.1	<2	<100	<1	--	14	760	<0.2	<2	9.3	0.66	2.6	<1	--	<1	290	230	<1	--	--	<2	25	460	<0.1	32
		03/19/13	<100	<1	<1	420	<1	460	<0.5	35	<2	1.4	<2	<100	<1	--	15	800	<0.2	<2	10	0.65	2.6	<1	--	<1	300	240	<1	--	--	<2	21	470	<0.1	35
		09/24/13	--	<1	<1	346	<1	--	<1	--	1.9	1.1	<1	--	<1	--	--	--	<0.2	--	8.2	--	--	<1	--	<0.5	--	--	<1	--	--	<1	21.3	--	<0.8	--
		03/11/14	<250	<1	<1	190	<1	194	<1	19.8	<1	<5	<1	<250	<1	--	8.13	410	<0.2	<1	4.8	--	1.86	<1	--	<0.5	160	158	<1	--	--	<10	11.4	237	<0.4	25.2
		09/08/14	--	<1	<1	240	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	5.9	--	--	<1	--	<1	--	--	<1	--	--	<2	11	--	<0.1	--
		03/17/15	--	<2	<2	180	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	5.5	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		09/22/15	--	<2	<2	244	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	6.22	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		03/22/16	--	<2	<2	176	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	4.78	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		09/21/16	--	<2	<2	363	<2	200	<1	41.1	<2	<2	<5	--	<2	<15	--	--	<0.2	<5	7.18	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	392	<0.1	24
JOF-B12	B-12	03/12/90	80000	1	<1	1600	--	1600	<0.1	24	**400**	--	240	550000	110	700	8.2	6000	--	<20	**740**	--	40	<1	46000	--	1400	8.4	--	--	--	400	1800	9	--	15
		06/19/90	22000	<1	<1	310	--	600	1	7.9	26	--	30	85000	28	<10	3.6	1400	--	<20	44	--	6.4	<1	11000	--	270	4.5	--	--	--	80	340	19	--	170
		09/04/90	2200	<1	1	70	--	<500	0.3	6.1	6	--	40	14000	2	<10	2.2	720	--	<20	9	--	4.3	<1	7400	--	<50	4.6	--	--	--	<10	60	19	--	3
		12/11/90	1800	<1	<1	40	--	<500	0.5	6	4	--	<10	5800	2	<10	2.2	700	--	<20	14	--	4.2	<1	7200	--	<50	4.6	--	--	--	<10	20	20	--	66
		03/05/91	100000	<1	1	1900	--	1700	2	22	91	--	220	480000	9	40	9.4	6300	--	<20	66	--	12	<1	4200	--	1000	5.6	--	--	--	400	2000	17	--	4
		06/24/91	2100	<1	<1	20	--	<500	0.9	6.4	4	--	<10	5300	1	<10	2.2	440	--	<20	17	--	3.8	<1	6700	--	<50	4.2	--	--	--	<10	40	19	--	<1
		09/24/91	32000	<1	<1	380	--	<500	0.5	14	14	--	56	83000	10	<10	5.9	1100	--	<20	21	--	4.1	<1	20000	--	160	9.3	--	--	--	80	300	23	--	3
		12/04/91	3800	--	2	120	--	<500	0.2	12	4	--	<10	9100	3	<10	4.6	840	--	--	18	--	4.2	<1	5800	--	160	17	--	--	--	<10	40	48	--	<1
		03/17/92	10000	--	10	140	--	<500	0.3	9.8	50	--	10	23000	16	<10	0.8	420	--	<20	47	--	2.9	<1	910	--	120	14	--	--	--	30	130	35	--	15
		06/10/92	4200	--	**15**	120	--	<500	<0.1	13	6	--	<10	20000	42	20	5.1	460	--	--	41	--	3	--	11000	--	110	12	--	--	--	--	80	42	--	38
		09/01/92	640	--	<1	80	--	<500	0.3	14	4	--	<10	1400	3	<10	4.8	390	--	--	11	--	3.2	--	6200	--	140	19	--	--	--	--	20	25	--	15
		12/15/92	3100	<1	3	100	--	<500	0.3	15	4	--	<10	7600	3	<10	5.4	560	<0.2	<20	11	0.5	3.2	<1	--	<10	120	20	--	--	--	<10	50	48	--	16
		03/15/93	7500	<1	2	150	--	<500	0.5	14	6	--	<10	20000	6	<10	5	500	0.2	<20	13	0.51	2	<1	--	<10	150	15	--	--	--	20	90	46	--	17
		09/21/93	1600	<1	<1	110	--	<500	0.2	14	7	--	<10	3800	3	<10	5.8	370	<0.2	<20	18	0.46	2.4	2	--	<10	140	16	--	--	--	--	50	45	--	15
		03/09/94	3100	<1	<1	110	--	<500	0.1	12	5	1	<10	8700	3	<10	4.7	240	<0.2	<20	10	0.63	2.5	<1	--	<10	130	14	<50	--	--	<10	420	36	0.1	17
		05/16/94	--	--	--	--	<1	--	--	--	--	1	--	--	--	--	--	--	<0.2	--	--	--	--	<1	--	<10	--	--	<50	--	--	<10	--	--	<0.1	--
		07/20/94	--	--	--	--	<1	--	--	--	--	<1	--	--	--	--	--	--	<0.2	--	--	--	--	<1	--	<10	--	--	<50	--	--	<10	--	--	<0.1	--

Well ID	Historical Well ID Ref.	Date	Inorganics																																Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	TDEC	-	6	10	2000	4	-	5	-	100	-	-	-	15~	-	-	-	2	-	100	10^	-	50	-	100	-	-	2	-	-	-	-	-	4	-
		EPA	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
JOF-B12 (cont.)	B-12	09/20/94	3900	<1	3	110	<1	<500	0.1	12	15	<1	<10	12000	2	<10	4.8	210	<0.2	<20	18	0.51	2.4	<1	--	<10	140	15	**4**	--	--	<10	90	42	<0.1	18
		03/22/95	1500	<1	<1	30	<1	<500	<0.1	9.2	8	<1	<10	2400	1	--	4.2	84	<0.2	--	6	--	1.8	<1	--	<10	<50	9.6	<2	--	--	<10	<10	22	<0.1	21
		09/05/95	1200	<1	<1	110	<1	<500	<0.1	13	1	<1	<10	3300	4	--	5.5	120	<0.2	<20	5	--	2.1	<1	--	<10	140	15	<2	--	--	<10	10	42	<0.1	36
		03/26/96	1500	<1	<1	80	<1	<500	<0.1	12	4	<1	<10	3900	<1	--	5.2	95	<0.2	20	4	--	1.9	<1	--	<10	50	14	<1	--	--	<10	10	38	<0.1	22
		09/24/96	2300	<1	1	130	<1	<500	<0.1	14	4	3	<10	7500	2	--	5.5	200	<0.2	<20	8	--	2	<1	--	<10	140	14	<2	--	--	<10	30	41	<0.1	16
		03/26/97	250	<1	<1	80	<1	<500	<0.1	12	1	<1	<10	610	2	--	4.6	48	<0.2	--	8	--	1.6	<1	--	<10	110	9.6	<2	--	--	<10	<10	21	<0.1	20
		09/10/97	1600	<1	2	90	<1	<500	<0.1	12	4	<1	<10	4600	2	--	4.9	70	<0.2	--	11	--	1.7	<1	--	<10	140	9.9	<2	--	--	<10	10	29	<0.1	17
		03/17/98	940	<1	<1	100	<1	<500	0.1	13	2	2	<10	1400	<1	--	5.4	53	<0.2	--	8	--	1.7	<1	--	<10	110	13	<2	--	--	<10	10	34	<0.1	22
		09/16/98	440	<1	<1	80	<1	<200	<0.1	13	3	<1	<10	700	<1	--	4.8	42	<0.2	--	5	--	1.8	<1	--	<10	140	13	<2	--	--	<10	10	34	<0.1	21
		09/16/98	440	<1	2	80	<1	<200	<0.1	12	3	<1	<10	620	<1	--	4.7	41	<0.2	--	5	--	1.8	<1	--	<10	130	12	<2	--	--	<10	10	34	<0.1	20
		03/10/99	600	1	1	100	1	200	0.1	14	5	1	10	1100	1	--	5.7	52	0.2	--	5	--	1.9	1	--	10	120	16	2	--	--	10	10	42	0.1	23
		09/10/99	480	1	1	180	1	200	0.2	24	3	1	10	880	1	--	8.9	160	0.2	--	12	--	2.8	1	--	10	260	27	2	--	--	10	10	76	0.1	23
		03/07/00	1400	1	1	410	1	200	0.22	38	3.4	4	10	1600	1	--	17	380	0.2	<20	9.3	--	5.3	1	5600	10	500	76	2	50	29	10	28	220	0.1	18
		03/07/00	1900	1	1	400	1	200	0.23	37	2.9	3.9	10	1700	1	--	17	370	0.2	<20	9.4	--	5.3	1	5700	10	490	75	2	50	49	10	24	230	0.1	18
		09/19/00	1000	<1	<1	340	1.2	<200	0.65	33	1.4	2.3	<10	2100	<1	--	14	830	<0.2	--	21	--	5.7	<1	--	<10	360	95	<2	390	17	<10	17	260	<0.1	19
		03/21/01	840	<1	<1	510	<1	<200	<0.1	39	2	<1	<10	910	<1	--	18	830	<0.2	<20	14	--	4.8	<1	5200	<10	480	130	<2	<50	12	<10	25	360	<0.1	18
		09/18/01	700	<1	<1	860	<1	<200	2	61	3	<1	<10	940	<1	--	28	1400	0.17	<20	21	--	2.3	<1	4800	<10	790	400	<2	<50	5.7	<10	30	620	<0.1	17
		03/13/02	390	<1	<1	880	<1	<200	0.35	60	<1	<1	20	490	<1	--	25	1400	<0.1	<20	14	--	6.2	<1	--	<10	790	390	<2	<50	9	<10	20	740	<0.1	22
		09/10/02	880	<1	<1	1000	<1	<200	0.44	68	<1	<1	10	700	<1	--	29	1500	<0.1	<20	16	--	4.7	<1	--	<10	950	520	<2	<50	20	<10	40	990	<0.1	20
		03/11/03	720	<1	<1	440	<1	<200	0.6	36	<1	<1	<10	2000	6	--	15	780	<0.1	<20	16	--	5.5	<1	5600	<10	480	290	<2	380	14	<10	30	580	<0.1	24
		09/09/03	1300	<0.1	1.1	470	<1	<200	<0.05	37	<1	1.2	<10	3000	1.1	--	15	810	<0.1	--	18.7	--	4.7	0.5	--	<10	500	310	<0.1	--	--	<10	20	600	<0.1	23
		09/09/03	1500	0.3	1	450	<1	<200	<0.05	38	<1	1.4	<10	3400	1.3	--	16	850	<0.1	--	20.3	--	4.7	0.4	--	<10	480	310	<0.1	--	--	<10	20	590	<0.1	25
		03/09/04	470	<0.6	<0.1	300	<1	<200	<0.05	26	1.8	0.5	<10	610	0.2	--	11	550	<0.1	<20	8.8	--	3.1	0.4	--	<10	330	264	<0.1	--	--	<10	10	480	<0.1	24
		09/14/04	410	<3	<1	370	<1	<200	0.3	33	1	<1	<10	670	<1	--	14	770	<0.1	<20	9	--	3.1	<1	--	<10	420	310	<2	<50	8	<10	<10	570	<0.1	24
		03/08/05	500	<3	<1	230	<1	<200	0.2	22	3	1	<10	890	<1	--	9.2	530	<0.1	<20	8	--	3.9	<1	--	<10	240	230	<2	<50	8	<10	10	400	<0.1	25
		09/07/05	740	<3	<1	450	<1	<200	0.4	41	1	<1	<10	970	<1	--	18	780	<0.1	<20	12	--	4.9	<1	--	<10	510	330	<2	--	--	<10	10	660	<0.1	15
		03/22/06	90	<3	<1	290	<1	<200	0.4	28	1	<1	10	200	<1	--	13	650	<0.1	<20	10	--	3	<1	4400	<10	350	260	<2	--	--	<10	20	480	<0.1	18
		09/19/06	400	<3	<1	650	<1	<200	0.6	54	1	1	<10	500	<1	--	25	1700	<0.1	<20	21	--	6.4	<1	--	<10	720	400	<2	--	--	<10	40	820	<0.1	16
		03/06/07	2200	<1	<1	500	<2	<200	0.8	41	7	1.2	2.6	2300	1.6	--	20	1400	<0.2	<5	18	--	4.3	2.4	--	<0.5	510	350	<1	--	--	<10	43	670	<0.1	18
		09/19/07	230	<1	<1	760	<2	<200	0.78	57	2.4	<10	1	210	<1	--	27	2300	<0.2	<5	21	--	4.7	2.4	--	0.63	720	500	<1	--	--	<10	59	1200	<0.1	16
		09/19/07	260	<1	<1	760	<2	<200	0.91	56	2.4	<10	1.4	230	<1	--	27	2200	<0.2	<5	22	--	4.8	3.1	--	<0.5	710	500	<1	--	--	<10	63	1200	<0.1	16
		03/12/08	190	<1	5.8	500	<2	<200	<0.5	39	1.9	<10	<1	210	<1	--	20	1600	<0.2	<5	16	--	3.5	3.4	--	<0.5	460	370	<1	--	--	<10	37	760	<0.1	21
		09/16/08	170	<1	2.9	780	<2	<200	<0.5	54	1.6	<10	1.3	280	<1	--	27	2200	<0.2	8.1	26	--	4.8	4.5	--	<0.5	660	470	<1	--	--	<10	44	920	<0.1	17
		03/10/09	260	<1	<1	550	<2	<200	0.78	40	2.8	<10	1.7	180	<1	--	20	1800	<0.2	<5	19	--	3.7	2.7	--	<0.5	480	440	<1	--	--	<10	45	880	<0.1	21
		09/15/09	430	<1	<1	640	<2	<200	0.87	47	2.2	<10	<2	350	<1	--	23	2000	<0.2	<5	20	--	4.4	1.5	--	<1	540	500	<1	--	--	<10	51	880	<0.1	20
		03/10/10	590	<1	<1	360	<2	<200	<0.5	30	2	<10	<2	510	<1	--	14	1000	<0.2	<5	13	--	3.4	1.9	--	<1	320	360	<1	--	--	5.7	33	660	<0.1	23
		09/14/10	510	<1	<1	620	<2	<200	<0.5	46	<2	<10	<2	330	<1	--	22	1600	<0.2	<5	17	--	4.4	1.2	--	<1	540	520	<1	--	--	2.8	51	970	<0.1	20
		09/14/10	440	<1	<1	630	<2	<200	<0.5	46	<2	<10	<2	290	<1	--	22	1600	<0.2	<5	17	--	4.4	1.3	--	<1	550	520	<1	--	--	3	51	1000	<0.1	21
		03/15/11	120	<1	<1	580	<2	<200	<0.5	46	2.2	<10	<2	180	<1	--	21	1700	<0.2	<5	18	--	3.8	4.9	--	<1	540	540	<1	--	--	<10	36	1000	<0.1	25
		09/13/11	110	<1	1	750	<2	<200	0.55	54	<2	<10	<2	110	<1	--	26	2200	<0.2	<5	20	--	4.6	2	--	<1	620	640	<1	--	--	<10	27	1200	<0.1	22
		09/13/11	150	<1	<1	770	<2	<200	0.51	55	<2	<10	<2	130	<1	--	27	2300	<0.2	<5	20	--	5	1.9	--	2.7	680	680	<1	--	--	<10	49	1200	<0.1	22
		03/20/12	<100	<1	<1	430	<2	<200	<0.5	36	<2	<10	<2	<100	<1	--	18	1300	<0.2	<5	11	--	3.4	2.6	--	<1	440	470	<1	--	--	<10	16	860	<0.1	26
		09/18/12	--	<1	1.3	670	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	22	--	--	3.5	--	<1	--	--	<1	--	--	5.7	28	--	<0.1	--
		09/18/12	--	<1	1.4	710	<1	--	<0.5	--	<2	1	<2	--	<1	--	--	--	<0.2	--	23	--	--	3.2	--	<1	--	--	<1	--	--	6.7	29	--	<0.1	--
		03/19/13	<100	<1	<1	510	<1	<200	<0.5	36	2.1	1.9	<2	<100	<1	--	17	1500	<0.2	<2	17	1.6	3.9	2.3	--	<1	460	650	<1	--	--	3	23	1200	<0.1	28
		09/24/13	--	<1	<1	495	<1	--	<1	--	1.8	1.1	<1	--	<1	--	--	--	<0.2	--	14.7	--	--	<1	--	<0.5	--	--	<1	--	--	<1	23.2	--	<0.8	--
		09/24/13	--	<1	<1	490	<1	--	<1	--	1.4	1.1	<1	--	<1	--	--	--	<0.2	--	14.4	--	--	<1	--	<0.5	--	--	<1	--	--	<1	23	--	<0.8	--
		03/11/14	<250	<1	<1	233	<1	52	<1	23.8	<1	<5	<1	<250	<1	--	10.5	696	<0.2	<1	9.1	--	2.75	<1	--	<0.5	265	423	<1	--	--	<10	15.4	654	<0.4	24.1

Well ID	Historical Well ID Ref.	Date	Inorganics																															Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	**TDEC**	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**-**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**100**	**10^**	**-**	**50**	**-**	**100**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
		EPA	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**1300~**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**-**	**1^^**	**-**	**50**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
JOF-B12 (cont.)	B12	09/08/14	--	<1	<1	500	<1	--	<0.5	--	<2	<1	16	--	<1	--	--	--	<0.2	--	16	--	--	1.1	--	<1	--	--	<1	--	--	3.4	22	--	<0.1	--
		09/08/14	--	<1	<1	300	<1	--	<0.5	--	<2	1.2	8.9	--	<1	--	--	--	<0.2	--	28	--	--	<1	--	<1	--	--	<1	--	--	3.3	70	--	<0.1	--
		03/17/15	--	<2	<2	270	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	13	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		09/22/15	--	<2	<2	502	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	17.5	--	--	<2	--	<2	--	--	<2	--	--	<5	25.9	--	<0.1	--
		09/22/15	--	<2	<2	492	<2	--	<1	--	<2	--	--	--	<2	--	--	--	<0.2	--	17.1	--	--	<2	--	<2	--	--	<2	--	--	--	--	--	<0.1	--
		03/21/16	--	<2	<2	286	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	16.5	--	--	<2	--	<2	--	--	<1	--	--	<5	26.5	--	<0.1	--
		09/21/16	--	<2	<2	601	<2	<200	<1	56.6	8.48	4.43	<5	--	<2	<15	--	--	<0.2	<5	26.8	--	--	<2	--	<2	--	--	<1	--	--	<5	58.6	1270	<0.1	25.1
		09/21/16	--	<2	<2	603	<2	<200	<1	56.6	2.98	4.47	<5	--	<2	<15	--	--	<0.2	<5	26.3	--	--	<2	--	<2	--	--	<1	--	--	<5	57.2	1240	<0.1	25
JOF-B13	B-13	03/12/90	140000	<1	**180**	1800	--	1200	3	23	**320**	--	190	450000	210	720	12	8400	--	<20	**280**	--	2.9	<1	54000	--	1200	4.3	--	--	--	480	900	8	--	<1
		06/19/90	32000	<1	<1	340	--	530	**30**	8.5	22	--	20	81000	180	<10	4	2300	--	<20	24	--	1.3	<1	6400	--	270	3.6	--	--	--	100	220	9	--	560
		09/04/90	110000	<1	<1	1500	--	1300	**13**	18	46	--	170	330000	10	40	10	5600	--	140	38	--	1.6	<1	87000	--	860	3.5	--	--	--	350	620	6	--	<1
		12/11/90	33000	<1	<1	290	--	<500	0.9	6.8	11	--	10	57000	6	<10	4	1500	--	<20	17	--	1	2	38000	--	170	3.6	--	--	--	60	110	9	--	52
		03/05/91	150000	1	1	1600	--	1100	2	18	83	--	170	340000	16	20	10	5800	--	<20	51	--	2.6	<1	12000	--	690	3	--	--	--	380	770	7	--	4
		06/24/91	54000	<1	3	440	--	<500	0.8	6.8	17	--	30	77000	10	100	5.1	1300	--	<20	28	--	18	<1	41000	--	320	3.4	--	--	--	80	200	6	--	<1
		09/24/91	30000	<1	<1	150	--	<500	0.4	7.2	10	--	48	55000	5	<10	3.4	690	--	<20	12	--	0.88	<1	6700	--	<50	3	--	--	--	30	120	10	--	<1
		12/04/91	130000	--	6	850	--	<500	0.3	9.1	40	--	130	110000	29	<10	11	1300	--	--	52	--	0.95	1	79000	--	470	3.2	--	--	--	190	400	10	--	<1
		03/17/92	62000	--	**19**	330	--	<500	1	6.3	56	--	20	51000	53	<10	1	650	--	<20	36	--	0.7	1	60000	--	130	3.9	--	--	--	90	240	13	--	<1
		06/10/92	21000	--	**36**	260	--	<500	<0.1	7.7	<1	--	<10	78000	100	50	2.9	860	--	--	73	--	4.5	--	24000	--	120	3.2	--	--	--	--	100	12	--	1
		09/01/92	48000	--	2	390	--	<500	0.3	7.4	20	--	10	74000	9	<10	4.1	840	--	--	20	--	1	--	46000	--	140	4.1	--	--	--	--	160	10	--	<1
		03/15/93	44000	<1	**36**	400	--	<500	1	18	--	--	30	120000	30	10	6.6	1700	<0.2	<20	47	0.27	1.5	<1	--	<10	180	7.4	--	--	--	120	260	44	--	2
		09/21/93	29000	<1	5	290	--	<500	0.5	18	14	--	<10	3400	11	<10	8.8	680	<0.2	<20	23	0.31	0.9	2	--	<10	140	7.1	--	--	--	--	110	50	--	<2
		03/08/94	7900	<1	2	200	--	<500	0.3	33	4	7	<10	10000	6	<10	14	470	<0.2	<20	14	0.36	1.3	<1	--	<10	90	9.7	<50	--	--	10	40	110	<0.1	<2
		05/16/94	--	--	--	--	<1	--	--	--	--	12	--	--	--	--	--	--	<0.2	--	--	--	--	<1	--	<10	--	--	<50	--	--	<10	--	--	0.1	--
		07/20/94	--	--	--	--	<1	--	--	--	--	12	--	--	--	--	--	--	<0.2	--	--	--	--	<1	--	<10	--	--	<50	--	--	20	--	--	<0.1	--
		09/20/94	69000	<1	**30**	600	3	<500	0.5	35	70	31	<10	85000	66	<10	18	860	<0.2	<20	55	0.36	2	<1	--	<10	280	9.3	2	--	--	110	240	120	<0.1	2
		09/20/94	60000	<1	**29**	590	3	<500	0.5	36	92	27	<10	83000	63	<10	18	870	<0.2	<20	80	0.33	1.7	<1	--	<10	280	9.3	<2	--	--	100	210	120	<0.1	3
		03/21/95	940	<1	<1	140	<1	<500	0.5	50	2	4	<10	830	<1	--	24	220	<0.2	--	12	--	1.5	<1	--	<10	<50	10	<2	--	--	<10	20	170	<0.1	1
		09/05/95	4800	1	2	230	<1	<500	0.2	49	4	6	<10	8700	3	--	22	230	<0.2	<20	14	--	1.3	<1	--	<10	90	9.5	<2	--	--	20	30	150	<0.1	23
		09/24/96	6000	<1	4	260	<1	<500	0.2	56	7	5	<10	7900	5	--	25	140	<0.2	<20	14	--	1.3	<1	--	<10	120	9.6	<2	--	--	<10	30	190	<0.1	20
		09/10/97	4000	<1	<1	250	<1	<500	0.4	64	5	<1	<10	4300	3	--	28	81	<0.2	--	18	--	1.4	<1	--	<10	130	12	<2	--	--	<10	20	220	<0.1	5
		03/17/98	4400	<1	3	430	<1	<500	1	110	7	6	<10	6300	2	--	44	120	<0.2	--	25	--	2	<1	--	<10	190	16	<2	--	--	10	40	320	<0.1	38
		09/15/98	6600	<1	2	300	<1	<200	0.8	79	9	6	<10	7600	5	--	30	97	<0.2	--	17	--	1.6	<1	--	<10	160	15	<2	--	--	10	40	250	<0.1	11
		03/10/99	6800	1	4	390	1	200	0.5	100	24	8	10	8200	6	--	40	120	0.2	--	29	--	1.9	1	--	10	180	19	2	--	--	10	40	330	0.1	1
		09/09/99	4000	1	2	300	1	200	0.7	82	26	12	10	5100	3	--	30	94	0.2	--	27	--	1.7	1	--	10	160	16	2	--	--	10	30	191	0.1	17
		09/19/00	2700	<1	1	340	1.3	<200	1.9	94	3.3	3.7	<10	2100	4.6	--	30	200	0.2	--	16	--	2.3	<1	--	<10	170	20	<2	680	49	<10	31	300	<0.1	7
		09/19/00	2700	<1	1	340	1.2	<200	1.9	95	2	3.8	<10	2500	5.1	--	31	200	0.2	--	16	--	2.3	<1	--	<10	180	20	<2	680	31	<10	21	300	<0.1	7
		03/21/01	5200	<1	3	570	<1	<200	1.3	160	11	2.7	13	4100	4.3	--	48	98	<0.2	36	27	--	2.9	<1	11000	<10	300	32	<2	<50	47	<10	53	530	<0.1	7
		09/18/01	4600	<1	<1	540	1.1	<200	**5.4**	150	9	6.7	10	5100	12	--	44	110	<0.1	<20	22	--	6.2	<1	9800	<10	290	30	<2	<50	45	<10	62	480	<0.1	2
		03/13/02	2300	<1	2	660	1	<200	1.3	200	3	<1	20	2300	<1	--	53	92	<0.1	<20	20	--	2.3	<1	--	<10	390	30	<2	<50	30	<10	40	570	<0.1	17
		09/10/02	7400	**9.3**	<1	560	<1	<200	1.8	160	2.9	<1	<10	5100	3.2	--	43	91	<0.1	<20	15	--	2.1	<1	--	<10	330	32	<2	<50	140	10	60	470	<0.1	<1
		03/11/03	4600	<1	<1	820	<1	<200	1.7	240	4	1.8	20	4700	4	--	57	110	<0.1	<20	32	--	4.1	<1	11000	<10	520	53	<2	1200	27	<10	60	720	<0.1	16
		09/14/04	5600	<3	2	670	<1	<200	1.2	210	7	2	<10	3900	4	--	48	82	0.1	<20	23	--	2.7	<1	11000	<10	450	51	<2	<50	55	<10	10	650	<0.1	20
		03/08/05	4000	<3	1	750	<1	<200	1.4	240	5	5	<10	3000	1	--	51	87	0.1	<20	27	--	4.7	<1	--	<10	520	60	<2	<50	35	<10	10	730	<0.1	<1
		09/07/05	7300	<3	2	670	<1	<200	1.4	210	5	2	<10	3500	4	--	46	83	0.2	<20	23	--	3.1	<1	--	<10	440	51	<2	--	--	<10	10	650	<0.1	<1
		03/22/06	2000	<3	<1	810	<1	<200	1.8	250	7	2	10	1700	2	--	53	85	0.2	<20	28	--	3.4	<1	--	<10	590	65	<2	--	--	<10	10	740	<0.1	<1
		09/19/06	2600	<3	<1	730	<1	<200	1.5	230	2	2	<10	1500	2	--	49	82	0.2	<20	22	--	3.6	<1	--	<10	530	58	<2	--	--	<10	20	690	<0.1	1.4
		03/06/07	2200	<1	<1	840	<2	<200	2.1	270	5.7	3.5	2.1	1200	1.7	--	52	99	<0.2	<5	26	--	3.6	2.2	--	<0.5	630	72	<1	--	--	<10	67	840	0.29	<5
		09/19/07	1200	<1	1.5	710	<2	<200	1.7	230	9.6	<10	3	620	2	--	48	87	<0.2	<5	27	--	2.8	3.6	--	<0.5	540	59	<1	--	--	<10	73	790	0.27	<5

			Inorganics																															Anions		
Well ID	Historical Well ID Ref.	Date	Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	TDEC	-	6	10	2000	4	-	5	-	100	-	-	-	15~	-	-	-	2	-	100	10^	-	50	-	100	-	-	2	-	-	-	-	-	4	-
		EPA	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
JOF-B13 (cont.)	B-13	03/12/08	4400	<1	7.1	840	<2	<200	1.7	280	8.2	<10	2	2700	2.5	--	47	140	<0.2	<5	32	--	3.6	4.2	--	<0.5	650	73	<1	--	--	<10	78	790	<0.1	<5
		03/12/08	4300	<1	7.3	830	<2	<200	1.7	270	8.7	<10	2.9	2600	2.6	--	47	130	<0.2	<5	33	--	3.6	3.8	--	<0.5	680	74	<1	--	--	<10	81	790	<0.1	<5
		09/16/08	1100	<1	2.8	720	<2	<200	1.6	230	3.6	<10	2.7	1000	2	--	42	110	0.32	<5	52	--	3.3	3.7	--	<0.5	560	68	<1	--	--	<10	56	660	<0.1	<5
		03/10/09	1600	<1	1	780	<2	<200	1.9	260	5.4	<10	2.5	870	1.2	--	42	130	0.2	<5	28	--	3.4	3	--	<0.5	650	85	<1	--	--	<10	68	820	<0.1	<5
		03/10/09	1800	<1	1.2	810	<2	<200	1.9	260	5	<10	2	1100	1.2	--	44	140	<0.2	<5	28	--	3.6	3.6	--	<0.5	670	86	<1	--	--	<10	69	820	<0.1	<5
		09/15/09	2600	<1	<1	880	<2	<200	2	300	5.4	<10	<2	1500	1.2	--	47	170	0.21	<5	32	--	3.7	3.3	--	<1	760	100	<1	--	--	<10	72	830	0.12	<5
		03/10/10	2200	<1	1.1	860	<2	<200	1.8	290	5.7	<10	<2	1700	1.9	--	44	180	0.22	<5	28	--	4.2	3.6	--	<1	780	110	<1	--	--	11	75	880	<0.1	<5
		09/14/10	2400	<1	<1	800	<2	<200	1.1	280	4.9	<10	<2	1400	<1	--	44	160	0.24	<5	26	--	4	1.9	--	<1	720	100	<1	--	--	5	73	890	<0.1	<5
		03/15/11	370	<1	<1	1000	<2	<200	1.3	360	5.3	<10	<2	320	<1	--	48	250	0.2	<5	43	--	4	6	--	<1	980	140	<1	--	--	<10	65	1100	<0.1	10
		03/15/11	880	<1	<1	1000	<2	<200	1.3	360	4	<10	<2	980	<1	--	48	250	0.2	<5	42	--	4.1	5.2	--	<1	990	140	<1	--	--	<10	64	1000	<0.1	10
		09/13/11	920	<1	1.5	840	<2	<200	1.6	300	4.4	<10	<2	1400	<1	--	43	210	0.31	11	23	--	4.3	2.7	--	<1	840	120	<1	--	--	<10	36	920	<0.1	10
		03/20/12	380	<1	<1	1000	<2	<200	1.8	360	4.2	<10	<2	350	<1	--	46	320	<0.2	<5	26	--	3.9	4.4	--	<1	1000	150	<1	--	--	<10	36	1100	<0.1	23
		03/20/12	300	<1	<1	990	<2	<200	1.7	360	3.8	<10	<2	340	<1	--	46	310	<0.2	<5	27	--	3.6	3.3	--	<1	1100	150	<1	--	--	<10	36	1100	<0.1	23
		09/18/12	--	<1	<1	970	<1	--	2	--	<2	2.6	<2	--	<1	--	--	--	<0.2	--	31	--	--	3.5	--	<1	--	--	<1	--	--	5.8	39	--	<0.1	--
		03/19/13	280	<1	1.2	780	<1	<200	1.8	360	3.9	6	<2	<100	<1	--	39	460	<0.2	<2	33	0.5	4.6	9.3	--	<1	1100	200	<1	--	--	4.4	43	1200	<0.1	37
		09/24/13	--	<1	<5	925	<1	--	<5	--	5.8	3.2	<1	--	<1	--	--	--	<0.2	--	19.6	--	--	<5	--	<2.5	--	--	<1	--	--	<1	37	--	<0.4	--
		03/11/14	434	<1	<10	904	<1	15.9	<10	391	2.5	<5	<1	276	<1	--	45	410	0.23	<10	19.8	--	5.12	<10	--	<5	956	174	<1	--	--	<10	41.9	974	<0.4	31.4
		03/11/14	356	<1	<10	923	<1	15.3	<10	378	2.5	<5	<1	<250	<1	--	43.4	395	0.23	<10	18.8	--	5.03	<10	--	<5	938	168	<1	--	--	<10	39.4	985	<0.4	31.4
		09/08/14	--	<1	<1	980	<1	--	1.4	--	2.7	2.6	<2	--	<1	--	--	--	0.31	--	26	--	--	2.7	--	<1	--	--	<1	--	--	4.9	38	--	<0.1	--
		03/17/15	--	<2	<2	1000	<2	--	2.2	--	3.7	5.2	<5	--	<2	--	--	--	<0.2	--	22	--	--	<2	--	<2	--	--	<2	--	--	<5	42	--	<0.1	--
		03/17/15	--	<2	<2	1000	<2	--	2.4	--	3.9	5.2	<5	--	<2	--	--	--	<0.2	--	22	--	--	<2	--	<2	--	--	<2	--	--	<5	41	--	<0.1	--
		09/22/15	--	<2	<2	826	<2	--	2.05	--	5.58	3.11	<5	--	<2	--	--	--	0.301	--	19.2	--	--	<2	--	<2	--	--	<2	--	--	<5	30.6	--	<0.1	--
		03/21/16	--	<2	<2	838	<2	--	2.01	--	3.23	3.47	<5	--	<2	--	--	--	<0.2	--	19.9	--	--	<2	--	<2	--	--	<1	--	--	<5	35.5	--	<0.1	--
		09/20/16	--	<2	<2	754	<2	<200	2.17	362	<2	3.21	<5	--	<2	16	--	--	<0.2	<5	17.6	--	--	<2	--	<2	--	--	<1	--	--	<5	34.6	987	<0.1	38.2
JOF-B16	94-B16	09/13/99	2800	1	2	60	1	400	0.4	92	12	5	10	5600	3	--	26	150	0.2	--	12	--	1.4	1	--	10	260	17	2	--	--	10	30	7	0.1	400
		12/14/99	2000	1	1	60	1	430	2.1	66	4	2	10	2900	2	--	25	48	0.2	--	10	--	1.8	3	--	10	180	20	2	--	--	10	40	8	0.1	260
		03/07/00	6300	1	2.4	48	1	500	0.14	94	3.9	3.2	10	4900	3.1	--	21	62	0.2	<20	1	--	0.62	2.7	7300	10	380	8.4	2	50	160	12	13	5	0.1	280
		06/07/00	5800	<1	2.1	50	<1	410	0.67	110	5.3	3	<10	4600	3.4	--	23	70	<0.2	<20	4.6	--	0.67	3.9	--	<10	410	9.7	<2	<50	180	11	18	5.4	<0.1	310
		09/20/00	9700	<1	4	100	1.7	230	2.7	55	9.2	6.6	12	10000	8.6	--	20	190	<0.2	--	17	--	2.2	3.8	--	<10	160	18	<2	530	190	18	43	15	<0.1	230
		03/21/01	130	<1	<1	17	<1	220	0.27	86	<1	<1	<10	160	2.1	--	17	<5	<0.2	23	<1	--	0.41	<1	2900	<10	350	6.2	<2	<50	<5	<10	<10	5.1	<0.1	270
		09/19/01	6100	<1	<1	80	<1	350	1.9	80	7	6	14	9200	7	--	23	160	<0.1	<20	9	--	1.8	<1	12000	<10	280	14	<2	<50	100	15	55	7	<0.1	290
		03/12/02	690	<1	<1	20	<1	<200	0.3	120	<1	<1	10	1100	2.5	--	25	27	<0.1	<20	5.1	--	<0.1	1.9	--	<10	420	8.7	<2	<50	21	<10	<10	5.2	<0.1	350
		09/11/02	<50	<1	<1	60	<1	<200	0.54	88	<1	<1	<10	5000	<1	--	22	110	<0.1	<20	4.3	--	1.3	<1	--	<10	310	15	<2	<50	150	40	30	8	0.1	300
JOF-B18	99-B18	12/14/99	4200	1	1	80	1	180	**5.1**	25	7	46	10	4200	35	--	8.2	1900	0.2	--	84	--	2.4	1	--	10	160	12	2	--	--	10	300	32	0.2	91
		03/07/00	10000	1	5	80	1	210	**13**	24	9.7	36	35	9000	84	--	8.1	1600	0.2	<20	59	--	3.1	1	14000	10	140	14	2	50	130	18	250	35	0.2	85
		06/07/00	4500	<1	1.3	<10	<1	<200	1.3	23	3	24	<10	2900	6.3	--	8.4	1300	<0.2	<20	38	--	1.6	<1	--	<10	<50	11	<2	<50	<5	<10	150	39	0.22	60
		03/21/01	31000	<1	**13**	210	2	<200	1.7	27	26	29	30	33000	30	--	11	1500	<0.2	<20	51	--	4.1	<1	32000	<10	180	17	<2	<50	250	59	250	81	0.36	58
		03/12/02	31000	<1	10	200	3	<200	1.9	36	20	29.9	50	34000	21	--	14	1900	<0.1	<20	44	--	2.3	<1	--	<10	220	39	<2	<50	230	50	280	110	0.37	88
JOF-B19	99-B19	09/13/99	1400	1	1	70	1	200	1.2	20	8	28	10	1500	1	--	5.6	1100	0.2	--	21	--	2.6	1	--	10	110	12	2	--	--	10	90	34	0.2	54
		12/14/99	1600	1	1	90	1	240	0.7	17	6	14	10	1700	1	--	6.5	700	0.2	--	14	--	2.1	1	--	10	120	11	2	--	--	10	80	41	0.1	47
		03/08/00	6100	1	2.7	94	1	240	1.2	21	15	13	21	5400	2.6	--	7.1	650	0.2	<20	17	--	1.9	1.1	11000	10	140	7.9	2	50	140	17	87	25	0.1	75
		06/07/00	7400	<1	2.4	100	<1	220	1.4	31	18	12	31	5100	3.3	--	8.5	850	<0.2	<20	23	--	2.2	<1	--	<10	200	11	<2	<50	230	19	100	51	0.1	70
		09/20/00	5100	<1	<1	100	2.1	270	3.3	29	13	11	43	3500	2	--	11	740	<0.2	--	19	--	3.8	<1	--	<10	220	26	<2	350	88	10	110	140	0.15	36
		03/21/01	1300	<1	<1	76	<1	<200	0.46	31	3	6.6	19	420	<1	--	9.1	590	<0.2	<20	16	--	1.8	<1	4100	<10	170	13	<2	<50	6	<10	66	57	0.12	86
		09/19/01	2000	<1	<1	150	1.5	320	3.1	36	2	14.1	47	480	<1	--	15	610	<0.1	<20	18	--	0.24	<1	4700	<10	290	64	<2	<50	<5	<10	130	230	0.18	32
		03/12/02	1700	<1	<1	140	1	<200	0.87	54	<1	6.6	40	60	<1	--	18	860	<0.1	<20	21	--	4	<1	--	<10	360	87	<2	<50	4	<10	80	250	0.17	64
		09/11/02	1800	<1	<1	117	<1	200	1.1	41	<1	7.5	40	190	<1	--	17	590	<0.1	<20	11	--	3.99	<1	--	<10	330	140	<2	<50	10	<10	90	330	0.19	30
JOF-B2	B-2	09/02/92	430000	--	**56**	2000	--	2200	**11**	220	**540**	--	160	560000	200	280	44	60000	--	--	**340**	--	36	--	6400	--	1100	23	--	--	--	--	1300	22	--	980

Well ID	Historical Well ID Ref.	Date	Inorganics																															Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	**TDEC**	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**-**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**100**	**10^**	**-**	**50**	**-**	**100**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
		EPA	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**1300~**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**-**	**1^^**	**-**	**50**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
JOF-B2 (cont.)	B-2	12/15/92	240000	<1	**49**	1600	--	2200	**23**	260	**170**	--	110	550000	120	20	37	66000	--	60	**270**	--	19	2	--	--	1800	25	<50	--	--	280	1100	20	--	1100
		03/16/93	76000	<1	**17**	440	--	1600	5	280	84	--	<10	440000	30	20	36	81000	--	<20	**180**	--	17	<1	--	--	780	5.5	--	--	--	70	490	20	--	1300
		06/08/93	220000	<1	10	1200	--	600	**10**	270	20	--	60	370000	3	10	35	42000	--	90	**190**	--	19	--	--	--	910	23	--	--	--	--	890	20	--	1100
		09/22/93	62000	<1	**12**	420	--	800	4	290	55	--	<10	290000	35	<10	32	43000	--	<20	**240**	--	18	--	--	--	1000	24	--	--	--	--	480	19	--	1300
		03/08/94	780000	<1	**17**	80	--	<500	2	300	43	--	<10	400000	2	<10	34	71000	--	290	94	--	18	--	--	--	1000	25	--	--	--	--	300	24	--	1100
		09/21/94	100000	<1	**18**	250	--	1500	**6**	320	18	--	<10	380000	4	27	33	44000	--	60	**250**	--	17	--	--	--	880	26	--	--	--	--	720	22	--	1600
JOF-B20A	99-B20A	12/14/99	5600	1	4	90	1	420	0.4	17	12	17	10	7800	7	--	6.9	5300	0.2	--	12	--	0.9	1	--	10	50	6	2	--	--	10	30	22	0.1	16
		03/07/00	7500	1	3.1	99	1	750	1.7	17	3.7	14	10	5600	6.9	--	6.9	4500	0.2	<20	10	--	0.92	1	9900	10	50	7.3	2	50	150	13	25	26	0.1	19
		06/07/00	28000	<1	**13**	210	1.8	1000	0.62	14	21	20	14	31000	11	--	7.6	2400	<0.2	<20	31	--	12	<1	--	<10	100	10	<2	<50	380	65	82	24	<0.1	30
		09/20/00	4700	<1	2	62	1.2	540	1.1	10	3.3	7	<10	4700	4.1	--	4.6	1500	<0.2	--	7.8	--	3.7	<1	--	<10	<50	6.5	<2	180	58	<10	<10	25	<0.1	20
		03/21/01	3200	<1	<1	49	<1	1300	0.45	12	3	3.8	<10	3300	<1	--	5.4	960	<0.2	<20	8	--	4.3	<1	8700	<10	<50	7.6	<2	<50	35	<10	19	20	<0.1	28
		09/19/01	3700	<1	<1	60	<1	720	1	13	3	6.9	<10	2700	<1	--	5.6	1000	<0.1	<20	3.7	--	3.5	<1	10000	<10	91	6.3	<2	<50	93	<10	16	28	<0.1	12
		03/12/02	3300	<1	3.1	60	<1	590	1.1	13	<1	<1	10	3900	6	--	6.2	510	<0.1	<20	3.7	--	5.1	<1	--	<10	50	8.3	<2	<50	50	<10	30	28	<0.1	22
		09/11/02	2600	<1	<1	50	1	260	0.96	15	<1	<1	<10	4000	2.8	--	6	480	<0.1	<20	3.9	--	0.9	<1	--	<10	120	7.8	<2	<50	33	<10	30	38	<0.1	20
JOF-B3	B-3	12/15/92	19000	<1	7	320	--	<500	0.4	12	24	--	20	18000	6	<10	5.1	900	--	<20	13	--	2.3	<1	--	--	250	12	--	--	--	30	90	35	--	12
		03/17/93	4600	<1	4	210	--	<500	2	11	8	--	<10	6000	2	<10	4.6	680	--	<20	23	--	1.6	<1	--	--	100	5.4	--	--	--	20	40	36	--	8
		06/08/93	950	<1	<1	130	--	<500	0.2	8.4	<1	--	<10	840	<1	<10	4	310	--	<20	11	--	1.7	--	--	--	80	12	--	--	--	--	30	37	--	3
		09/22/93	1300	<1	4	180	--	<500	0.2	9	15	--	<10	1600	4	<10	4.8	580	--	<20	22	--	1.8	--	--	--	70	12	--	--	--	--	40	35	--	11
		03/08/94	5200	2	3	200	--	<500	0.1	9	14	--	<10	5000	3	<10	5	370	--	<20	13	--	1.7	--	--	--	110	13	--	--	--	--	30	39	--	10
		09/21/94	4700	<1	2	180	--	<500	0.1	7.5	2	--	<10	3200	<1	<10	4.3	240	--	<20	10	--	1.9	--	--	--	100	13	--	--	--	--	30	38	--	6
		03/22/95	890	--	<1	70	<1	<500	0.2	7.3	3	--	<10	630	1	--	4.4	130	--	--	17	--	1.7	--	--	--	<50	13	--	--	--	--	<10	34	--	12
		09/05/95	350	--	<1	110	<1	<500	0.1	7.5	<1	--	<10	310	<1	--	3.5	120	--	--	4	--	1.6	<1	--	--	<50	13	<2	--	--	--	<10	30	--	57
		09/05/95	780	--	<1	120	<1	<500	<0.1	9.3	<1	--	<10	680	<1	--	4.2	150	--	--	4	--	1.6	<1	--	--	60	13	<2	--	--	--	10	30	--	19
		03/21/96	550	--	<1	100	<1	<500	<0.1	7.2	3	--	<10	520	<1	--	4.1	97	--	--	9	--	1.5	--	--	--	80	11	--	--	--	--	10	33	--	12
		09/23/96	1200	--	<1	120	<1	<500	0.2	7	5	--	<10	1300	<1	--	3.8	130	--	--	2	--	1.7	--	--	--	60	14	--	--	--	--	10	35	--	12
		03/26/97	500	--	<1	130	<1	<500	0.2	8.3	3	--	<10	550	<1	--	4.4	120	--	--	11	--	1.7	--	--	--	50	14	--	--	--	--	<10	35	--	14
		09/09/97	570	--	<1	100	<1	<500	<0.1	6.6	2	--	<10	540	<1	--	3.6	89	--	--	8	--	1.6	--	--	--	80	14	--	--	--	--	<10	31	--	12
JOF-B30	B-30	08/10/11	520	<1	5.6	12	<1	<200	<0.5	12	<2	3.4	<2	480	<1	--	2.1	920	--	42	6.8	--	--	<1	--	<1	--	4	<1	<1	17	<2	<10	4.2	--	7.5
		08/10/11	450	<1	5.6	11	<1	<200	<0.5	12	<2	3.3	<2	440	<1	--	2	910	--	40	6.5	--	--	<1	--	<1	--	4	<1	<1	18	<2	<10	4.1	--	7.4
		10/13/11	210	<1	5.7	11	<1	<200	<0.5	14	3.7	2.7	2.1	440	<1	--	2.5	1200	--	23	6	--	--	<1	--	<1	--	5.1	<1	<1	<10	<2	14	5.5	--	13
		10/13/11	210	<1	5.6	10	<1	<200	<0.5	14	<2	2.7	<2	450	<1	--	2.5	1200	--	23	5.5	--	--	<1	--	<1	--	5	<1	<1	<10	<2	<10	5.5	--	13
		11/30/11	--	<1	7.5	9.9	<1	--	<0.5	--	4	5.9	<2	--	<1	--	--	--	<0.2	--	6.1	--	--	3.4	--	<1	--	--	<1	--	--	2.1	<10	--	0.4	--
		03/19/13	<100	<1	2.9	7.5	<1	<200	<0.5	10	3.4	5.1	<2	490	<1	--	1.9	960	<0.2	6.1	5.9	<0.1	2.2	<1	--	<1	11	7	<1	--	--	<2	<10	4.8	0.48	13
JOF-B4	B-4	12/15/92	110000	<1	8	1100	--	<500	3	180	99	--	160	42000	92	<10	18	1400	--	<20	**120**	--	1.4	<1	--	--	890	23	--	--	--	90	280	38	--	130
		03/17/93	1800	<1	<1	40	--	<500	0.7	53	3	--	<10	2900	3	<10	14	1300	--	<20	14	--	2	<1	--	--	60	21	--	--	--	<10	40	39	--	89
		06/08/93	82000	1	2	840	--	<500	2	150	9	--	90	49000	2	<10	24	2100	--	<20	27	--	3.8	--	--	--	670	24	--	--	--	--	280	26	--	270
		09/22/93	4000	<1	1	80	--	<500	0.7	88	3	--	<10	2800	5	<10	23	1600	--	<20	23	--	1.3	--	--	--	100	22	--	--	--	--	60	27	--	260
		03/08/94	9500	<1	3	130	--	<500	0.4	92	7	--	<10	5300	14	<10	21	2100	--	<20	32	--	1.6	--	--	--	140	24	--	--	--	--	60	29	--	240
		09/20/94	24000	<1	4	230	2	<500	0.5	75	8	--	<10	14000	15	<10	17	1800	--	<20	29	--	1.7	--	--	<10	160	22	<50	--	--	20	60	29	--	230
JOF-B5	B-5	03/13/90	--	<1	**42**	**2600**	--	530	**13**	37	**260**	--	370	91000	190	30	10	18000	--	<20	**480**	--	4.7	<1	54000	--	1000	28	--	--	--	110	1100	19	--	50
		03/13/90	9800	<1	6	360	--	<500	**12**	17	23	--	30	12000	9	20	4.6	8100	--	<20	**120**	--	2.3	<1	17000	--	130	24	--	--	--	10	210	20	--	51
		12/11/90	6800	<1	<1	290	--	<500	**10**	15	12	--	30	8200	10	<10	4.2	3500	--	<20	**110**	--	1.9	<1	15000	--	120	22	--	--	--	<10	230	20	--	88
		03/05/91	5200	3	4	140	--	<500	5	14	15	--	200	6400	18	<10	3.4	3200	--	<20	87	--	1.5	<1	16000	--	<50	19	--	--	--	<20	230	16	--	42
		06/24/91	8100	<1	<1	140	--	<500	2	20	8	--	20	5900	5	20	5.5	1600	--	<20	**130**	--	7.2	<1	18000	--	<50	20	--	--	--	<10	260	26	--	53
		09/23/91	37000	<1	3	760	--	<500	**6**	46	26	--	210	36000	22	20	14	6000	--	30	**240**	--	2.3	2	60000	--	240	20	--	--	--	30	710	23	--	58
		12/03/91	20000	--	5	250	--	<500	2	28	31	--	130	16000	14	<10	9.2	2800	--	--	**170**	--	1.5	<1	19000	--	310	19	--	--	--	30	430	29	--	62
		12/03/91	20000	--	5	270	--	<500	2	29	28	--	130	14000	15	<10	9.4	2700	--	--	**170**	--	1.5	<1	20000	--	880	19	--	--	--	10	440	29	--	58
		03/17/92	98000	--	7	440	--	<500	3	25	45	--	100	33000	37	<10	3	1900	--	<20	**180**	--	1.4	7	170000	--	160	18	--	--	--	60	450	28	--	68

Well ID	Historical Well ID Ref.	Date	Inorganics																																Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	TDEC	-	6	10	2000	4	-	5	-	100	-	-	-	15~	-	-	-	2	-	100	10^	-	50	-	100	-	-	2	-	-	-	-	-	4	-
		EPA	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
JOF-B5 (cont.)	B-5	06/09/92	22000	--	4	410	--	<500	2	26	34	--	60	16000	20	20	7.5	1400	--	--	**140**	--	3.4	--	37000	--	130	21	--	--	--	--	350	32	--	440
		09/02/92	7500	--	1	110	--	<500	2	19	5	--	20	4200	5	<10	5	770	--	--	95	--	1.6	--	19000	--	<50	21	--	--	--	--	260	33	--	20
		12/14/92	2600	<1	1	20	--	<500	1	22	4	--	<10	1300	2	<10	4.6	460	--	<20	86	--	1.4	2	--	--	<50	21	--	--	--	<10	250	34	--	47
		06/08/93	2300	<1	1	30	--	<500	1	20	1	--	<10	1200	<1	<10	4	230	--	<20	77	--	1.5	--	--	--	<50	20	--	--	--	--	220	34	--	60
		03/09/94	1200	<1	<1	20	--	<500	0.8	20	2	--	<10	680	1	<10	4.4	130	--	<20	75	--	1.4	--	--	--	<50	20	--	--	--	--	210	34	--	53
		05/16/94	--	--	--	--	<1	--	--	--	--	8	--	--	--	--	--	--	0.5	--	--	--	--	<1	--	<10	--	--	<50	--	--	<10	--	--	0.5	--
		07/20/94	--	--	--	--	<1	--	--	--	--	5	--	--	--	--	--	--	0.2	--	--	--	--	<1	--	<10	--	--	<50	--	--	<10	--	--	0.2	--
		09/20/94	370	<1	<1	<10	<1	<500	0.9	20	<1	11	<10	10	<1	<10	4.4	100	0.2	<20	86	--	1.5	<1	--	<10	<50	20	<10	--	--	<10	200	34	0.4	58
		03/22/95	370	<1	<1	<10	<1	<500	1	20	1	3	<10	50	<1	--	4.7	72	0.3	--	81	--	1.4	<1	--	<10	<50	20	<2	--	--	<10	220	34	0.5	52
		09/05/95	450	1	1	<10	<1	<500	1	22	1	3	<10	120	<1	--	5	99	<0.2	<20	58	--	1.3	<1	--	<10	<50	20	<2	--	--	<10	230	32	0.6	53
		03/21/96	520	<1	1	<10	<1	<500	1	20	<1	3	<10	170	<1	--	4.6	45	0.2	<20	68	--	1.4	<1	--	<10	<50	19	<1	--	--	<10	210	36	0.5	51
		03/21/96	510	<1	<1	<10	<1	<500	1	20	<1	3	<10	160	<1	--	4.6	45	0.2	<20	70	--	1.4	<1	--	<10	<50	20	<1	--	--	<10	220	34	0.5	49
		09/23/96	500	<1	2	<10	<1	<500	1	20	1	4	<10	160	<1	--	4.4	73	<0.2	<20	72	--	1.4	<1	--	<10	<50	21	<2	--	--	<10	210	36	0.3	53
		03/26/97	490	<1	<1	<10	<1	<500	1	21	<1	<1	<10	40	<1	--	4.6	54	0.2	--	93	--	1.6	<1	--	<10	<50	21	<2	--	--	<10	350	35	0.5	53
		09/10/97	490	<1	<1	<10	<1	<500	0.8	20	<1	<1	<10	370	<1	--	4.6	64	0.4	--	77	--	1.4	<1	--	<10	<50	22	<2	--	--	<10	200	33	0.4	42
		03/17/98	860	<1	<1	10	<1	<500	1	19	<1	2	<10	380	2	--	4.3	62	0.6	--	87	--	1.8	<1	--	<10	<50	21	<2	--	--	<10	210	32	0.4	60
		09/16/98	900	<1	<1	10	<1	<200	1	18	2	3	<10	480	<1	--	4	70	<0.2	--	76	--	1.4	<1	--	<10	<50	22	<2	--	--	<10	210	32	0.5	31
		03/09/99	850	1	1	10	1	200	1.2	18	6	4	10	350	1	--	4.4	78	1.1	--	73	--	1.4	1	--	10	50	21	2	--	--	10	200	31	0.4	57
		09/10/99	940	1	1	10	1	200	1.1	20	3	4	10	510	1	--	4.4	94	1.7	--	62	--	1.4	1	--	10	50	22	2	--	--	10	210	25	0.4	84
		03/08/00	780	1	1	14	1	200	1	19	1	4.5	10	310	1	--	4.6	100	0.75	<20	68	--	1.8	1	4400	10	50	22	2	50	5	10	200	32	0.5	66
		09/19/00	840	<1	<1	13	1.5	<200	1.7	18	1.9	3.3	<10	230	1	--	4.5	85	**6.6**	--	70	--	1.6	<1	--	<10	<50	22	<2	200	7.2	<10	190	31	0.48	59
		03/20/01	1100	<1	<1	13	<1	<200	2.3	19	<1	2.2	<10	420	<1	--	4.6	74	1.4	<20	72	--	1.5	<1	5500	<10	<50	17	<2	<50	7.3	<10	210	30	0.39	68
		09/18/01	670	<1	<1	11	1.2	<200	2.1	18	<1	4.6	13	240	<1	--	4.5	59	1.3	<20	65	--	1.4	<1	4100	<10	<50	21	<2	<50	<5	<10	190	34	0.43	70
		03/12/02	590	<1	<1	<10	<1	<200	0.89	19	<1	<1	10	150	<1	--	4.7	65	0.8	<20	63	--	0.98	<1	--	<10	<50	25	<2	<50	<5	<10	190	30	0.44	57
		09/10/02	730	<1	<1	<10	<1	<200	1.4	19	<1	<1	<10	170	<1	--	4.6	58	1.2	<20	54	--	1.1	<1	--	<10	<50	26	<2	<50	10	<10	200	30	0.45	63
		03/11/03	590	<1	<1	<10	<1	200	1.1	18	<1	<1	<10	180	<1	--	4.3	58	0.9	<20	66	--	1.3	<1	5000	<10	<50	20	<2	140	<5	<10	200	30	0.34	63
		09/09/03	410	0.5	<0.1	<10	<1	<200	1.1	17	<0.5	1.6	10	90	0.5	--	4.1	55	0.8	--	65.1	--	1.2	<0.2	--	<10	<50	24	0.3	--	--	<10	190	31	0.47	59
		03/09/04	340	<0.6	<0.1	<10	<1	<200	1.13	18	0.1	1.6	10	60	0.2	--	4.2	55	1.3	<20	55.6	--	0.74	0.2	--	<10	<50	22	<0.1	--	--	<10	200	31	0.43	63
		09/14/04	380	<3	<1	<10	<1	<200	1	18	<1	<1	<10	50	<1	--	4	55	0.8	<20	67	--	1.3	<1	--	<10	<50	24	<2	<50	<5	<10	190	31	0.41	66
		09/14/04	380	<3	1	<10	<1	<200	1.1	18	<1	<1	<10	60	<1	--	4	55	0.7	<20	65	--	0.93	<1	--	<10	<50	24	<2	<50	<5	<10	190	32	0.43	59
		03/08/05	400	<3	<1	<10	<1	<200	1.1	18	2	3	10	60	<1	--	4.2	57	0.8	<20	59	--	1.5	<1	--	<10	<50	24	<2	<50	<5	<10	200	32	0.37	62
		09/07/05	350	<3	<1	<10	<1	<200	1.1	19	1	1	<10	60	<1	--	4.1	65	0.7	<20	70	--	2	<1	--	<10	<50	25	<2	--	--	<10	190	33	0.41	59
		03/22/06	530	<3	<1	10	1	<200	1.3	18	2	1	10	170	<1	--	4.1	61	**2.1**	<20	70	--	1.6	<1	--	<10	<50	25	<2	--	--	<10	200	33	0.43	62
		05/24/06	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		05/24/06	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		09/19/06	400	<3	<1	<10	<1	<200	1.1	19	7	1	<10	60	1	--	4.4	56	0.5	<20	71	--	1.4	<1	--	<10	<50	25	<2	--	--	<10	210	34	0.43	62
		03/06/07	680	<1	<1	6.6	<2	<200	1.6	19	1.1	1.7	8.9	<100	<1	--	4.6	59	0.52	<5	65	--	1.4	1.3	--	<0.5	<10	27	<1	--	--	<10	200	30	0.46	63
		09/19/07	320	<1	<1	6.6	<2	<200	1.2	22	1.1	<10	7.8	<100	<1	--	4.6	69	0.5	<5	68	--	1.3	1.8	--	<0.5	<10	28	<1	--	--	<10	200	32	0.52	67
		03/12/08	950	<1	<1	12	<2	<200	1.2	20	1.8	<10	10	420	<1	--	4.8	70	0.77	<5	77	--	1.4	1.3	--	<0.5	<10	26	<1	--	--	<10	230	30	0.22	64
		09/16/08	420	<1	2.5	6.4	<2	<200	1.4	18	<1	<10	10	<100	<1	--	4.5	57	0.76	<5	74	--	1.6	<1	--	<0.5	<10	27	<1	--	--	<10	200	31	0.34	68
		09/16/08	360	<1	3.5	7.9	<2	<200	1.4	20	<1	<10	9.4	<100	<1	--	4.9	63	0.76	<5	74	--	1.5	1.2	--	<0.5	<10	27	<1	--	--	<10	190	31	0.34	68
		03/10/09	780	<1	<1	9.6	<2	<200	1.1	20	1.5	<10	11	170	<1	--	4.9	64	0.55	<5	73	--	1.6	1.9	--	<0.5	<10	27	<1	--	--	<10	220	32	0.31	68
		09/15/09	2000	<1	1.1	20	<2	<200	1.6	22	2.9	<10	13	680	3	--	5.4	87	0.38	<5	76	--	2.2	2.2	--	<1	<10	30	<1	--	--	<10	210	32	0.45	66
		03/10/10	540	<1	<1	7.6	<2	<200	1.2	19	<2	<10	8.3	120	<1	--	4.9	69	0.61	<5	67	--	1.6	1.4	--	<1	<10	28	<1	--	--	<2	190	34	0.56	70
		09/14/10	890	<1	<1	11	<2	<200	0.69	21	<2	<10	7.3	220	<1	--	5.1	71	0.27	<5	72	--	1.6	<1	--	<1	<10	29	<1	--	--	<2	210	35	0.36	66
		09/14/10	810	<1	<1	11	<2	<200	0.71	21	2.3	<10	7.5	210	<1	--	5.1	72	0.29	<5	74	--	1.5	<1	--	<1	<10	28	<1	--	--	<2	210	35	0.36	66
		03/16/11	390	<1	<1	7.8	<2	<200	0.55	20	2.1	<10	7.5	110	<1	--	5	65	0.66	<5	63	--	1.4	<1	--	<1	<10	27	<1	--	--	<10	180	35	0.47	67
		09/14/11	450	<1	1.2	5.9	<2	<200	1	21	<2	<10	8.2	140	<1	--	5.1	59	0.28	<5	65	--	1.6	<1	--	<1	<10	30	<1	--	--	<10	180	36	0.42	67

Well ID	Historical Well ID Ref.	Date	Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
			Inorganics																															Anions		
	MCLs	**TDEC**	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**-**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**100**	**10^**	**-**	**50**	**-**	**100**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
		EPA	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**1300~**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**-**	**1^^**	**-**	**50**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
JOF-B5 (cont.)	B-5	11/30/11	--	--	--	--	--	--	<0.5	--	--	--	--	--	--	--	--	--	0.24	--	70	--	--	--	--	--	--	--	--	--	--	--	190	--	0.41	--
		03/21/12	360	<1	3.4	<5	<2	<200	0.91	20	<2	<10	7.8	<100	<1	--	5	53	0.22	<5	61	--	1.3	6.1	--	<1	<10	27	<1	--	--	<10	170	36	0.43	69
		09/18/12	--	<1	<1	6.6	<1	--	0.78	--	<2	<1	7.2	--	<1	--	--	--	0.23	--	68	--	--	<1	--	<1	--	--	<1	--	--	<2	160	--	0.51	--
		09/18/12	--	<1	<1	7	<1	--	0.74	--	<2	<1	13	--	<1	--	--	--	0.31	--	66	--	--	<1	--	<1	--	--	<1	--	--	<2	160	--	0.52	--
		03/19/13	420	<1	<1	5.8	<1	<200	1.1	21	<2	1	8.4	<100	<1	--	4.7	58	0.27	<2	70	0.56	2.9	<1	--	<1	23	33	<1	--	--	<2	180	36	0.52	72
JOF-B6	B-6	03/18/92	73000	--	**530**	270	--	5100	5	140	9	--	370	270000	113	<10	4.9	2500	--	<20	**720**	--	6.9	24	21000	--	590	11	--	--	--	490	750	6	--	280
		06/09/92	230000	--	**1300**	840	--	1200	**21**	50	**240**	--	130	980000	250	90	26	2000	--	--	**2000**	--	30	--	9000	--	<80	4.2	--	--	--	--	2200	3	--	100
		09/01/92	81000	--	**390**	340	--	2400	5	80	96	--	390	290000	11	90	16	1600	--	--	58	--	29	--	2300	--	400	7.4	--	--	--	--	820	3	--	170
		12/14/92	36000	<1	**250**	170	--	2900	2	96	59	--	210	170000	77	<10	13	1600	--	330	**370**	--	8.3	16	--	--	420	7.5	--	--	--	310	360	5	--	400
		03/16/93	20000	2	**210**	110	--	1600	1	74	28	--	140	110000	33	<10	10	1500	--	250	**110**	--	6.7	<1	--	--	190	6	--	--	--	210	280	4	--	190
		06/09/93	12000	1	**30**	50	--	2200	0.3	140	7	--	30	13000	7	<10	15	1800	--	40	44	--	6.4	--	--	--	380	8.8	--	--	--	--	<10	5	--	350
		09/21/93	28000	6	**220**	170	--	4100	2	150	32	--	150	120000	47	<10	19	2000	--	300	**280**	--	8.1	--	--	--	480	9.6	--	--	--	--	360	6	--	450
		03/08/94	8300	2	**48**	60	--	1000	0.5	96	6	--	20	26000	8	<10	12	1600	--	70	51	--	5.2	--	--	--	270	6.8	--	--	--	--	80	3	--	200
		05/18/94	--	--	--	--	2	--	--	--	--	24	--	--	--	--	--	--	0.3	--	--	--	--	<1	--	<10	--	--	<50	--	--	<10	--	--	0.3	--
		07/20/94	--	--	--	--	**5**	--	--	--	--	22	--	--	--	--	--	--	0.2	--	--	--	--	2	--	<10	--	--	<50	--	--	80	--	--	0.1	--
		09/20/94	3900	<1	**25**	50	2	6800	0.4	200	3	14	<10	15000	9	<10	19	2400	<0.2	30	26	--	7.9	<1	--	<10	540	14	<10	--	--	40	50	10	0.1	620
		03/22/95	150	<1	2	<10	<1	6400	0.4	180	<1	3	<10	440	<1	--	17	2200	<0.2	--	15	--	6.2	<1	--	<10	280	12	<2	--	--	<10	30	8	0.2	540
		09/06/95	210	<1	3	30	1	10000	0.5	260	<1	5	<10	740	2	--	22	3200	<0.2	20	9	--	8.8	3	--	<10	710	18	<2	--	--	<10	50	11	0.2	580
		03/25/96	170	<1	<1	<10	<1	18000	0.6	350	<1	14	<10	150	<1	--	26	4000	<0.2	<20	4	--	11	<1	--	<10	1000	20	<1	--	--	<10	70	14	0.1	820
		09/24/96	140	<1	2	30	<1	18000	0.6	360	<1	7	<10	440	<1	--	19	3400	<0.2	<20	24	--	12	<1	--	<10	940	18	<2	--	--	<10	70	15	<0.1	770
		09/24/96	160	<1	2	30	<1	19000	0.6	360	<1	7	<10	630	<1	--	19	3400	<0.2	<20	20	--	12	<1	--	<10	950	17	<2	--	--	<10	50	15	<0.1	790
		03/26/97	70	2	2	30	<1	7800	0.3	190	<1	2	<10	1800	<1	--	18	2000	<0.2	--	13	--	7.9	<1	--	<10	450	13	<2	--	--	<10	10	7	0.1	500
		09/09/97	90	<1	<1	20	<1	13000	0.6	270	<1	2	<10	1200	<1	--	17	2900	<0.2	--	12	--	11	<1	--	<10	730	17	<2	--	--	<10	40	8	0.2	600
		03/18/98	80	<1	2	20	1	9600	0.4	220	<1	6	<10	940	<1	--	15	2600	<0.2	--	12	--	9.2	<1	--	<10	590	14	<2	--	--	10	40	9	0.1	670
		09/15/98	120	<1	<1	20	1	14000	0.6	250	2	10	<10	330	<1	--	14	3500	<0.2	--	16	--	10	<1	--	<10	720	18	<2	--	--	<10	60	13	0.1	760
		03/09/99	100	1	1	20	1	15000	0.6	280	3	5	10	220	1	--	15	3600	0.2	--	9	--	12	1	--	10	790	17	2	--	--	10	50	14	0.1	1200
		09/13/99	90	2	1	20	1	18000	0.6	270	14	4	10	380	1	--	15	3800	0.2	--	12	--	11	1	--	10	800	18	2	--	--	10	50	16	0.1	1000
		03/08/00	83	1	1	28	1	18000	0.36	290	1	9.1	10	270	1	--	17	3800	0.2	<20	9.8	--	12	1	3600	10	930	18	2	50	5	10	40	19	0.1	850
		09/20/00	1400	2.3	5	30	1.9	15000	0.9	250	2.1	6.4	<10	3300	<1	--	16	3700	<0.2	--	16	--	11	<1	--	<10	840	19	<2	820	29	<10	36	20	<0.1	850
		03/21/01	66	<1	<1	14	<1	12000	0.6	220	<1	<1	<10	170	<1	--	16	1500	<0.2	44	8	--	7.7	<1	3500	<10	650	13	<2	<50	<5	<10	37	14	<0.1	--
		03/21/01	69	<1	<1	18	<1	11000	0.64	220	<1	<1	<10	170	<1	--	15	1400	<0.2	33	9	--	7.6	<1	3300	<10	620	13	<2	<50	<5	<10	36	14	<0.1	740
		09/19/01	690	<1	<1	24	1.1	16000	1.1	18	<1	1.9	14	250	<1	--	4.5	60	0.12	<20	14	--	9.1	<1	4200	<10	780	17	<2	<50	<5	<10	190	14	0.13	760
		03/12/02	80	<1	<1	20	<1	13000	0.42	220	<1	<1	<10	470	<1	--	18	1600	<0.1	<20	13	--	8.5	9.2	--	<10	640	17	<2	<50	<5	<10	30	13	0.13	600
		09/10/02	90	<1	<1	20	<1	8300	0.61	190	<1	3.2	<10	810	<1	--	14	2200	<0.1	<20	10	--	8.3	<1	--	<10	570	15	<2	<50	<5	<10	50	14	0.19	560
		03/12/03	600	<1	<1	20	<1	4500	0.3	110	<1	14	<10	2100	6	--	13	580	<0.1	<20	7	--	5.4	<1	6000	<10	280	8.8	<2	680	<5	<10	26	6.1	0.13	290
		09/09/03	<50	0.4	1.4	840	<1	3400	0.15	80	<1	1.7	<10	820	<0.1	--	9.3	460	<0.1	--	7.8	--	5.6	0.9	--	<10	540	8.6	<0.1	--	--	10	<10	4.6	0.13	240
		03/09/04	<50	<0.6	1.3	10	1	3600	0.14	81	1.1	1.3	<10	650	0.2	--	9	400	<0.1	<20	6.2	--	4.6	0.7	--	<10	200	7.1	<0.1	--	--	<10	<10	5.4	0.12	220
		09/14/04	<50	<3	2	10	<1	7700	0.2	140	<1	<1	<10	430	<1	--	12	230	<0.1	<20	1	--	5.8	<1	--	<10	400	12	<2	<50	<5	<10	<10	14	0.14	420
		03/08/05	50	<3	1	10	<1	4800	<0.1	100	1	3	<10	440	<1	--	12	250	<0.1	<20	6	--	5.5	<1	--	<10	260	10	<2	<50	<5	<10	<10	7.2	0.11	292
		03/08/05	<50	<3	1	10	<1	4900	<0.1	100	1	1	<10	410	<1	--	12	240	<0.1	<20	5	--	5.5	<1	--	<10	260	11	<2	<50	<5	<10	<10	7.8	0.1	312
		09/07/05	<50	<3	1	10	1	6400	0.1	110	1	<1	<10	210	<1	--	10	240	<0.1	<20	6	--	6	<1	--	<10	320	10	<2	--	--	<10	<10	11	0.11	300
		03/22/06	260	<3	2	10	<1	2700	<0.1	68	2	<1	<10	720	<1	--	7.8	140	<0.1	<20	7	--	3.7	<1	--	<10	190	5.8	<2	--	--	<10	<10	4	0.14	183
		09/19/06	300	<3	1	20	1	8400	0.1	130	<1	1	<10	930	<1	--	11	440	<0.1	<20	9	--	7.1	<1	--	<10	380	12	<2	--	--	<10	20	16	0.12	260
		03/06/07	110	<1	<1	7.7	<2	1200	<0.5	44	1.2	1.1	1.8	340	<1	--	5.8	190	<0.2	<5	4.6	--	3.8	<1	--	<0.5	110	4.3	<1	--	--	<10	10	1.9	0.12	120
		09/19/07	<100	<1	2.3	26	<2	8200	0.52	120	<1	<10	1.4	2000	<1	--	12	760	<0.2	<5	18	--	6.7	1.3	--	<0.5	370	13	<1	--	--	<10	50	16	<0.1	380
		03/12/08	<100	<1	1.2	8.9	<2	1200	<0.5	45	<1	<10	1.2	580	<1	--	6.7	210	<0.2	<5	5.3	--	3.7	1.2	--	<0.5	98	4.4	<1	--	--	<10	11	2.3	<0.1	140
		09/16/08	110	<1	5	22	<2	6900	0.5	100	<1	<10	1.3	600	<1	--	11	490	<0.2	5.8	24	--	7	<1	--	<0.5	330	13	<1	--	--	<10	47	15	<0.1	320
		03/10/09	150	<1	1.6	7	<2	1300	<0.5	37	1.3	<10	1.5	430	<1	--	5.6	200	<0.2	<5	5.2	--	4	<1	--	<0.5	82	4.8	<1	--	--	<10	11	2.4	<0.1	120

Well ID	Historical Well ID Ref.	Date	Inorganics																															Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	TDEC	-	6	10	2000	4	-	5	-	100	-	-	-	15~	-	-	-	2	-	100	10^	-	50	-	100	-	-	2	-	-	-	-	-	4	-
		EPA	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
JOF-B6 (cont.)	B-6	03/10/09	120	<1	1.8	7.8	<2	1300	<0.5	36	2.1	<10	1.5	430	<1	--	5.4	190	<0.2	<5	5.4	--	3.9	1.6	--	<0.5	79	5.2	<1	--	--	<10	12	2.6	0.11	120
		09/15/09	<100	<1	3	15	<2	5500	<0.5	94	<2	<10	<2	2700	<1	--	11	290	<0.2	<5	5.5	--	6.1	<1	--	<1	240	12	<1	--	--	<10	13	12	0.15	270
		03/10/10	<100	<1	1.4	10	<2	3300	<0.5	70	<2	<10	<2	500	<1	--	9.1	200	<0.2	<5	6	--	5	<1	--	<1	160	7.9	<1	--	--	<2	12	7.7	0.15	190
		09/14/10	<100	<1	1.1	21	<2	6500	<0.5	100	<2	<10	<2	880	<1	--	11	390	<0.2	<5	10	--	7	<1	--	<1	300	13	<1	--	--	<2	24	17	<0.1	310
		03/16/11	<100	<1	1.5	7.9	<2	1400	<0.5	39	<2	<10	<2	400	<1	--	5.6	190	<0.2	<5	5	--	4.1	2.3	--	<1	92	5	<1	--	--	<10	11	3.7	<0.1	120
		03/16/11	<100	<1	<1	8.7	<2	1400	<0.5	41	<2	<10	<2	380	<1	--	5.8	190	<0.2	<5	4.9	--	3.9	<1	--	<1	94	5.1	<1	--	--	<10	16	3.7	<0.1	130
		09/13/11	<100	<1	2.3	20	<2	6100	<0.5	100	<2	<10	<2	600	<1	--	11	270	<0.2	7.4	9.6	--	6.9	1	--	<1	300	13	<1	--	--	<10	22	16	0.1	280
		11/30/11	--	--	1.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.1	--	--	--	--	--	--	--	--	--	--	--	<10	--	--	--
		11/30/11	--	--	1.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	--	--	--	--	--	--	--	--	--	<10	--	--	--
		03/21/12	<100	<1	2.2	8.5	<2	2900	<0.5	62	<2	<10	<2	300	<1	--	8.2	150	<0.2	<5	4.6	--	4.1	3.6	--	<1	160	6.9	<1	--	--	<10	12	6.6	0.14	180
		09/19/12	--	<1	1.6	8.3	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	5.3	--	--	<1	--	<1	--	--	<1	--	--	<2	12	--	0.13	--
		03/20/13	<100	<1	1.5	6.4	<1	1300	<0.5	34	<2	2.2	<2	280	<1	--	5.1	160	<0.2	2.4	5.2	0.54	4.2	<1	--	<1	84	5.3	<1	--	--	<2	11	3.4	<0.1	120
		03/20/13	<100	<1	1.4	7.4	<1	1300	<0.5	33	<2	2.3	<2	240	<1	--	4.8	160	<0.2	2.8	5.8	0.5	4.4	<1	--	<1	84	5.1	<1	--	--	<2	12	3.3	0.14	130
		03/20/13	160	<1	<1	28	<1	7200	<0.5	110	<2	<1	<2	<100	<1	--	12	1500	<0.2	<2	18	0.49	4.9	<1	--	<1	370	18	<1	--	--	<2	26	18	<0.1	340
		09/25/13	--	<1	<1	20.3	<1	--	<1	--	<1	<1	2	--	<1	--	--	--	<0.2	--	14	--	--	<1	--	<0.5	--	--	<1	--	--	<1	33.2	--	<0.4	--
		09/25/13	--	<1	<1	20.9	<1	--	<1	--	<1	<1	<1	--	<1	--	--	--	<0.2	--	13.9	--	--	<1	--	<0.5	--	--	<1	--	--	<1	28.4	--	<0.4	--
		03/11/14	525	<1	<1	20.3	<1	6620	<1	107	<1	<5	<1	814	<1	--	10.7	722	<0.2	<1	11.3	--	4.58	<1	--	<0.5	326	13.6	<1	--	--	<10	26.6	16.6	<0.4	281
		09/09/14	--	<1	<1	19	<1	--	<0.5	--	<2	<1	<2	--	2.7	--	--	--	<0.2	--	10	--	--	<1	--	2.4	--	--	<1	--	--	<2	23	--	<0.1	--
		03/17/15	--	<2	<2	16	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	10	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		09/23/15	--	<2	<2	17.4	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	9.4	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		03/22/16	--	<2	<2	17.3	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	9.17	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		09/21/16	--	<2	<2	15.7	<2	7680	<1	104	<2	<2	<5	--	<2	<15	--	--	<0.2	<5	7.99	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	19.7	<0.1	333
		09/21/16	--	<2	<2	17.1	<2	7650	<1	104	<2	<2	<5	--	<2	<15	--	--	<0.2	<5	7.92	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	19.3	<0.1	334
JOF-B7	B-7	12/15/92	2900	<1	10	10	--	<500	0.4	43	6	--	<10	7100	10	<10	4.4	900	--	<20	23	--	2.9	2	--	--	<50	3.7	--	--	--	<10	40	3	--	14
		03/16/93	28000	<1	**23**	140	--	<500	4	47	94	--	250	79000	30	<10	6.2	780	--	100	99	--	4.6	<1	--	--	130	3.6	--	--	--	160	770	4	--	15
		06/08/93	340000	<1	**64**	760	--	<500	**14**	78	**910**	--	870	310000	140	<10	39	2000	--	400	**600**	--	7.8	--	--	--	930	3.8	--	--	--	--	2700	3	--	29
		09/21/93	170000	2	**150**	940	--	<500	**33**	120	**700**	--	1500	490000	350	<10	25	6100	--	510	**850**	--	11	--	--	--	1200	4.2	--	--	--	--	5400	2	--	35
		03/09/94	3000	2	2	30	--	<500	0.3	39	5	--	<10	4200	4	<10	4.4	260	--	<20	9	--	2.4	--	--	--	50	3.6	--	--	--	--	40	3	--	15
		05/18/94	--	--	--	--	<1	--	--	--	--	2	--	--	--	--	--	--	0.4	--	--	--	--	<1	--	<10	--	--	<50	--	--	<10	--	--	0.3	--
		07/20/94	--	--	--	--	<1	--	--	--	--	3	--	--	--	--	--	--	<0.2	--	--	--	--	<1	--	<10	--	--	<50	--	--	10	--	--	0.2	--
		09/20/94	3500	2	3	30	<1	<500	0.8	50	8	--	<10	8700	5	<10	5.1	360	--	20	9	--	3	--	--	<10	60	3.7	**110**	--	--	20	80	2	--	23
		03/21/95	90	<1	<1	<10	<1	<500	0.1	44	7	<1	<10	100	<1	--	5.1	96	<0.2	--	6	--	2.4	<1	--	<10	<50	3.6	<2	--	--	<10	<10	4	0.2	21
		09/06/95	1700	<1	2	10	<1	<500	<0.1	54	3	2	<10	2100	1	--	6	370	<0.2	<20	9	--	2.6	<1	--	<10	60	3.7	<2	--	--	<10	20	2	0.3	33
		03/26/96	3900	<1	2	10	<1	<500	0.4	46	9	8	10	6000	6	--	5.6	180	<0.2	<20	8	--	2.7	2	--	<10	<50	3.5	<1	--	--	10	50	3	0.2	20
		09/25/96	810	<1	<1	10	<1	<500	0.2	51	2	2	<10	1500	<1	--	5.2	420	<0.2	<20	5	--	2.5	<1	--	<10	70	3.6	<2	--	--	<10	10	3	0.1	23
		03/26/97	3000	<1	8	20	<1	<500	0.9	56	22	11	20	13000	11	--	6	220	<0.2	--	51	--	3	<1	--	<10	70	3.9	<2	--	--	20	130	2	0.2	22
		09/09/97	3600	<1	3	20	<1	<500	0.4	51	15	3	10	9400	4	--	6	500	<0.2	--	22	--	2.7	<1	--	<10	50	2.8	<2	--	--	10	70	4	0.2	31
		03/18/98	1100	<1	2	10	<1	<500	0.4	46	8	<1	<10	2000	<1	--	5.2	170	<0.2	--	10	--	2.5	<1	--	<10	<50	3.6	<2	--	--	<10	10	3	0.2	28
		03/18/98	1800	<1	2	10	<1	<500	<0.1	48	6	<1	<10	2800	<1	--	5	140	<0.2	--	9	--	2.5	<1	--	<10	70	3.6	<2	--	--	<10	20	3	0.2	24
		09/16/98	1500	<1	3	10	<1	<200	0.3	47	16	5	<10	3500	2	--	5	320	<0.2	--	11	--	2.4	<1	--	<10	60	3.5	<2	--	--	<10	40	4	0.2	15
		09/16/98	5800	<1	7	20	<1	<200	0.4	43	26	10	20	13000	5	--	4.8	410	<0.2	--	26	--	2.5	<1	--	<10	60	3.8	<2	--	--	10	90	5	0.2	13
		03/09/99	720	1	2	10	1	200	0.3	46	15	4	10	1800	2	--	5.1	220	0.2	--	11	--	2.4	1	--	10	50	3.8	2	--	--	10	10	4	0.2	38
		03/09/99	3600	1	4	10	1	200	0.1	46	62	4	10	6000	3	--	5.4	160	0.2	--	17	--	2.6	2	--	10	60	3.8	2	--	--	10	30	3	0.2	40
		09/13/99	600	1	1	10	1	200	0.2	50	18	7	10	1500	1	--	5.1	360	0.2	--	15	--	2.5	1	--	10	50	3.8	2	--	--	10	10	2	0.2	28
		03/08/00	2000	1	2.5	14	1	430	0.4	48	28	23	10	3700	2.6	--	5.4	250	0.2	<20	21	--	2.8	1	6700	10	72	3.8	2	50	45	10	27	4	0.2	14
		09/20/00	3900	1.3	3	22	1.5	<200	0.3	43	9	2	14	5200	4.5	--	5.1	330	<0.2	--	8.4	--	2.7	<1	--	<10	70	3.4	<2	350	64	12	25	4	0.22	20
		03/21/01	3700	<1	8	16	<1	<200	1.4	42	17	2	<10	6300	4.8	--	4.9	330	<0.2	<20	17	--	3.4	<1	12000	<10	60	3.5	<2	<50	35	12	43	4.9	0.18	21
		09/18/01	3000	<1	<1	21	1.1	<200	2.4	44	12	6.8	160	4900	2.8	--	5.2	470	<0.1	<20	<1	--	9	<1	9800	<10	70	18	<2	<50	29	<10	100	5	0.26	20

Well ID	Historical Well ID Ref.	Date	Inorganics																															Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	**TDEC**	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**-**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**100**	**10^**	**-**	**50**	**-**	**100**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
		EPA	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**1300~**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**-**	**1^^**	**-**	**50**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
JOF-B7 (cont.)	B-7	03/12/02	1800	<1	<1	20	<1	<200	0.64	40	3	<1	20	4800	<1	--	4.6	390	<0.1	<20	7.2	--	2.3	<1	--	<10	60	2.9	<2	<50	28	<10	30	5.2	0.23	16
		09/10/02	12000	<1	<1	50	1	<200	2.3	42	2	2.9	20	13000	2.8	--	5.9	390	<0.1	30	7.7	--	2.7	<1	--	<10	90	4	<2	<50	280	40	100	4.9	0.24	13
JOF-B8	B-8	03/18/92	240000	--	**640**	1300	--	6000	1	270	**830**	--	1400	590000	21	<10	9.6	4000	--	1300	60	--	9.4	11	8600	--	1200	24	--	--	--	1500	3200	9	--	560
		06/10/92	810000	--	**940**	**3500**	--	8700	**61**	410	**870**	--	3300	180000	430	160	110	6500	--	--	**2800**	--	48	--	19000	--	2700	25	--	--	--	--	7400	8	--	900
		09/02/92	590000	--	**1100**	**2600**	--	7500	**35**	370	**1200**	--	2300	1500000	540	520	70	4600	--	--	**3200**	--	130	--	5200	--	2100	22	--	--	--	--	5500	8	--	965
		12/14/92	330000	<1	**900**	1400	--	7100	**43**	380	**630**	--	2000	1200000	450	30	51	7000	--	1700	**2600**	--	19	20	--	--	2800	24	--	--	--	2000	5800	8	--	110
		03/16/93	160000	<1	**480**	1200	--	5300	**26**	320	**400**	--	1100	650000	220	20	45	4800	--	910	**1400**	--	14	12	--	--	1200	1.9	--	--	--	1100	3000	12	--	790
		06/09/93	52000	<1	**37**	170	--	3200	3	290	41	--	100	53000	18	<10	35	2000	--	80	**160**	--	8.5	--	--	--	800	24	--	--	--	--	220	12	--	880
		09/21/93	78000	3	**110**	450	--	6300	3	340	81	--	250	150000	50	<10	38	2300	--	210	**300**	--	10	--	--	--	1200	23	--	--	--	--	690	8	--	970
		03/08/94	11000	2	**27**	100	--	2700	1	310	18	--	30	25000	10	<10	33	1800	--	40	76	--	8.3	--	--	--	840	25	<50	--	--	--	140	14	--	790
		05/18/94	--	--	--	--	2	--	--	--	--	98	--	--	--	--	--	--	**17**	--	--	--	--	1	--	<10	--	--	<50	--	--	40	--	--	0.2	--
		07/20/94	--	--	--	--	2	--	--	--	--	57	--	--	--	--	--	--	**8.2**	--	--	--	--	<1	--	<10	--	--	<50	--	--	80	--	--	0.2	--
		09/20/94	14000	2	**20**	120	2	7000	1	320	12	--	<10	29000	15	<10	29	1800	--	40	60	--	9.5	--	--	<10	840	23	<10	--	--	60	110	8	--	930
		03/22/95	1600	5	<1	<10	<1	8600	0.9	310	<1	50	<10	1900	<1	--	29	1800	0.2	--	27	--	9.5	3	--	<10	650	23	<2	--	--	<10	50	11	0.2	920
		09/06/95	990	2	1	30	<1	8500	0.8	340	2	41	<10	1200	4	--	25	1800	0.3	<20	20	--	10	3	--	<10	910	21	<2	--	--	<10	40	8	0.3	730
		03/25/96	1800	2	4	10	<1	10000	1	320	4	57	<10	3700	<1	--	29	1900	0.6	<20	29	--	9.5	<1	--	<10	780	25	<1	--	--	<10	50	16	0.2	760
		09/24/96	850	<1	<1	20	<1	12000	0.8	360	3	32	<10	890	<1	--	26	1700	<0.2	<20	21	--	9.2	<1	--	<10	880	22	<2	--	--	<10	40	10	0.2	800
		03/26/97	660	<1	3	20	<1	10000	0.8	330	1	40	<10	700	<1	--	27	1700	0.2	--	32	--	9.6	1	--	<10	910	24	<2	--	--	<10	20	12	0.2	850
		09/10/97	1800	<1	<1	20	<1	10000	0.8	320	7	31	<10	3200	<1	--	25	1800	**3.5**	--	36	--	10	<1	--	<10	860	22	<2	--	--	<10	40	9	0.3	870
		03/18/98	950	<1	<1	20	1	9800	1	310	4	45	<10	1300	<1	--	22	1700	0.2	--	30	--	10	<1	--	<10	790	22	<2	--	--	<10	40	11	0.2	980
		09/16/98	1900	<1	2	30	<1	9000	2	300	13	55	<10	2800	1	--	22	1700	<0.2	--	35	--	9.9	<1	--	<10	790	21	<2	--	--	<10	70	10	0.2	920
		03/09/99	2600	1	3	30	1	10000	1.1	270	16	43	10	3200	1	--	22	1600	0.2	--	25	--	9.7	1	--	10	730	22	2	--	--	10	50	12	0.2	1200
		09/10/99	2400	3	5	20	1	12000	0.8	270	21	30	10	4300	1	--	22	1600	1	--	40	--	9.8	1	--	10	730	21	2	--	--	10	60	9	0.2	1100
		03/08/00	3000	1	1.5	39	1	12000	0.69	260	9.5	42	10	2600	1	--	23	1700	0.61	<20	30	--	11	1	6700	10	820	21	2	50	84	10	53	12	0.2	710
		09/20/00	5900	<1	7	54	2.2	11000	1.4	240	8.3	29	18	10000	5.6	--	21	1600	**5.3**	--	32	--	10	1	--	<10	760	19	<2	840	92	18	70	13	0.25	850
		03/20/01	680	<1	<1	28	<1	12000	1	250	2	20	<10	440	<1	--	20	1500	<0.2	32	18	--	9.1	<1	4500	<10	710	19	<2	<50	<5	<10	41	14	0.21	810
		09/18/01	1800	<1	<1	29	1.4	12000	1.6	270	8	37.6	13	3600	<1	--	21	1700	0.86	<20	22	--	8.9	<1	5800	<10	780	18	<2	<50	8.1	<10	60	13	0.24	780
		09/18/01	1900	<1	<1	29	1.3	13000	1.8	270	7	35.8	15	4100	<1	--	21	1700	0.9	<20	21	--	8.9	<1	6000	<10	770	18	<2	<50	10	<10	67	13	0.23	780
		03/12/02	3100	<1	<1	30	<1	14000	0.6	280	2	19	20	4400	1.6	--	22	1800	**4.5**	<20	15	--	11	11	--	<10	810	23	<2	<50	45	<10	40	14	0.27	800
		09/10/02	3600	<1	<1	40	<1	7900	2.3	280	<1	30	<10	2600	<1	--	22	1800	1.6	<20	15	--	8.8	<1	--	<10	830	19	<2	<50	96	<10	60	12	0.25	840
		03/11/03	2400	<1	<1	30	<1	12000	1.7	300	2	20	20	2200	<1	--	24	1900	1.9	<20	25	--	9.2	<1	8000	<10	890	19	<2	1100	<5	<10	60	15	0.24	840
		09/09/03	1400	0.2	0.7	20	<1	11000	1.37	290	<1	2.5	<10	1400	1.2	--	23	1900	1.4	--	27.9	--	9.9	2	--	<10	860	22	<0.1	--	--	<10	30	14	0.26	1100
		03/09/04	1800	<0.6	1.7	30	1	10000	1.43	290	3.7	36.9	<10	2500	1.6	--	24	2000	1.5	<20	25.8	--	9.9	1.9	--	<10	870	22	0.2	--	--	<10	<10	14	0.23	1000
		09/14/04	1900	<3	2	30	<1	9700	0.9	330	5	39	<10	2200	<1	--	27	2200	2	<20	19	--	9	<1	5700	<10	950	22	<2	<50	7	<10	<10	13	0.25	1100
		03/08/05	1400	<3	<1	20	<1	12000	0.7	370	3	48	<10	930	<1	--	29	2400	0.7	<20	21	--	10	<1	--	<10	1000	24	<2	<50	<5	<10	<10	14	0.22	1142
		09/07/05	1400	<3	2	20	<1	12000	1.1	380	3	49	<10	690	<1	--	29	2500	0.9	<20	21	--	9.3	<1	--	<10	1100	22	<2	--	--	<10	<10	14	0.24	1100
		09/07/05	1400	<3	2	20	<1	12000	1.1	390	3	50	<10	720	<1	--	30	2600	0.8	<20	22	--	11	1	--	<10	1200	22	<2	--	--	<10	<10	15	0.24	1100
		03/22/06	1600	<3	2	<10	<1	12000	0.9	350	6	46	10	1400	<1	--	27	2400	0.8	<20	25	--	12	<1	--	<10	1100	20	<2	--	--	<10	<10	16	0.26	990
		09/19/06	2300	3	2	30	<1	11000	0.8	360	5	50	<10	1900	1	--	26	2500	**2.1**	<20	22	--	13	1	--	<10	1100	20	<2	--	--	<10	<10	15	0.26	1100
		03/06/07	1700	<1	<1	28	<2	12000	1.1	340	4.5	40	3.2	830	1.2	--	26	2500	0.49	<5	22	--	12	1	--	<0.5	1000	20	<1	--	--	<10	47	13	0.29	1100
		09/19/07	1300	<1	2	29	<2	10000	0.81	320	9.9	43	3.2	620	1.3	--	22	2400	<0.2	<5	24	--	12	2.4	--	<0.5	960	20	<1	--	--	<10	48	16	0.2	1000
		03/12/08	2000	<1	<1	30	<2	10000	0.58	320	6.2	48	3.1	1200	<1	--	23	2400	0.21	<5	25	--	11	<1	--	<0.5	910	18	<1	--	--	<10	45	13	0.33	980
		09/16/08	1000	<1	2.9	26	<2	10000	0.9	340	3	49	2.4	560	<1	--	24	2600	0.66	<5	25	--	13	<1	--	<0.5	1100	19	<1	--	--	<10	44	10	0.18	1100
		03/10/09	1900	<1	1.6	28	<2	10000	0.54	320	3.6	50	3.8	900	<1	--	22	2500	0.83	<5	27	--	12	<1	--	<0.5	950	18	<1	--	--	<10	43	10	0.14	1100
		09/15/09	1000	<1	1.4	28	<2	10000	1	360	3.4	52	<2	470	<1	--	25	2700	<0.2	7.3	31	--	12	<1	--	<1	1000	18	<1	--	--	<10	46	9.8	0.41	1200
		09/15/09	2000	<1	1.5	32	<2	11000	1	390	4.3	52	<2	820	1.4	--	27	3000	<0.2	<5	30	--	14	<1	--	<1	1200	21	<1	--	--	<10	64	9.8	0.4	1200
		03/10/10	2900	<1	2.8	40	<2	10000	0.86	360	12	65	4.9	3400	2.2	--	24	2700	1.4	6.8	32	--	15	<1	--	<1	1100	19	<1	--	--	9.3	52	8.6	0.36	120
		09/14/10	1400	<1	<1	28	<2	10000	<0.5	380	<2	53	<2	490	<1	--	24	2800	0.26	<5	24	--	14	<1	--	<1	1200	20	<1	--	--	<2	43	8.4	0.23	1400

Well ID	Historical Well ID Ref.	Date	Inorganics																																	Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	**TDEC**	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**-**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**100**	**10^**	**-**	**50**	**-**	**100**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
		EPA	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**1300~**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**-**	**1^^**	**-**	**50**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
JOF-B8 (cont.)	B-8	03/16/11	820	<1	1.2	24	<2	9800	<0.5	360	<2	53	<2	170	<1	--	22	2700	<0.2	<5	34	--	13	6	--	<1	1000	16	<1	--	--	<10	36	9.9	0.32	1100
		09/13/11	840	<1	<1	24	<2	10000	<0.5	370	<2	51	<2	170	<1	--	23	2600	0.24	11	18	--	15	<1	--	<1	1200	19	<1	--	--	<10	36	7.5	0.26	1100
		09/13/11	860	<1	1.2	24	<2	9900	0.5	370	<2	50	<2	220	<1	--	23	2700	0.27	10	19	--	14	1.5	--	<1	1100	18	<1	--	--	<10	37	7.5	0.23	1100
		11/30/11	--	--	--	--	--	--	--	--	--	49	--	--	--	--	--	--	<0.2	--	22	--	--	<1	--	--	--	--	--	--	--	--	41	--	0.25	--
		03/21/12	910	<1	1.2	22	<2	9700	<0.5	360	3.7	49	<2	160	<1	--	22	2600	<0.2	<5	24	--	13	3.4	--	<1	1100	16	<1	--	--	<10	35	6.8	0.27	1100
		09/19/12	--	<1	<1	23	<10	--	<0.5	--	<2	47	<2	--	<1	--	--	--	<0.2	--	28	--	--	<1	--	<1	--	--	<1	--	--	<2	34	--	0.3	--
		03/20/13	780	<1	1	26	<1	9200	0.81	300	4.4	51	<2	160	<1	--	17	2500	<0.2	<2	24	<0.1	15	<1	--	<1	960	17	<1	--	--	<2	40	7.4	0.31	1100
JOF-B8R	B-8R	03/20/13	<100	<1	<1	25	<1	990	<0.5	24	<2	2.4	<2	<100	<1	--	4.7	1100	<0.2	<2	12	0.24	1.4	<1	--	<1	140	14	<1	--	--	<2	19	10	<0.1	87
		09/25/13	--	<1	<1	33.2	<1	--	<1	--	<1	2.1	1.1	--	<1	--	--	--	<0.2	--	11.1	--	--	<1	--	<0.5	--	--	<1	--	--	<1	24.2	--	<0.4	--
		03/11/14	<250	<1	<1	24.6	<1	832	<1	25.7	1.5	<5	<1	416	<1	--	5.23	422	<0.2	<1	6.7	--	1.17	<1	--	<0.5	183	13.7	<1	--	--	<10	14.4	10.5	<0.4	78.4
		03/11/14	<250	<1	<1	24.3	<1	842	<1	25.6	1.6	<5	<1	442	<1	--	5.24	420	<0.2	<1	6.7	--	1.18	<1	--	<0.5	182	13.7	<1	--	--	<10	14.6	10.5	<0.4	78.7
		09/08/14	--	<1	<1	27	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	7.8	--	--	<1	--	<1	--	--	<1	--	--	<2	19	--	<0.1	--
		03/17/15	--	<2	<2	21	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	5.3	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		03/17/15	--	<2	<2	20	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	5.1	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		09/22/15	--	<2	<2	30.1	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	9.99	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		03/22/16	--	<2	<2	28.2	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	2.87	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		03/22/16	--	<2	<2	27.6	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	2.94	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		09/21/16	--	<2	<2	26.9	<2	1460	<1	28.8	<2	<2	<5	--	<2	<15	--	--	<0.2	<5	7.82	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	13.4	<0.1	135
JOF-B9	B-9	03/12/90	53000	<1	2	1400	--	<500	<0.1	23	40	--	40	110000	24	20	6.8	2200	--	<20	34	--	1	<1	29000	--	560	2.8	--	--	--	140	180	2	--	<1
		06/19/90	49000	<1	<1	600	--	640	**6**	16	14	--	20	44000	54	<10	6.4	930	--	<20	19	--	0.64	1	24000	--	340	2.9	--	--	--	90	140	2	--	<1
		06/19/90	24000	<1	1	450	--	540	**22**	18	13	--	10	30000	45	<10	4.7	660	--	<20	12	--	0.62	<1	12000	--	250	2.9	--	--	--	50	100	2	--	<1
		09/04/90	3300	<1	<1	70	--	<500	0.1	11	2	--	10	2800	2	<10	3.4	82	--	<20	5	--	0.25	<1	5400	--	70	2.5	--	--	--	<10	40	2	--	<1
		12/11/90	5900	<1	<1	70	--	<500	0.5	8.7	3	--	<10	6400	3	<10	3.7	140	--	<20	8	--	0.3	<1	11000	--	50	2.6	--	--	--	<10	60	2	--	950
		03/05/91	740	4	<1	150	--	<500	0.9	51	3	--	<10	480	4	<10	3.5	43	--	<20	10	--	0.41	<1	5200	--	210	2.7	--	--	--	<10	10	4	--	<1
		06/25/91	10000	<1	1	160	--	<500	0.3	20	10	--	<10	6100	13	40	5.6	1500	--	<20	15	--	8.1	1	18000	--	<50	2.6	--	--	--	<10	280	2	--	2
		06/25/91	24000	<1	1	340	--	<500	0.4	16	8	--	<10	24000	14	40	4.9	380	--	<20	15	--	8.7	<1	33000	--	140	2.7	--	--	--	20	60	2	--	2
		09/24/91	5800	<1	<1	110	--	<500	0.1	9.9	5	--	18	6000	4	<10	3.3	150	--	<20	7	--	0.23	<1	6700	--	<50	2.3	--	--	--	10	17	2	--	<1
		12/04/91	7300	--	<1	130	--	<500	<0.1	11	16	--	90	9100	4	<10	4	260	--	--	12	--	0.23	<1	7200	--	80	2.6	--	--	--	<10	80	2	--	<1
		03/17/92	2700	--	1	50	--	<500	<1	7.3	<1	--	<10	2600	4	<10	0.5	76	--	<20	2	--	0.2	3	9200	--	<80	2.8	--	--	--	<10	20	2	--	1
		06/08/92	6000	--	1	100	--	<500	0.1	8.4	7	--	<10	7300	6	10	3.3	100	--	--	8	--	0.9	--	12000	--	<80	2.9	--	--	--	--	<10	2	--	5
		09/02/92	7400	--	9	100	--	<500	5	5.8	26	--	<10	7600	5	<10	2.8	140	--	--	18	--	0.4	--	15000	--	<50	3	--	--	--	--	20	2	--	<1
		06/07/93	1600	<1	<1	30	--	<500	<0.1	5.8	<1	--	<10	1500	<1	<10	2.3	40	--	<20	1	--	0.4	--	--	--	<50	2.7	--	--	--	--	<10	3	--	<2
		03/09/94	810	1	<1	20	--	<500	<0.1	5.6	1	--	<10	960	1	<10	2.5	20	--	<20	1	--	0.2	--	--	--	<50	2.8	--	--	--	--	<10	3	--	<2
		05/16/94	--	--	--	--	<1	--	--	--	--	<1	--	--	--	--	--	--	<0.2	--	--	--	--	<1	--	<10	--	--	<50	--	--	<10	--	--	0.1	--
		05/16/94	--	--	--	--	<1	--	--	--	--	<1	--	--	--	--	--	--	0.2	--	--	--	--	<1	--	<10	--	--	<50	--	--	<10	--	--	0.1	--
		07/20/94	--	--	--	--	<1	--	--	--	--	<1	--	--	--	--	--	--	<0.2	--	--	--	--	<1	--	<10	--	--	<50	--	--	<10	--	--	<0.1	--
		09/20/94	310	<1	<1	10	<1	<500	<0.1	50	<1	--	<10	240	<1	<10	2.4	9	--	<20	<1	--	0.2	--	--	<10	<50	2.7	<10	--	--	10	<10	3	--	<1
		03/21/95	140	<1	<1	<10	<1	<500	<0.1	5	1	<1	<10	90	<1	--	2.6	<5	0.3	--	<1	--	0.2	<1	--	<10	<50	2.8	<2	--	--	<10	<10	3	<0.1	2
		09/05/95	360	<1	<1	10	<1	<500	<0.1	5	<1	1	<10	420	1	--	2.4	12	<0.2	<20	<1	--	0.2	<1	--	<10	<50	2.6	<2	--	--	<10	<10	3	0.2	<2
		03/26/96	980	2	2	20	<1	<500	<0.1	4.9	<1	2	<10	1100	2	--	2.5	<5	<0.2	30	<1	--	0.2	2	--	<10	<50	2.7	<1	--	--	<10	<10	3	0.1	<2
		09/23/96	260	<1	<1	<10	<1	<500	<0.1	5	<1	<1	<10	300	<1	--	2.5	6	<0.2	<20	<1	--	0.4	<1	--	<10	<50	2.6	<2	--	--	<10	<10	3	<0.1	2
		03/25/97	460	<1	<1	<10	<1	<500	0.1	5.9	<1	<1	<10	660	<1	--	2.8	17	<0.2	--	<1	--	0.1	<1	--	<10	<50	2.7	<2	--	--	<10	<10	3	<0.1	4
		03/25/97	350	<1	<1	<10	<1	<500	<0.1	5.5	<1	<1	<10	500	<1	--	2.6	6	<0.2	--	<1	--	0.1	<1	--	<10	<50	2.7	<2	--	--	<10	<10	2	<0.1	3
		09/10/97	1200	<1	<1	10	<1	<500	<0.1	5	1	2	<10	1400	3	--	2.7	18	<0.2	--	<1	--	0.3	<1	--	<10	<50	1.8	<2	--	--	<10	<10	3	<0.1	6
		03/18/98	1500	<1	<1	30	<1	<500	<0.1	6	<1	<1	<10	1600	<1	--	2.7	24	<0.2	--	3	--	0.4	<1	--	<10	<50	2.6	<2	--	--	<10	<10	3	<0.1	3
		09/15/98	1400	<1	1	20	<1	<200	<0.1	5.1	2	<1	<10	1100	1	--	2.6	19	<0.2	--	2	--	0.3	<1	--	<10	<50	2.8	<2	--	--	<10	<10	4	<0.1	1
		03/10/99	2500	1	1	40	1	200	0.1	4.9	8	2	10	2400	2	--	2.8	47	0.2	--	4	--	0.2	1	--	10	50	2.9	2	--	--	10	10	4	0.1	3
		09/09/99	4600	1	2	60	1	200	0.1	6.4	9	4	10	4500	4	--	3.3	93	0.2	--	4	--	0.2	1	--	10	50	2.6	2	--	--	10	10	4	0.1	7

Well ID	Historical Well ID Ref.	Date	Inorganics																														Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	**TDEC**	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**-**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**100**	**10^**	**-**	**50**	**-**	**100**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
		EPA	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**1300~**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**-**	**1^^**	**-**	**50**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
JOF-B9 (cont.)	B-9	03/07/00	2300	1	1	38	1	400	0.1	6.2	1.8	2.2	10	1700	1.4	--	3.3	40	0.2	<20	1	--	0.23	1	6600	10	50	2.5	2	50	49	10	10	4	0.1	3
		09/19/00	1200	<1	<1	21	1.1	<200	0.11	5	<1	<1	<10	900	1.8	--	2.7	29	<0.2	--	1.8	--	0.3	<1	--	<10	<50	2.3	<2	79	22	<10	<10	4	0.11	4
		03/20/01	1300	<1	<1	17	<1	<200	<0.1	5.5	<1	<1	<10	1000	<1	--	3	22	<0.2	<20	<1	--	0.35	<1	5900	<10	<50	2.3	<2	<50	18	<10	<10	3.5	<0.1	2
		09/18/01	150	<1	<1	<10	<1	<200	<0.1	5.8	<1	<1	<10	150	<1	--	3.2	5.6	<0.1	<20	<1	--	<0.1	<1	4300	<10	<50	1.2	<2	<50	<5	<10	<10	4	0.11	1
		03/12/02	2100	<1	<1	40	<1	620	<0.1	6.1	<1	<1	<10	2000	<1	--	3.5	45	<0.1	<20	<1	--	<0.1	<1	--	<10	<50	1.3	<2	<50	34	<10	<10	3.2	<0.1	1.2
		03/12/02	1600	<1	<1	30	<1	520	<0.1	6.1	<1	<1	10	1600	<1	--	3.4	40	<0.1	<20	<1	--	<0.1	<1	--	<10	<50	1.4	<2	<50	26	<10	<10	3.2	<0.1	1.2
		09/10/02	2400	<1	<1	30	<1	<200	<0.1	6	<1	<1	<10	1300	<1	--	3.3	28	<0.1	<20	<1	--	<0.1	<1	--	<10	<50	2.7	<2	<50	79	<10	10	3.3	0.19	1.4
		03/11/03	3800	<1	2	60	<1	300	<0.1	6	2	<1	<10	3200	17	--	3.3	58	<0.1	<20	<1	--	0.8	<1	10000	<10	<50	2.5	<2	90	48	<10	20	3.9	<0.1	8.4
		09/09/03	3700	0.1	0.7	50	<1	<200	0.1	6	<1	2.5	<10	3100	3.5	--	3.4	53	0.1	--	4.3	--	0.2	20.5	--	<10	<50	3	<0.1	--	--	<10	10	3.5	<0.1	7.3
		03/09/04	2400	<0.6	0.5	40	<1	<200	0.17	5.8	1.9	1.8	<10	2400	2.5	--	3.1	51	<0.1	<20	1.6	--	0.3	<0.2	--	<10	<50	2.4	<0.1	--	--	<10	<10	3.5	<0.1	3
		09/14/04	1400	<3	<1	20	<1	<200	<0.1	5.7	2	<1	<10	1200	<1	--	2.8	19	<0.1	<20	<1	--	<0.1	<1	--	<10	<50	3.2	<2	<50	20	<10	<10	3.5	<0.1	5.9
		03/08/05	1800	<3	<1	30	<1	220	<0.1	6.1	3	3	<10	1300	<1	--	3.1	26	<0.1	<20	<1	--	1.7	<1	--	<10	<50	2.2	<2	<50	34	<10	10	3.8	<0.1	<1
		09/07/05	1600	<3	<1	20	<1	<200	<0.1	5.9	2	<1	<10	960	<1	--	2.9	20	<0.1	<20	<1	--	0.6	<1	--	<10	<50	3.3	<2	--	--	<10	<10	4	<0.1	<1
		03/22/06	2000	<3	<1	30	1	300	<0.1	6.2	4	<1	<10	1600	2	--	3.3	34	<0.1	<20	2	--	0.7	<1	--	<10	<50	2.9	<2	--	--	<10	<10	4	<0.1	<1
		03/22/06	2000	<3	<1	30	<1	<200	<0.1	6.1	4	<1	<10	1600	2	--	3.2	36	<0.1	<20	3	--	0.7	<1	--	<10	<50	2.9	<2	--	--	<10	<10	4	<0.1	<1
		09/19/06	700	<3	<1	20	<1	<200	<0.1	5.4	<1	1	<10	500	<1	--	2.8	14	<0.1	<20	<1	--	0.8	<1	--	<10	<50	2.3	<2	--	--	<10	10	3.4	<0.1	<1
		03/06/07	1600	<1	<1	24	<2	<200	<0.5	6	1.7	<1	1.6	960	1.5	--	3.2	20	<0.2	<5	1.3	--	<0.5	<1	--	<0.5	11	3	<1	--	--	<10	<10	2.9	<0.1	<5
		09/19/07	320	<1	<1	10	<2	<200	<0.5	5.8	<1	<10	1	180	<1	--	2.9	<10	<0.2	<5	<1	--	<0.5	<1	--	<0.5	<10	3.9	<1	--	--	<10	<10	3.2	<0.1	<5
		03/12/08	1600	<1	<1	28	<2	<200	<0.5	6.2	2.1	<10	<1	1000	<1	--	3.2	29	<0.2	<5	1.6	--	<0.5	<1	--	0.53	12	2.8	<1	--	--	<10	<10	3.2	<0.1	<5
		09/16/08	340	<1	1.5	11	<2	<200	<0.5	5.7	<1	<10	1	270	<1	--	2.9	<10	<0.2	<5	1.4	--	<0.5	<1	--	<0.5	<10	3.1	<1	--	--	<10	<10	2.9	<0.1	<5
		03/10/09	1600	<1	<1	25	<2	<200	<0.5	5.9	2.2	<10	4	990	<1	--	3	22	<0.2	<5	1.5	--	<0.5	<1	--	<0.5	10	3	<1	--	--	<10	<10	3.1	<0.1	<5
		09/15/09	1500	<1	<1	22	<2	<200	<0.5	6.1	<2	<10	<2	820	1.1	--	3.3	15	<0.2	<5	1.3	--	<0.5	<1	--	<1	10	3.3	<1	--	--	<10	13	4.7	<0.1	<5
		03/10/10	2400	<1	<1	41	<2	<200	<0.5	6	2.6	<10	<2	2000	1.9	--	3.3	36	<0.2	<5	2.1	--	0.79	<1	--	<1	14	3	<1	--	--	3.5	<10	4.1	<0.1	<5
		03/10/10	1900	<1	<1	39	<2	<200	<0.5	6	<2	<10	<2	1700	<1	--	3.3	32	<0.2	<5	<1	--	0.67	<1	--	<1	13	3.5	<1	--	--	<2	<10	4.1	<0.1	<5
		09/14/10	5100	<1	<1	53	<2	<200	<0.5	6.3	12	<10	<2	3200	1.4	--	3.3	62	<0.2	<5	7.7	--	1.2	<1	--	<1	20	3.4	<1	--	--	3.4	15	4	<0.1	<5
		03/15/11	860	<1	<1	27	<2	<200	<0.5	6.2	<2	<10	<2	1000	<1	--	3.1	22	<0.2	<5	<1	--	<0.5	<1	--	<1	10	2.7	<1	--	--	<10	<10	4.3	<0.1	<5
		09/13/11	140	<1	<1	10	<2	<200	<0.5	6.2	<2	<10	<2	150	<1	--	3	<10	<0.2	<5	<1	--	<0.5	<1	--	<1	<10	3.2	<1	--	--	<10	<10	4.2	<0.1	<5
		11/30/11	--	<1	<1	8.7	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	<1	--	--	<1	--	<1	--	--	<1	--	--	<2	<10	--	<0.1	--
		03/20/12	<100	<1	1	6.6	<2	<200	<0.5	6.1	<2	<10	<2	<100	<1	--	3	<10	<0.2	<5	<1	--	<0.5	1.7	--	<1	<10	2.7	<1	--	--	<10	<10	4.2	<0.1	<5
		03/20/12	<100	<1	<1	7	<2	<200	<0.5	5.8	<2	<10	<2	<100	<1	--	3	<10	<0.2	<5	<1	--	<0.5	<1	--	<1	<10	2.8	<1	--	--	<10	<10	4.3	<0.1	<5
		09/18/12	--	<1	<1	8	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	<1	<0.1	--	<1	--	<1	--	--	<1	--	--	<2	<10	--	<0.1	--
		03/19/13	160	<1	<1	8.5	<1	330	<0.5	9.7	<2	<1	<2	110	<1	--	2.8	2.7	<0.2	<2	<1	<0.1	<0.5	<1	--	<1	21	3.1	<1	--	--	<2	<10	4	<0.1	<5
		09/24/13	--	<1	<1	14.8	<1	--	<1	--	1.3	<1	<1	--	<1	--	--	--	<0.2	--	1.2	<0.25	--	<1	--	<0.5	--	--	<1	--	--	1.4	<10	--	<0.4	--
		03/11/14	<250	<1	<1	9.3	<1	<10	<1	5.56	<1	<5	<1	<250	<1	--	2.92	3.4	<0.2	<1	<1	<0.25	0.298	<1	--	<0.5	5.2	3.17	<1	--	--	<10	<10	5.2	<0.4	<4
		09/08/14	--	<1	<1	6.5	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	<1	--	--	<1	--	<1	--	--	<1	--	--	<2	<10	--	<0.1	--
		09/08/14	--	<1	<1	6.9	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	<1	--	--	<1	--	<1	--	--	<1	--	--	<2	<10	--	<0.1	--
		03/17/15	--	<2	<2	6.9	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		09/22/15	--	<2	<2	5.74	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		09/22/15	--	<2	<2	6.5	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<2	--	--	<5	<25	--	<0.1	--
		03/21/16	--	<2	<2	6.84	<2	--	<1	--	<2	<2	<5	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	--	<0.1	--
		09/20/16	--	<2	<2	9.59	<2	<200	<1	5.83	<2	<2	<5	--	<2	<15	--	--	<0.2	<5	<2	--	--	<2	--	<2	--	--	<1	--	--	<5	<25	4.59	<0.1	<5
JOF-C1	C-1	03/12/90	21000	1	**130**	160	--	48000	4	560	23	--	30	190000	24	250	110	6700	--	300	32	--	120	<1	30000	--	2400	37	--	--	--	110	270	10	--	2000
		06/19/90	14000	<1	**390**	170	--	40000	**37**	560	8	--	50	250000	38	300	93	5300	--	<20	30	--	110	<1	14000	--	2400	33	--	--	--	120	310	12	--	2000
		09/04/90	6800	<1	**250**	140	--	30000	2	520	12	--	<10	230000	8	300	87	4800	--	250	19	--	100	<1	15000	--	2100	34	--	--	--	<10	190	11	--	2000
		12/10/90	1600	<1	**250**	80	--	29000	1	550	7	--	<10	200000	5	240	72	4100	--	230	25	--	120	3	11000	--	2100	30	--	--	--	20	140	13	--	910
		03/06/91	8900	<1	**320**	70	--	29000	3	580	13	--	10	190000	11	220	64	4000	--	200	46	--	110	1	22000	--	2300	29	--	--	--	70	400	14	--	160
		06/25/91	49000	<1	**280**	320	--	22000	0.9	580	49	--	40	230000	29	240	50	3600	--	320	73	--	100	5	49000	--	2300	30	--	--	--	160	580	9	--	1800
		09/23/91	5000	3	**200**	110	--	20000	0.6	570	9	--	21	120000	2	180	38	2900	--	190	18	--	99	<1	8600	--	1800	27	--	--	--	30	120	16	--	1800

Well ID	Historical Well ID Ref.	Date	Inorganics																														Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	TDEC	-	6	10	2000	4	-	5	-	100	-	-	-	15~	-	-	-	2	-	100	10^	-	50	-	100	-	-	2	-	-	-	-	-	4	-
		EPA	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
JOF-C1 (cont.)	C-1	12/03/91	11000	--	**250**	150	--	20000	2	620	23	--	30	140000	7	170	41	3400	--	--	41	--	100	<1	14000	--	2500	27	--	--	--	40	230	16	--	1800
		03/17/92	1800	--	**240**	30	--	18000	0.9	570	<1	--	<10	80000	2	200	6.4	3300	--	160	11	--	79	<1	13000	--	1700	27	--	--	--	30	220	17	--	1400
		06/09/92	4100	--	**220**	30	--	18000	2	600	5	--	<10	97000	3	160	30	2200	--	--	20	--	98	--	17000	--	1800	29	--	--	--	--	120	17	--	1600
		12/15/92	4300	<1	**200**	30	--	20000	<0.1	640	8	--	<10	96000	7	160	28	2600	--	150	19	--	100	<1	--	--	2100	31	--	--	--	<10	190	17	--	1600
		06/08/93	2600	<1	**200**	30	--	7900	0.5	560	<1	--	<10	79000	<1	120	24	3100	--	190	7	--	91	--	--	--	1900	30	--	--	--	--	120	17	--	1400
		03/08/94	2300	1	**170**	40	--	6300	0.8	600	4	--	<10	66000	3	130	22	3100	--	160	16	--	93	--	--	--	1900	32	--	--	--	--	100	18	--	1400
		09/21/94	1200	<1	**230**	40	--	14000	0.2	450	2	--	<10	50000	<1	150	20	1900	--	160	10	--	92	--	--	--	1600	31	--	--	--	--	80	17	--	1500
JOF-C2	C-2	03/13/90	28000	2	**110**	330	--	16000	**13**	420	47	--	60	82000	43	280	4.4	410	--	330	38	--	95	<1	21000	--	1600	36	--	--	--	200	280	17	--	1200
		06/20/90	4600	2	**44**	80	--	17000	**20**	490	3	--	<10	5900	35	250	1	56	--	<20	5	--	90	<1	10000	--	1700	37	--	--	--	120	70	17	--	1100
		09/04/90	7200	3	**72**	110	--	15000	**7**	460	25	--	10	7500	14	290	1.5	140	--	280	12	--	82	3	11000	--	1700	41	--	--	--	150	60	18	--	1100
		12/10/90	11000	2	**49**	120	--	16000	2	450	9	--	<10	21000	15	280	1.3	100	--	240	11	--	96	3	18000	--	1700	39	--	--	--	110	70	17	--	66
		03/06/91	2400	<1	**46**	68	--	18000	1	540	7	--	160	2800	5	270	4.9	17	--	310	7	--	92	<1	8200	--	2100	40	--	--	--	100	30	19	--	1200
		03/06/91	3300	6	**42**	120	--	17000	0.7	540	6	--	120	3600	4	270	5.5	36	--	350	6	--	91	<1	8000	--	2100	20	--	--	--	120	30	19	--	1200
		06/25/91	5400	<1	**38**	60	--	16000	1	510	8	--	40	7700	5	270	1.5	40	--	300	8	--	92	3	12000	--	1900	43	--	--	--	60	40	16	--	1200
		09/23/91	15000	4	**54**	150	--	16000	2	510	17	--	56	24000	9	260	2.3	180	--	280	13	--	98	1	12000	--	1600	41	--	--	--	90	110	18	--	1400
		12/04/91	5800	--	**60**	80	--	17000	0.8	490	11	--	20	9800	8	260	1.3	160	--	--	7	--	98	<1	6400	--	1800	41	--	--	--	50	60	19	--	1200
		09/02/92	11000	--	**57**	110	--	16000	2	370	15	--	<10	16000	13	310	1.3	88	--	--	8	--	95	3	18000	--	1300	44	--	--	--	100	80	23	--	43
		12/15/92	2000	<1	**39**	40	--	18000	0.3	410	5	--	<10	1500	2	240	0.4	<5	--	250	3	--	91	<1	--	--	1400	39	--	--	--	70	<10	21	--	1100
		06/08/93	14000	1	**59**	130	--	8000	3	440	10	--	<10	18000	9	220	1.5	120	--	270	5	--	90	--	--	--	1600	39	--	--	--	--	100	20	--	1000
		03/08/94	1400	1	**49**	60	--	6300	0.2	540	1	--	<10	1300	<1	220	0.9	29	--	320	2	--	95	--	--	--	1900	44	--	--	--	--	<10	20	--	1200
		09/21/94	1600	<1	**35**	50	--	14000	0.2	470	3	--	<10	1600	3	250	0.7	20	--	280	2	--	97	--	--	--	2200	43	--	--	--	--	10	20	--	1500
JOF-C3	C-3	03/13/90	42000	3	**160**	450	--	16000	**18**	480	68	--	90	92000	53	280	5.9	720	--	320	53	--	92	2	35000	--	1600	36	--	--	--	280	410	16	--	950
		06/20/90	580	3	**44**	70	--	24000	0.2	140	<1	--	<10	740	4	150	0.3	46	--	<20	<1	--	63	<1	4200	--	580	20	--	--	--	30	110	19	--	330
		09/04/90	1200	<1	**39**	60	--	23000	0.1	120	1	--	40	580	1	150	7.7	<5	--	240	2	--	52	<1	4100	--	520	21	--	--	--	<10	30	18	--	350
		12/10/90	370	1	**37**	40	--	22000	<0.1	96	<1	--	<10	400	<1	150	1.1	26	--	160	2	--	58	2	3300	--	410	20	--	--	--	<10	<10	19	--	580
		03/06/91	650	2	**50**	60	--	28000	<0.1	120	<1	--	140	320	2	150	1.2	<5	--	200	15	--	59	<1	3900	--	400	20	--	--	--	50	20	21	--	330
		06/25/91	4000	<1	**40**	80	--	18000	2	150	6	--	20	5100	6	150	2.8	32	--	220	6	--	53	8	8900	--	580	24	--	--	--	20	20	15	--	300
		09/23/91	1600	<1	**43**	100	--	20000	<0.1	180	<1	--	43	2300	2	170	3.4	99	--	210	11	--	70	<1	2300	--	500	25	--	--	--	10	22	18	--	600
		12/04/91	810	--	**56**	70	--	21000	<0.1	200	3	--	20	1700	<1	160	3.1	100	--	--	1	--	70	<1	2000	--	700	26	--	--	--	<10	10	18	--	580
		12/15/92	720	<1	**40**	40	--	24000	0.1	170	<1	--	<10	320	3	160	1.7	<5	--	170	<1	--	65	<1	--	--	560	28	--	--	--	<10	<10	19	--	240
		06/08/93	540	<1	**45**	50	--	11000	<0.1	130	<1	--	<10	80	<1	140	1.3	<5	--	180	<1	--	63	--	--	--	500	24	--	--	--	--	<10	20	--	340
		03/08/94	460	1	**53**	60	--	8000	<0.1	130	<1	--	<10	180	<1	130	1.9	34	--	150	2	--	56	--	--	--	500	24	--	--	--	--	<10	23	--	270
		09/21/94	540	<1	**49**	40	--	15000	0.1	140	<1	--	<10	210	<1	140	2.1	40	--	140	1	--	57	--	--	--	480	25	--	--	--	--	<10	23	--	340
JOF-C4	C-4	03/12/90	2400	<1	**12**	50	--	4900	0.5	9.1	3	--	<10	30000	3	<10	2	4800	--	<20	21	--	0.67	<1	12000	--	60	19	--	--	--	20	60	13	--	73
		06/19/90	200000	<1	**16**	1300	--	5300	**29**	22	**170**	--	150	230000	150	80	20	7900	--	<20	**150**	--	5.3	<1	36000	--	660	22	--	--	--	490	870	14	--	67
		09/04/90	60000	<1	**61**	640	--	2900	**10**	15	37	--	70	190000	50	30	8.7	6500	--	80	42	--	1.3	<1	56000	--	400	23	--	--	--	230	390	13	--	60
		12/10/90	62000	1	**26**	450	--	5200	**6**	13	39	--	50	110000	48	20	8.2	5700	--	40	47	--	2.6	2	53000	--	260	21	--	--	--	150	310	14	--	250
		03/06/91	270000	**8**	**41**	1500	--	4600	**35**	31	**230**	--	300	310000	200	60	23	8900	--	160	**190**	--	6.5	1	3800	--	670	23	--	--	--	810	1700	16	--	74
		06/25/91	140000	2	**20**	1000	--	5200	1	20	**110**	--	100	180000	100	150	17	7000	--	100	97	--	24	<1	64000	--	560	21	--	--	--	360	720	12	--	67
		09/23/91	68000	6	**11**	630	--	4900	**7**	18	68	--	110	110000	54	30	9.9	6100	--	20	69	--	3.6	1	60000	--	160	19	--	--	--	200	440	14	--	84
		12/03/91	49000	--	**29**	390	--	5700	4	13	50	--	60	96000	47	<10	7.2	5600	--	--	54	--	1	<1	44000	--	200	19	--	--	--	110	300	15	--	100
		03/16/93	15000	<1	**14**	220	--	3900	3	11	23	--	<10	42000	25	10	3.1	4900	--	<20	29	--	1.3	<1	--	--	70	19	--	--	--	50	120	14	--	69
		09/22/93	37000	<1	**14**	320	--	4000	1	11	34	--	20	70000	29	<10	5.9	5800	--	<20	35	--	0.7	--	--	--	160	18	--	--	--	--	190	12	--	70
		03/08/94	4500	<1	6	130	--	1800	0.5	9.8	8	--	<10	20000	8	<10	2.5	4700	--	<20	16	--	0.7	--	--	--	70	19	--	--	--	--	60	13	--	60
		09/21/94	1800	<1	6	70	--	3400	0.2	8	1	--	<10	16000	2	<10	2	3800	--	<20	12	--	0.7	--	--	--	<50	18	--	--	--	--	60	13	--	67
JOF-C5	C-5	03/13/90	2000	**8**	**32**	90	--	8800	2	170	4	--	30	4100	11	70	2.3	81	--	420	62	--	61	<1	4200	--	760	15	--	--	--	20	110	11	--	420
		06/20/90	470000	**13**	**300**	**4100**	--	18000	**240**	660	**620**	--	790	830000	240	360	48	10000	--	<20	**250**	--	85	1	14000	--	3900	21	--	--	--	3000	4700	13	--	460
		09/04/90	8000	1	**46**	100	--	4600	3	210	11	--	20	7400	10	170	1	130	--	280	7	--	53	1	9000	--	1000	15	--	--	--	210	60	14	--	520

Well ID	Historical Well ID Ref.	Date	Inorganics																																Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	TDEC	-	6	10	2000	4	-	5	-	100	-	-	-	15~	-	-	-	2	-	100	10^	-	50	-	100	-	-	2	-	-	-	-	-	4	-
		EPA	-	6	10	2000	4	-	5	-	100	-	1300~	-	15~	-	-	-	2	-	-	1^^	-	50	-	-	-	-	2	-	-	-	-	-	4	-
JOF-C5 (cont.)	C-5	12/10/90	26000	1	**68**	210	--	9000	**10**	230	22	--	20	45000	43	180	2.4	290	--	260	22	--	56	2	26000	--	1100	15	--	--	--	300	230	15	--	77
		03/06/91	17000	**7**	**81**	160	--	7800	**10**	210	34	--	90	15000	31	160	3.5	580	--	200	22	--	55	1	9300	--	810	17	--	--	--	220	150	17	--	510
		06/25/91	38000	5	**90**	320	--	9400	2	240	52	--	40	64000	52	190	3.8	470	--	300	38	--	56	1	32000	--	1300	15	--	--	--	380	420	13	--	520
		09/23/91	7800	4	**43**	70	--	8600	0.2	220	1	--	37	11000	6	170	0.8	130	--	230	7	--	62	4	5900	--	830	14	--	--	--	200	50	16	--	600
		12/04/91	18000	--	**61**	140	--	10000	5	220	21	--	30	28000	14	160	1.6	250	--	--	18	--	58	<1	11000	--	1000	15	--	--	--	270	140	16	--	480
		03/17/93	6100	<1	**40**	50	--	8400	2	150	5	--	<10	1900	5	160	0.3	38	--	270	<1	--	52	<1	--	--	660	14	--	--	--	270	20	14	--	280
		09/22/93	37000	2	**140**	360	--	8000	**14**	180	54	--	50	170000	64	150	4.7	840	--	250	19	--	50	--	--	--	930	14	--	--	--	--	460	11	--	270
		03/08/94	14000	3	**99**	130	--	3500	**7**	160	19	--	<10	21000	28	150	1.6	260	--	330	19	--	53	--	--	--	750	14	--	--	--	--	110	12	--	280
		09/21/94	17000	3	**94**	140	2	7100	**8**	120	19	--	<10	24000	43	170	1.3	160	--	280	23	--	53	--	--	10	580	14	<50	--	--	280	130	12	--	310
JOF-C6	C-6	03/13/90	5700	5	**36**	170	--	14000	4	250	7	--	20	20000	14	<10	3.3	240	--	310	76	--	63	<1	11000	--	1000	17	--	--	--	30	180	11	--	580
		06/20/90	39000	<1	**33**	470	--	13000	5	280	51	--	60	80000	43	50	8.3	830	--	<20	38	--	78	<1	9800	--	1400	21	--	--	--	140	290	14	--	580
		09/04/90	35000	2	**55**	410	--	6400	3	240	31	--	30	52000	31	110	9.1	710	--	280	20	--	70	3	37000	--	1300	21	--	--	--	190	250	14	--	470
		12/10/90	16000	2	**41**	160	--	12000	5	200	12	--	<10	20000	250	90	4.6	270	--	200	11	--	76	<1	21000	--	1200	18	--	--	--	50	90	14	--	480
		03/06/91	17000	6	**30**	230	--	14000	1	190	21	--	140	24000	18	40	6.9	390	--	120	21	--	62	1	5800	--	1000	24	--	--	--	70	120	16	--	480
		06/25/91	29000	2	**42**	240	--	13000	3	120	33	--	70	43000	28	60	16	1800	--	80	22	--	39	<1	47000	--	840	24	--	--	--	80	160	15	--	200
		09/23/91	71000	4	**12**	620	--	14000	**7**	140	82	--	100	120000	58	80	20	2400	--	180	49	--	46	<1	59000	--	750	20	--	--	--	290	410	16	--	260
		12/04/91	69000	--	**62**	440	--	17000	4	110	86	--	50	80000	47	40	16	1900	--	--	50	--	45	<1	19000	--	890	18	--	--	--	230	320	14	--	290
		03/17/92	110000	--	**83**	630	--	11000	**11**	87	73	--	0	150000	85	20	4.6	3000	--	0	**110**	--	26	<1	79000	--	0	25	--	--	--	0	570	20	--	1400
		06/09/92	22000	--	**44**	190	--	9200	3	81	25	--	<10	47000	17	30	17	2400	--	--	11	--	20	--	35000	--	420	26	--	--	--	--	70	21	--	74
		09/02/92	11000	--	**37**	220	--	12000	0.3	79	11	--	<10	41000	11	20	15	3100	--	--	11	--	26	<1	23000	--	430	25	--	--	--	30	90	19	--	140
		03/17/93	12000	1	**21**	220	--	9500	1	69	12	--	<10	45000	16	20	15	3500	--	<20	12	--	17	<1	--	--	400	25	--	--	--	50	70	19	--	56
		09/22/93	340000	1	**570**	**2700**	--	8700	**31**	160	**520**	--	260	370000	390	60	66	6800	--	<20	**230**	--	24	--	--	--	1500	26	--	--	--	--	3100	16	--	120
		03/08/94	14000	<1	**42**	330	--	3300	3	69	74	--	<10	57000	50	10	16	3900	--	<20	28	--	15	--	--	--	420	24	--	--	--	--	120	20	--	47
		09/21/94	25000	<1	**50**	260	1	7200	2	59	72	--	<10	53000	32	18	13	2800	--	20	47	--	10	--	--	<10	320	22	<50	--	--	70	130	17	--	110
JOF-JSP1	JSP-1	09/02/92	1300	--	**98**	100	--	800	<0.1	36	18	--	<10	300	3	80	3.8	6	--	--	8	--	3.7	--	3500	--	130	11	--	--	--	--	<10	12	--	2
JOF-JSP2	JSP-2	03/05/91	750	--	<1	120	--	<500	2	51	1	--	<10	4200	1	--	5.5	6200	<0.2	<20	96	--	--	2	9200	--	140	--	--	--	--	<10	60	--	--	--
JOF-JSP4	JSP-4	06/24/91	340	**20**	**410**	180	--	3700	0.6	77	6	--	<10	520	2	70	4.2	100	--	380	2	--	3.5	16	3400	--	380	6.4	--	--	--	180	<10	7	--	650
JOF-JSP5	JSP-5	06/24/91	1300	**22**	**430**	260	--	3500	0.6	72	10	--	<10	720	3	80	3.9	98	--	440	3	--	3.6	22	4600	--	420	6.8	--	--	--	200	<10	7	--	520
JOF-JSP7	JSP-7	06/24/91	120	<1	**46**	<20	--	1400	0.3	110	1	--	<10	340	<1	120	4	<5	--	<20	7	--	17	8	1600	--	2700	380	--	--	--	<10	<10	300	--	620
JOF-SS13	SS-13	04/23/86	--	--	3	70	--	--	2	60.2	2	--	<10	8770	5	--	7.5	9000	0.3	--	39	0.12	1.4	<1	--	<0.2	--	18	--	--	--	--	30	9	--	85
		08/11/88	19000	--	7	260	--	<500	**86**	51	18	28	30	33000	27	25	8.8	7200	--	<20	41	--	4.8	<1	--	<10	190	14	--	<50	--	20	3500	4	--	60
		12/11/90	3500	<1	7	140	--	<500	1	53	8	--	10	12000	7	<10	7	6200	--	<20	49	--	0.83	<1	14000	--	180	15	--	--	--	<10	60	7	--	480
		03/06/91	28000	3	4	250	--	16000	0.6	190	3	--	150	44000	2	<10	7.9	410	--	130	24	--	0.4	<1	35000	--	1100	13	--	--	--	90	160	10	--	70
		06/24/91	130000	1	**12**	820	--	620	3	63	77	--	100	160000	66	140	18	8300	--	100	**170**	--	30	<1	69000	--	440	16	--	--	--	160	780	6	--	91
		09/23/91	19000	<1	4	260	--	<500	1	55	16	--	62	33000	17	<10	8	6000	--	<20	40	--	1.1	<1	16000	--	80	11	--	--	--	40	160	10	--	40
		12/03/91	8500	--	8	170	--	580	0.4	37	8	--	30	16000	8	<10	5.4	5100	--	--	38	--	0.66	<1	13000	--	140	10	--	--	--	<10	130	10	--	36
		03/16/92	130000	--	**33**	780	--	<500	5	43	29	--	90	100000	120	<10	3.4	4700	--	<20	**170**	--	0.9	<1	130000	--	230	11	--	--	--	220	930	9	--	54
		06/09/92	48000	--	**13**	440	--	<500	4	46	48	--	30	61000	31	50	10	4900	--	--	75	--	4.7	--	50000	--	170	13	--	--	--	--	370	8	--	54

Stantec

Well ID	Historical Well ID Ref.	Date	Inorganics																															Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	**TDEC**	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**-**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**100**	**10^**	**-**	**50**	**-**	**100**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
		EPA	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**1300~**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**-**	**1^^**	**-**	**50**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
JOF-SS13 (cont.)	SS-13	09/02/92	38	--	8	350	--	<500	0.9	36	27	--	20	49000	28	30	8	4000	--	--	57	--	4	--	50000	--	140	11	--	--	--	--	250	11	--	<1
		12/15/92	21000	<1	10	300	--	<500	0.8	48	27	--	20	27000	19	<10	6.2	4900	--	<20	47	--	1.5	2	--	--	110	12	--	--	--	30	240	9	--	1400
		06/08/93	37000	<1	6	340	--	<500	1	41	16	--	20	47000	16	<10	7.5	4000	--	<20	40	--	1	--	--	--	150	12	--	--	--	--	220	7	--	64
		03/09/94	120000	<1	**22**	200	--	<500	0.6	34	16	--	<10	26000	21	<10	4.8	3000	--	<20	29	--	0.6	--	--	--	120	9.7	--	--	--	--	100	9	--	42
		09/21/94	28000	3	**65**	350	--	<500	2	31	**110**	--	<10	80000	41	10	6.7	2900	--	<20	85	--	1.2	--	--	--	120	10	--	--	--	--	280	10	--	28
JOF-SS15	SS-15	04/23/86	--	--	<1	60	--	--	**6**	34.3	8	--	100	6660	14	--	8.2	3110	0.8	--	**260**	0.33	1.1	<1	--	<0.2	--	84	--	--	--	--	90	16	--	160
		12/11/90	13000	<1	6	120	--	4100	**25**	39	7	--	20	15000	8	20	15	12000	--	<20	91	--	1.4	<1	32000	--	190	28	--	--	--	20	300	13	--	88
		03/06/91	3800	1	4	80	--	3900	**12**	39	4	--	170	8000	4	10	13	13000	--	<20	76	--	0.9	<1	22000	--	170	26	--	--	--	20	310	14	--	220
		06/24/91	43000	<1	8	420	--	4000	0.8	47	47	--	40	70000	32	80	22	14000	--	<20	**130**	--	13	<1	52000	--	360	27	--	--	--	120	440	11	--	200
		09/23/91	15000	<1	6	130	--	3800	4	44	12	--	49	14000	13	10	15	14000	--	20	88	--	1.5	<1	16000	--	<50	20	--	--	--	20	280	12	--	190
		12/03/91	19000	--	8	140	--	4200	2	40	14	--	30	26000	10	<10	16	13000	--	--	62	--	1.3	<1	20000	--	<50	22	--	--	--	<10	170	13	--	190
		03/16/92	12000	--	10	120	--	3600	3	36	11	--	<10	12000	11	<10	2.2	13000	--	<20	96	--	1.4	<1	29000	--	140	19	--	--	--	20	330	14	--	170
		06/09/92	46000	--	9	260	--	3800	3	40	42	--	10	55000	25	50	17	12000	--	--	94	--	4.8	--	60000	--	180	22	--	--	--	--	300	13	--	180
		09/02/92	5800	--	4	60	--	3600	1	32	6	--	<10	5500	7	10	9.9	11000	--	--	68	--	2	--	21000	--	150	20	--	--	--	--	200	13	--	185
		06/08/93	4100	<1	2	50	--	1900	4	34	2	--	10	3800	3	<10	8.7	11000	--	<20	65	--	1.8	--	--	--	140	19	--	--	--	--	230	12	--	180
		03/08/94	3000	<1	3	50	--	--	2	35	3	--	<10	3200	4	<10	9.7	11000	--	<20	50	--	1.8	--	--	--	150	21	--	--	--	--	160	13	--	160
		09/21/94	2900	<1	1	40	<1	2600	0.9	26	1	--	<10	1900	2	12	7	8300	--	<20	48	--	1.7	--	--	<10	130	20	<50	--	--	<10	100	12	--	160
		03/20/95	2000	--	<1	<10	<1	3800	1	33	<1	--	<10	1000	2	--	9.6	11000	--	--	52	--	2	--	--	--	<50	19	--	--	--	--	140	13	--	190
		09/07/95	1900	--	<1	40	1	3700	2	30	1	--	<10	2000	1	--	8.2	10000	--	--	55	--	2	<1	--	--	130	18	--	--	--	--	130	11	--	130
		03/25/96	3600	--	<1	30	<1	3400	1	29	48	--	<10	5200	3	--	8.6	9500	--	--	44	--	2.2	--	--	--	130	19	--	--	--	--	140	13	--	220
		09/24/96	1900	<1	1	30	<1	3800	3	32	8	--	<10	1600	2	--	8.2	9900	--	--	54	--	2.3	<1	--	--	140	18	--	--	--	--	150	14	--	130
		03/26/97	1600	<1	2	20	<1	3800	2	34	3	19	<10	1000	2	--	8.2	10000	--	--	65	--	2.6	--	--	--	120	22	--	--	--	--	140	17	--	210
		09/10/97	1300	<1	<1	20	<1	3500	2	29	1	--	<10	650	<1	--	7.7	9000	--	--	47	--	2.4	<1	--	--	140	20	<2	--	--	--	120	17	--	210
JOF-SS16	SS-16	04/23/86	--	--	10	30	--	--	**6**	294	3	--	10	2250	4	--	32.1	9040	0.5	--	**260**	0.04	4.5	<1	--	<0.2	--	29	--	--	--	--	130	12	--	820
		12/11/90	480	<1	6	30	--	5400	0.8	390	<1	--	<10	470	1	40	24	4100	--	330	92	--	21	2	12000	--	720	28	--	--	--	<10	30	13	--	140
		03/06/91	130	<1	**16**	50	--	3900	0.5	520	1	--	180	830	1	70	17	4600	--	390	37	--	46	<1	8700	--	950	28	--	--	--	<10	60	18	--	1200
		06/24/91	5600	<1	**14**	80	--	5000	0.7	460	8	--	<10	7100	5	70	23	7300	--	340	72	--	36	<1	19000	--	1000	29	--	--	--	20	80	13	--	1200
		09/23/91	6700	<1	**16**	80	--	5600	2	580	6	--	47	8200	3	80	16	6300	--	510	53	--	48	<1	7900	--	1200	27	--	--	--	10	160	16	--	1500
		12/03/91	480	--	**14**	30	--	5700	0.4	440	2	--	<10	2700	3	60	23	8600	--	--	80	--	39	1	7100	--	1100	27	--	--	--	<10	60	17	--	1400
		03/16/92	7500	--	**31**	80	--	5700	2	560	5	--	<10	8800	2	70	2.6	6600	--	450	58	--	39	<1	17000	--	1100	27	--	--	--	20	220	17	--	1300
		06/09/92	5700	--	**14**	20	--	5400	3	480	4	--	<10	4400	<1	70	24	9400	--	--	75	--	38	--	16000	--	980	30	--	--	--	--	240	16	--	1300

Well ID	Historical Well ID Ref.	Date	Inorganics																															Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	**TDEC**	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**-**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**100**	**10^**	**-**	**50**	**-**	**100**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
		EPA	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**1300~**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**-**	**1^^**	**-**	**50**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
JOF-SS16 (cont.)	SS-16	09/02/92	1800	--	**14**	20	--	4900	1	420	2	--	10	4400	5	60	23	8700	--	--	95	--	38	--	14000	--	900	29	--	--	--	--	120	17	--	1200
		12/15/92	1100000	<1	**520**	930	--	8400	**260**	680	**160**	--	460	200000	100	170	23	16000	--	1200	**730**	--	55	18	--	--	1600	29	--	--	--	<10	17000	16	--	1400
		03/16/93	1300	<1	**12**	20	--	4900	1	430	9	--	<10	3600	<1	60	25	9600	--	210	**120**	--	34	<1	--	--	940	29	--	--	--	<10	130	15	--	1100
		06/08/93	18000	<1	**19**	20	--	3000	5	520	<1	--	<10	5500	<1	50	20	9100	--	480	87	--	42	--	--	--	1100	28	--	--	--	--	250	15	--	1200
		09/21/93	4800	<1	**14**	20	--	5600	2	380	2	--	<10	4600	<1	50	26	10000	--	320	94	--	26	--	--	--	1100	28	--	--	--	--	200	15	--	1200
		03/09/94	1200	<1	**12**	20	--	2100	2	470	<1	--	<10	3300	2	50	27	8900	--	240	**110**	--	33	--	--	--	990	30	--	--	--	--	120	14	--	1200
		09/21/94	910	<1	**12**	10	<1	4700	2	370	<1	--	<10	1900	1	64	20	6400	--	150	**110**	--	31	--	--	<10	730	30	<50	--	--	<10	100	14	--	1200

~ Action Level
^ nitrate TDEC MCL is listed since there is no MCL for nitrite
^^ nitrite MCL is listed since it is a more conservative value
-- no data
Bold numbers indicate that measured values exceed TDEC MCLs
cont. - continued
EPA - Environmental Protection Agency; MCLs established in 40 CFR Part 141 Appendix I
Grey cells indicate Grey cells indicate that measured values exceed EPA MCLs
MCL - Maximum Contaminant Level
mg/L - milligrams per liter
Ref. - reference
TDEC - Tennessee Department of Environment and Conservation; MCLs established in Rules of TDEC Solid Waste Management Appendix III
ug/L - micrograms per liter

Well ID	Historical Well ID Ref.	Date	General Chemistry										
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-10-AP1	10-AP1	03/16/11	--	32	--	268	0.1	5.6	705	19.2	1200	5.8	--
		09/14/11	--	28	--	249	0.1	5.5	714	20.3	590	1.1	--
		03/21/12	--	32	--	367	0.2	5.6	739	21.6	590	6.4	2.3
		09/19/12	--	28	--	329	0.2	5.5	711	21.2	--	3.6	0
		03/20/13	--	16	--	387	0.3	5.5	701	19	--	3.4	0
		09/25/13	--	20	--	304	0	5.5	687	23.1	--	3	7.1
		03/12/14	--	16	--	326	0.2	5.4	687	18	--	<2	8.2
		09/09/14	--	24	--	337	0.1	5.2	691	20.9	--	<2.5	4.7
		09/23/15	--	20	--	--	--	--	--	--	--	<2.5	3.4
		03/22/16	--	16	--	345	0	5.5	693	21.1	--	<2.5	3.8
		09/21/16	--	18	--	348	1.3	5.3	675	24.5	--	--	--
		09/21/16	--	--	--	--	--	5.78	--	--	549	7.8	10.6
JOF-10-AP2	10-AP2	03/16/11	--	104	--	67	0.1	5.4	1071	18.4	810	2.1	--
		09/14/11	--	100	--	151	0.1	5.4	1039	19.2	800	<1	--
		03/21/12	--	100	--	299	0.2	5.3	1269	19.8	970	1.5	2.2
		09/19/12	--	60	--	325	0.2	5.4	1130	20	--	6.5	1.4
		03/20/13	--	48	--	458	0.2	5.3	1278	17.2	--	4.2	2.5
		09/25/13	--	48	--	319	0	5.4	1228	19.4	--	<2	5.2
		03/12/14	--	40	--	351	0.1	5.2	1264	16.5	--	<2	7.2
		09/09/14	--	52	--	342	0.2	5.2	1284	20.8	--	8	4.7
		09/23/15	--	44	--	--	--	--	--	--	--	<2.5	5
JOF-10-AP3	10-AP3	03/16/11	--	24	--	304	0.2	5.4	1443	19.1	560	12	--
		04/21/11	--	64	--	285	0.9	6.2	1384	14.8	--	--	--
		09/14/11	--	24	--	330	0.3	5.5	1384	19.3	1200	4.2	--
		03/21/12	--	28	--	452	0.2	5.4	1365	21.5	1100	13	15.8
		09/19/12	--	20	--	428	0.4	5.3	1386	17.6	--	8	2.7
		03/20/13	--	12	--	525	0.3	5.2	1380	16.7	--	9.9	8.2
		09/25/13	--	12	--	433	0.5	5.1	1347	21.1	--	7.4	10.5
		03/12/14	--	16	--	422	1.5	5.1	1306	9.5	--	7.2	7.1
		09/09/14	--	12	--	466	1.2	4.9	1319	28.7	--	11	9.1
		09/23/15	--	12	--	--	--	--	--	--	--	3.89	4.9
		03/22/16	--	18	--	446	1	5.1	1235	21.9	--	4.8	8.2
		09/22/16	--	--	--	--	--	5.24	--	--	1030	<2.5	--
		09/22/16	--	10	--	421	1.4	4.9	1219	19.3	--	--	--
JOF-A1	A-1	02/11/82	--	44	--	--	--	6.9	118	15.2	70	--	--
		03/24/82	--	45	--	--	1	6.9	115	15.3	70	--	--
		04/13/82	--	47	--	--	0.7	6.8	91	16.1	60	--	--
		05/25/82	--	46	--	--	2.7	6.2	134	15.4	60	--	--
		08/11/88	--	70	--	0	1.7	6.7	161	23.8	70	--	--
		06/20/90	--	55	--	300	1.1	6.2	121	16.8	1900	640	--
		09/04/90	--	62	--	-134	0.7	6.5	123	21.5	70	7	--
		09/04/90	--	64	--	--	--	--	--	--	90	7	--
		12/11/90	--	60	--	-75	0.8	6.6	126	17.5	70	8	--
		12/11/90	--	--	--	--	--	--	--	--	80	9	--
		03/05/91	--	53	--	-74	1	6.4	127	13.6	120	54	--
		06/25/91	--	73	--	176	1.8	6.7	142	17.5	70	16	--
		09/24/91	--	65	--	-51	0.3	6.6	157	16.9	90	14	--
		09/24/91	--	--	--	--	--	--	--	--	70	13	--
		12/04/91	--	79	--	172	1.4	6.7	160	15.2	100	35	--
		03/17/92	--	95	--	-79	0.8	6.7	149	16.4	60	26	--

Well ID	Historical Well ID Ref.	Date	General Chemistry										
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-A1 (cont.)	A-1	03/17/92	--	--	--	--	--	--	--	--	70	16	--
		06/10/92	--	70	--	144	1.4	6.37	129	18.2	150	2	--
		09/01/92	--	60	--	175	0.7	3.9	130	19.1	80	7	--
		12/14/92	--	64	--	172	0.9	6.5	125	18	70	20	--
		06/07/93	--	58	--	120	0.8	6.5	154	19.2	80	31	--
		06/07/93	--	--	--	--	--	--	--	--	70	35	--
		03/07/94	--	52	--	72	0.7	6.49	124	17.1	80	36	--
		09/20/94	--	40	--	158	0.3	6.12	100	16.4	60	4	--
		03/25/97	--	57	--	161	0.3	6.12	102	17.2	--	--	--
		03/19/98	--	48	--	143	0.7	6.28	101	16.1	80	43	--
		03/19/98	--	44	--	96	0.3	6.18	105	16.9	50	5	--
		09/15/98	--	52	--	155	1	6.31	108	19.7	60	16	--
		09/15/98	--	50	--	193	0.3	6.07	96	17.4	50	2	--
		03/10/99	--	52	--	79	1.5	6.4	115.4	11.88	--	--	--
		03/10/99	--	48	--	87	0.37	6.03	100.1	16.15	--	--	--
		09/10/99	--	44	--	17	2.54	6.27	109.5	18.33	70	--	--
		03/07/00	--	52	--	159	0.61	6.21	101.6	18.06	70	2	--
		09/19/00	--	48	--	315	1.18	6.22	112.3	18.41	70	97	--
		03/20/01	--	56	--	134	2.67	6.41	115	14.33	60	31	--
JOF-A2	A-2	02/11/82	--	55	--	--	--	6.9	155	15.2	80	--	--
		03/24/82	--	59	--	--	1.2	6.5	56	15	90	--	--
		04/13/82	--	57	--	--	0.5	6.85	110	15.7	50	--	--
		05/25/82	--	57	--	--	2.7	6.4	145	15	70	--	--
		08/11/88	--	46	--	0	0.9	6.3	120	18.8	90	--	--
		03/18/92	--	98	--	-162	0.4	7.61	141	15.5	60	29	--
		03/18/92	--	--	--	--	--	--	--	--	60	31	--
		06/09/92	--	70	--	77	0.7	6.87	177	19.7	150	6	--
		06/09/92	--	--	--	--	--	--	--	--	160	8	--
		09/01/92	--	84	--	-3	1.6	6.9	172	20.7	60	18	--
		12/14/92	--	72	--	75	0.7	6.9	155	19.4	60	30	--
		03/16/93	--	67	--	79	0.5	7.1	150	15.7	70	30	--
		03/16/93	--	--	--	--	--	--	--	--	50	39	--
		06/09/93	--	64	--	151	0.5	6.54	121	18.6	70	30	--
		09/21/93	--	72	--	193	0.2	6.65	144	17.8	30	19	--
		09/21/93	--	--	--	--	--	--	--	--	<10	21	--
		03/08/94	--	85	--	98	0.7	6.89	160	14.1	90	26	--
		03/08/94	--	--	--	--	--	--	--	--	90	27	--
		09/20/94	--	55	--	136	0.06	6.37	133	17.3	70	<1	--
		03/22/95	--	66	--	147	0.3	6.72	151	18.2	40	7	--
		03/22/95	--	--	--	--	--	--	--	--	70	4	--
		09/06/95	--	66	--	116	0.03	6.57	114	17	60	<1	--
		03/21/96	--	70	--	109	0.05	6.46	144	16.5	50	3	--
		09/24/96	--	80	--	159	0.06	6.51	144	17.3	90	5	--
		03/26/97	--	78	--	120	0.05	6.45	144	16.3	90	2	--
		09/09/97	--	70	--	90	0.4	6.56	148	17.2	70	3	--
		03/18/98	--	70	--	59	0.2	6.68	148	16.3	90	7	--
		09/15/98	--	72	--	74	0.08	6.62	140	17.6	60	12	--
		03/09/99	--	80	--	56	0.17	6.43	140.4	16.22	--	--	--
		09/13/99	--	76	--	99	0.8	6.9	159	17.96	80	14	--
		03/07/00	--	72	--	155	0.85	6.87	159	16.85	80	51	--
		09/20/00	--	72	--	151	0.67	6.62	149	20.23	80	24	--
		03/20/01	--	76	--	164	3.44	6.9	161	13	80	170	--

Well ID	Historical Well ID Ref.	Date	General Chemistry										
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-A3	A-3	02/11/82	--	64	--	--	--	6.85	137	15.4	60	--	--
		03/24/82	--	57	--	--	1.3	6.8	129	15.3	40	--	--
		04/13/82	--	59	--	--	--	6.7	100	16	130	--	--
		05/25/82	--	55	--	--	2.7	6.2	112	15.3	40	--	--
		03/18/92	--	60	--	-53	0.2	6.5	128	15.5	--	--	--
		06/08/92	--	56	--	19	0.8	6.24	122	19.3	90	18	--
		09/01/92	--	69	--	265	1.5	6	124	23.5	80	34	--
		09/01/92	--	--	--	--	--	--	--	--	60	34	--
		03/15/93	--	54	--	159	0.6	6.1	1076	15.9	30	19	--
		09/21/93	--	52	--	282	0.3	6.12	112	19.1	20	12	--
		03/07/94	--	51	--	139	0.9	6.27	113	17.1	60	27	--
		09/20/94	--	54	--	122	0.1	6.15	105	16.2	50	<1	--
JOF-B1	B-1	03/12/90	--	26	--	307	0.1	5.1	2130	18.7	1700	7200	--
		06/19/90	--	15	--	404	1.8	4.9	2300	22.3	80	10	--
		09/04/90	--	14	--	134	1.2	4.9	2390	21.3	1900	280	--
		12/10/90	--	0	--	342	1	4.7	2260	19.5	1900	300	--
		03/06/91	--	4	--	472	1.2	5	2400	18.4	1000	470	--
		06/25/91	--	0	--	417	1.5	4.6	2460	19.3	2100	160	--
		09/23/91	--	1	--	379	0.6	4.5	2490	19	1900	420	--
		12/04/91	--	1	--	779	1.3	4.7	2450	16.4	1800	670	--
		03/17/92	--	0	--	341	0.6	4.6	2330	19.6	570	980	--
		06/09/92	--	0	--	496	0.5	4.52	2366	19.6	2000	380	--
		09/02/92	--	0	--	357	0.2	4.6	173	18.9	2100	680	--
		12/15/92	--	3	--	478	0.1	4.4	2390	18.7	1900	210	--
		03/17/93	--	0.5	--	616	0.8	4.6	2370	16.3	2000	340	--
		06/08/93	--	0	--	386	0.2	4.52	2310	18.7	2000	190	--
		09/21/93	--	0	--	519	0.2	4.4	2415	19	2000	2	--
		03/08/94	--	4	--	400	0.3	4.53	2487	17.3	1900	72	--
		09/20/94	--	0	--	378	0.06	4.23	2421	18.6	1700	87	--
		03/20/95	--	1	--	364	0.08	4.5	2415	18.2	2200	22	--
		09/05/95	--	1	--	420	0.4	4.6	2517	19	1700	49	--
		03/21/96	--	0	--	412	0.2	4.4	2528	17.9	1600	110	--
		09/23/96	--	0	--	652	0.1	4.47	2558	18.3	2200	170	--
		03/26/97	--	0	--	404	0.1	4.5	2410	18.5	2000	17	--
		09/09/97	--	0	--	394	0.3	4.51	2528	18.1	2100	22	--
JOF-B10	89-B10	03/12/90	--	19	--	289	4.8	5.9	67	17.9	170	630	--
		06/19/90	--	21	--	416	5.1	5.2	13	19.2	370	3800	--
		09/04/90	--	16	--	242	5	5.2	60	20.3	410	2900	--
		12/12/90	--	13	--	439	5.8	5.2	57	16.8	340	1300	--
		03/05/91	--	15	--	430	5.8	5.4	57	16	760	4100	--
		06/26/91	--	20	--	413	6.2	5.3	55	20.2	310	1600	--
		09/24/91	--	14	--	479	5.2	5.1	59	16.8	240	1400	--
		12/04/91	--	16	--	433	4.8	5.3	70	15.2	290	660	--
		03/17/92	--	20	--	390	4.8	5.4	54	17.5	90	440	--
		06/10/92	--	15	--	581	5.7	5.4	46	17.9	160	330	--
		09/01/92	--	16	--	580	4.9	5.6	52	18.7	--	--	--
		12/14/92	--	22	--	555	5	5.5	575	17.4	330	510	--
		03/15/93	--	10	--	575	5.6	5.5	581	17.4	180	620	--

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JOF-B10 (cont.)	89-B10	09/21/93	--	14	--	601	4.8	5.36	62	18	280	890	--
		03/09/94	--	14	--	464	6.1	5.36	45	8.2	260	440	--
		05/16/94	--	21	--	496	5.9	5.4	45	23.1	--	--	--
		07/20/94	--	16	--	525	5.2	5.17	63	22.9	--	--	--
		09/20/94	--	18	--	412	3.7	5.39	49	26.3	420	360	--
		03/21/95	--	10	--	400	4.9	5.42	58	17.2	60	37	--
		09/06/95	--	12	--	590	5.3	5.34	68	20.6	120	46	--
		03/26/96	--	14	--	494	5	5.35	64	16	<10	4	--
		09/24/96	--	12	--	606	5.3	5.33	67	18.2	100	41	--
		03/26/97	--	12	--	627	5.1	5.28	67	18.8	100	10	--
		09/10/97	--	11	--	561	5.4	5.3	75	18.6	120	25	--
		09/10/97	--	--	--	--	--	--	--	--	130	31	--
		03/19/98	--	20	--	454	6.3	5.6	54	16	190	210	--
		03/19/98	--	18	--	484	5.5	5.41	64	18.3	40	8	--
		09/15/98	--	22	--	596	6	5.39	51	23.2	290	570	--
		09/15/98	--	20	--	612	5.2	5.23	73	20.3	80	33	--
		03/10/99	--	12	--	475	6.11	5.43	49.6	12.57	--	320	--
		03/10/99	--	12	--	512	5.87	5.28	58.7	16.88	--	32	--
		03/10/99	--	--	--	--	--	--	--	--	--	38	--
		09/10/99	--	20	--	427	6.45	5.3	52.1	22.95	100	<1	--
		03/07/00	--	16	--	611	6.14	5.12	54.7	21.23	130	30	--
		09/19/00	--	20	--	616	5.73	5.12	50.4	24.48	290	1210	--
		11/28/00	--	24	--	545	5.21	4.79	60.7	17.54	40	3	--
		03/20/01	--	20	--	557	5.23	5.31	63.7	15.47	60	26	--
		09/18/01	--	12	--	607	4.6	5.31	77	20.4	110	42	--
		03/12/02	--	24	--	585	5.28	5.26	71	17.33	160	52	--
		09/10/02	--	22	--	504	5.17	5.19	82.2	19.05	100	120	--
		09/10/02	--	--	--	--	--	--	--	--	200	78	--
		03/11/03	--	20	--	512	5.32	5.19	77.2	17.52	190	200	--
		09/09/03	--	--	--	--	--	--	--	--	130	71	--
		03/09/04	--	28	--	510	5.6	5.4	78.4	16.9	80	60	--
		09/14/04	--	28	--	591	5.5	5.3	89	18.3	180	170	--
		03/08/05	--	16	--	561	5.5	5.2	81	16.7	100	29	--
		09/07/05	--	12	--	619	5.2	5	90.3	18.6	80	29	57.9
		03/22/06	--	20	--	466	5.5	5.4	72	16.2	50	6	19.2
		09/19/06	--	--	--	--	--	--	--	--	80	31	--
		09/19/06	--	28	--	496	5.3	5.3	85	19.1	190	34	--
		03/06/07	--	24	--	243	5	5.7	73	17.3	60	19	--
		09/19/07	--	28	--	496	5.3	5.3	77	18.2	92	100	--
		03/12/08	--	28	--	432	5.3	5.3	75	18.1	79	76	--
		09/16/08	--	28	--	451	5.6	5.3	89	18.5	53	7.1	--
		03/10/09	--	32	--	434	4.8	5.7	80	18.9	66	9.4	--
		09/15/09	--	12	--	329	5.6	4.9	100	20.5	60	22	--
		09/15/09	--	--	--	--	--	--	--	--	57	14	--
		03/10/10	--	16	--	440	5.8	5.4	87	18.1	71	8.4	--
		09/14/10	--	12	--	282	5.7	5.1	97	18.9	93	8.8	--
		03/15/11	--	16	--	321	5.7	5.1	78	15.7	61	4.9	--
		09/13/11	--	16	--	340	5.7	5.3	97	19.3	63	2.8	--
		03/20/12	--	20	--	546	0.2	5.3	85	22.4	51	2.8	6.3
		09/18/12	--	16	--	474	5.8	5.3	91	19	--	2.1	5.1

Well ID	Historical Well ID Ref.	Date	General Chemistry										
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JOF-B10 (cont.)	B-10	03/19/13	--	16	--	552	5.8	5.2	79	19.6	46	2.3	4.9
		09/24/13	--	16	--	419	5.6	5.4	88	21.2	--	2.4	7.4
		03/11/14	--	16	--	437	5.8	5.2	83	19.9	30	<2	6.4
		09/08/14	--	16	--	488	5.9	4.9	103	20.5	--	30	5.1
		03/17/15	--	12	--	455	6.7	5.2	83	21.3	--	<2.5	5.2
		09/22/15	--	12	--	--	--	--	--	--	--	<2.5	5.1
		03/21/16	--	--	--	--	--	--	--	--	--	5.2	--
		03/21/16	--	18	--	431	5.8	5.3	107	18.1	--	5.8	10.6
		09/20/16	--	--	--	--	--	5.52	--	--	92	8.1	16.1
		09/20/16	--	16	--	528	6.4	5	128	19.1	--	--	--
JOF-B11	B-11	03/13/90	--	23	--	583	--	5.4	115	15	590	9800	--
		06/19/90	--	12	--	425	3.5	5	116	21.5	260	5400	--
		09/04/90	--	11	--	236	3.1	5.4	127	21.6	320	2000	--
		12/12/90	--	9	--	303	3.1	5.7	131	16.9	240	940	--
		03/06/91	--	7	--	455	3	5.3	132	16	360	3500	--
		06/25/91	--	140	--	343	4.3	5.9	138	17.7	150	600	--
		09/23/91	--	11	--	295	2.7	5.1	128	17.1	190	450	--
		12/04/91	--	11	--	294	3.4	5.6	137	14.7	370	1200	--
		03/18/92	--	9	--	290	2.3	5.2	290	16.4	80	450	--
		06/09/92	--	0	--	506	2.8	5.14	117	18.2	230	290	--
		09/02/92	--	7	--	402	3.1	5	130	20.3	190	460	--
		03/17/93	--	11	--	546	2.5	5.3	144	13.7	90	3200	--
		09/22/93	--	45	--	548	2.4	5.05	155	18	180	2400	--
		03/08/94	--	9	--	491	2.2	5.19	142	15.4	150	250	--
		05/16/94	--	18	--	519	2.8	5.16	138	18.1	--	--	--
		07/20/94	--	11	--	519	3	5.07	87	23.1	--	--	--
		09/20/94	--	8	--	392	1.3	5.35	81	25.7	130	53	--
		03/22/95	--	6	--	401	1.9	5.12	144	15	130	59	--
		09/06/95	--	12	--	468	1.7	5.49	157	20.5	110	22	--
		03/21/96	--	6	--	589	3	5.01	151	16.5	80	34	--
		09/23/96	--	4	--	644	1.6	4.91	156	19.2	120	12	--
		03/26/97	--	10	--	521	1.5	5.12	145	18.8	100	13	--
		09/09/97	--	9	--	561	1.4	5.01	152	18.1	90	16	--
		03/19/98	--	8	--	467	1.4	5.01	174	17.5	110	12	--
		03/19/98	--	--	--	--	--	--	--	--	100	14	--
		09/16/98	--	7	--	564	1.5	4.91	166	21.7	110	40	--
		03/09/99	--	16	--	517	1.74	5.06	182	16.57	--	--	--
		09/14/99	--	8	--	511	2.1	4.82	197	19.02	190	88	--
		09/14/99	--	--	--	--	--	--	--	--	190	110	--
		03/08/00	--	16	--	609	1.46	4.73	458	18.91	350	13	--
		09/20/00	--	8	--	643	4.38	4.79	591	22.71	430	24	--
		03/21/01	--	16	--	484	6.77	5.39	1174	15.32	810	69	--
		09/19/01	--	8	--	583	1.36	4.9	1832	19.52	1100	76	--
		03/12/02	--	24	--	582	1.26	5	2337	16.69	1400	17	--
		09/11/02	--	16	--	472	1.4	4.81	1677	21.41	980	21	--
		03/12/03	--	16	--	483	1.69	5.2	1496	17.25	960	96	--
		03/12/03	--	--	--	--	--	--	--	--	960	64	--
		09/09/03	--	--	--	--	--	--	--	--	690	14	--
		03/09/04	--	16	--	513	1.6	5.2	846	15.6	480	66	--
		09/14/04	--	20	--	601	1.7	5.2	707	21.7	430	22	--

Well ID	Historical Well ID Ref.	Date	General Chemistry										
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-B11 (cont.)	B-11	03/08/05	--	12	--	562	1.5	4.9	756	15.1	410	27	--
		09/07/05	--	8	--	495	1.5	4.7	669	23	450	28	55.9
		03/22/06	--	8	--	501	1.6	4.9	780	15.6	470	18	34.8
		09/19/06	--	16	--	360	1.4	5.4	892	22.2	520	32	--
		03/06/07	--	16	--	290	1.3	5.2	968	18.6	560	15	--
		03/06/07	--	--	--	--	--	--	--	--	580	16	--
		09/19/07	--	12	--	461	1.7	4.9	947	23.3	630	28	--
		03/12/08	--	16	--	475	1.5	5.1	1077	20.8	650	14	--
		09/16/08	--	8	--	499	1.7	4.9	747	21.4	480	5.2	--
		03/10/09	--	12	--	469	1.4	5.1	1194	22.1	740	32	--
		09/15/09	--	4	--	348	1.3	4.8	1125	22.4	780	32	--
		03/10/10	--	12	--	498	1.4	5	879	19.9	470	28	--
		03/10/10	--	--	--	--	--	--	--	--	430	26	--
		09/14/10	--	8	--	311	1.4	4.8	838	27.5	530	23	--
		03/15/11	--	16	--	331	1.8	5.3	1271	15	830	19	--
		09/13/11	--	8	--	360	1.2	4.9	1426	25.8	870	5	--
		03/20/12	--	12	--	483	0.2	5	1182	21.7	680	3.6	7.6
		09/18/12	--	12	--	508	0.8	5	1840	20.4	--	1.5	0
		03/19/13	--	14	--	579	1.5	5.2	1649	16.3	830	1.1	0.6
		03/19/13	--	--	--	--	--	--	--	--	830	1.1	--
		09/24/13	--	16	--	408	1.1	5.1	1526	19.4	--	<2	5.8
		03/11/14	--	12	--	428	1.3	5.2	920	17.3	490	<2	5.1
		09/08/14	--	12	--	512	1	4.8	949	19.2	--	<2.5	4.5
		03/17/15	--	12	--	458	1.8	5.2	791	18.8	--	<2.5	0
		09/22/15	--	10	--	--	--	--	--	--	--	<2.5	--
		03/22/16	--	12	--	485	1	5.2	809	18.7	--	<2.5	--
		09/21/16	--	12	--	509	1.6	4.9	1421	20.9	870	3.2	--
JOF-B12	B-12	03/12/90	--	68	--	317	3.9	8.3	122	15.5	1200	4900	--
		06/19/90	--	18	--	397	2.8	5.4	99	18	220	920	--
		09/04/90	--	10	--	227	2.1	5.3	98	19.9	140	210	--
		12/11/90	--	10	--	414	2.8	5.3	96	17.8	80	100	--
		03/05/91	--	30	--	411	3.7	5.3	97	14.2	570	9600	--
		06/24/91	--	26	--	363	3	5.3	100	18.7	90	69	--
		09/24/91	--	13	--	453	2.2	5.4	114	16.7	820	480	--
		12/04/91	--	15	--	418	1.8	5.4	227	15.9	190	140	--
		03/17/92	--	20	--	366	2.2	5.4	194	16.4	70	430	--
		06/10/92	--	10	--	512	2.5	5.3	209	16.8	190	180	--
		09/01/92	--	20	--	567	1.5	5.5	248	18.6	190	20	--
		12/15/92	--	10	--	566	0.8	5.3	229	16.3	70	200	--
		03/15/93	--	9	--	522	2.6	5.3	217	16.9	130	110	--
		09/21/93	--	11	--	581	0.9	5.22	233	18.1	140	160	--
		03/09/94	--	15	--	415	2.4	5.26	188	13.3	140	96	--
		05/16/94	--	21	--	475	3.7	5.51	141	22.3	--	--	--
		07/20/94	--	16	--	508	2	5.17	177	20.7	--	--	--
		09/20/94	--	14	--	317	0.7	5.55	100	22.8	180	100	--
		03/22/95	--	10	--	394	2.4	5.39	147	16.3	110	30	--
		09/05/95	--	10	--	514	0.9	5.22	225	20.8	98	54	--
		03/26/96	--	12	--	570	1.7	5.25	201	15.4	110	38	--
		09/24/96	--	14	--	642	1	5.24	213	17.8	190	72	--
		03/26/97	--	16	--	596	2.2	5.38	141	17.2	100	16	--

Well ID	Historical Well ID Ref.	Date	General Chemistry										
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-B12 (cont.)	B-12	09/10/97	--	15	--	521	1	5.3	177	19.6	140	53	--
		03/17/98	--	16	--	517	1.8	5.43	203	16.4	120	7	--
		09/16/98	--	17	--	552	0.7	5.31	186	20.4	100	3	--
		09/16/98	--	--	--	--	--	--	--	--	110	4	--
		03/10/99	--	20	--	522	2.01	5.34	216	15.77	--	--	--
		09/10/99	--	24	--	151	0.78	5.17	368	20.19	270	--	--
		03/07/00	--	22	--	581	0.59	5.03	766	18.88	570	16	--
		03/07/00	--	--	--	--	--	--	--	--	580	18	--
		09/19/00	--	20	--	547	1.3	5.08	869	27.56	580	22	--
		03/21/01	--	24	--	526	2.16	5.18	1272	16.82	710	<1	--
		09/18/01	--	12	--	576	0.41	5.08	2102	20.04	1200	16	--
		03/13/02	--	24	--	562	1.34	5.13	2383	16.44	1500	7	--
		09/10/02	--	24	--	486	0.38	5.05	3138	19.98	1900	8	--
		03/11/03	--	20	--	478	1.77	5.22	1825	16.29	1100	35	--
		09/09/03	--	--	--	--	--	--	--	--	1200	52	--
		09/09/03	--	--	--	--	--	--	--	--	1200	44	--
		03/09/04	--	24	--	508	1.4	5.3	1569	16.4	840	11	--
		09/14/04	--	28	--	294	0.6	5.3	1941	19.5	1000	8	--
		03/08/05	--	20	--	358	1.2	5.2	1339	16.1	700	10	--
		09/07/05	--	12	--	193	0.8	5.1	2065	20	1300	10	10.7
		03/22/06	--	20	--	447	1.3	5.4	1637	16.5	870	4	18.6
		09/19/06	--	16	--	300	0.4	5.3	2745	20.4	1500	7	--
		03/06/07	--	20	--	277	0.8	5.3	2180	17.4	1300	48	--
		09/19/07	--	16	--	373	0.3	5.1	3190	20.2	2000	6.1	--
		03/12/08	--	16	--	493	1.6	5.2	2380	17.7	1300	3.4	--
		09/16/08	--	16	--	505	0.6	5.1	3092	19.2	1800	3.5	--
		03/10/09	--	20	--	493	1.2	5.2	2950	18	1700	3	--
		09/15/09	--	12	--	361	0.8	5.1	2830	20.5	1700	6	--
		03/10/10	--	20	--	490	1.6	5.3	2277	17.4	1100	7.6	--
		09/14/10	--	18	--	318	0.6	5.1	3052	20.5	1900	4.2	--
		09/14/10	--	--	--	--	--	--	--	--	1900	3.4	--
		03/15/11	--	12	--	343	1.8	5.2	3290	16	1900	7.4	--
		09/13/11	--	16	--	366	0.7	5.1	3897	23.3	2200	2.6	--
		09/13/11	--	--	--	--	--	--	--	--	2200	2.2	--
		03/20/12	--	12	--	528	0.2	5.2	2870	21.6	1600	<1	0
		09/18/12	--	16	--	480	0.7	5.2	4348	20.6	--	1.7	0
		09/18/12	--	--	--	--	--	--	--	--	--	2.2	--
		03/19/13	--	12	--	522	1.7	5.3	3877	17.7	2000	2.9	2
		09/24/13	--	14	--	449	1	5.3	3879	20.9	--	2.8	6.7
		09/24/13	--	--	--	--	--	--	--	--	--	3.2	--
		03/11/14	--	20	--	448	1.7	5.3	2306	19.3	1160	<2	5.6
		09/08/14	--	16	--	391	0.8	5.1	3490	20.7	--	4.8	3.5
		09/08/14	--	--	--	--	--	--	--	--	--	4.3	--
		03/17/15	--	14	--	461	2.5	5.5	2506	19.6	--	<2.5	0.9
		09/22/15	--	28	--	--	--	--	--	--	--	<2.5	4.7
		09/22/15	--	--	--	--	--	--	--	--	--	<2.5	--
		03/21/16	--	16	--	452	2.1	5.3	2458	18.9	--	<2.5	3.9
		09/21/16	--	--	--	--	--	5.31	--	--	2080	65	--
		09/21/16	--	16	--	470	1.7	5.1	4120	20.3	--	--	62.1
		09/21/16	--	--	--	--	--	5.32	--	--	2410	55.2	--

Well ID	Historical Well ID Ref.	Date	General Chemistry										
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-B13	B-13	03/12/90	--	59	--	267	1.3	6.3	65	17	530	7400	--
		06/19/90	--	51	--	407	2.6	5.4	70	20	250	1300	--
		09/04/90	--	11	--	246	3.5	5.5	65	20.1	190	6300	--
		12/11/90	--	21	--	63	5.3	5.3	428	16.7	300	770	--
		03/05/91	--	16	--	428	5.7	5.3	62	14.3	730	6900	--
		06/24/91	--	15	--	392	6.5	5.4	60	18.3	180	810	--
		09/24/91	--	14	--	478	6	5.2	60	16.7	210	550	--
		12/04/91	--	12	--	403	6.6	5.6	62	14.2	290	960	--
		03/17/92	--	13	--	387	6	5.5	44	16.3	40	970	--
		06/10/92	--	15	--	599	6.2	5.4	54	17.9	350	2300	--
		09/01/92	--	14	--	593	4.9	5.4	71	19.3	250	660	--
		03/15/93	--	8	--	577	6.3	5.7	178	16.5	140	2400	--
		09/21/93	--	8	--	568	5.9	5.47	220	11.5	30	460	--
		03/08/94	--	6	--	508	5.9	5.21	392	14.4	380	97	--
		05/16/94	--	22	--	503	6.1	5.26	346	19.5	--	--	--
		07/20/94	--	10	--	543	6.1	5.03	397	23.8	--	--	--
		09/20/94	--	7	--	382	4.3	5.39	226	25.5	410	500	--
		09/20/94	--	--	--	--	--	--	--	--	400	790	--
		03/21/95	--	4	--	392	6	5.09	573	16	510	190	--
		09/05/95	--	6	--	522	6.5	5.2	585	18.2	410	100	--
		09/24/96	--	4	--	639	6.3	4.98	643	17.7	700	95	--
		09/10/97	--	14	--	578	6.5	4.99	759	17.7	590	17	--
		03/17/98	--	10	--	535	6.2	4.99	1116	17.1	730	98	--
		09/15/98	--	6	--	598	6.4	4.88	840	18.5	750	46	--
		03/10/99	--	4	--	533	6.65	4.93	1087	15.79	--	--	--
		09/09/99	--	4	--	513	6.56	4.91	807	19.47	850	85	--
		09/19/00	--	4	--	617	6.19	4.87	913	21.7	870	48	--
		09/19/00	--	--	--	--	--	--	--	--	670	32	--
		03/21/01	--	4	--	540	6.02	4.82	1867	18.81	1300	130	--
		09/18/01	--	40	--	608	5.53	4.88	1497	19.47	990	88	--
		03/13/02	--	4	--	538	6.12	4.95	1800	16.82	1200	66	--
		09/10/02	--	4	--	508	6.22	4.8	1552	19.05	1100	98	--
		03/11/03	--	4	--	518	6.34	4.77	2265	16.34	2400	78	--
		09/14/04	--	4	--	612	6.5	4.7	2074	17.9	2200	57	--
		03/08/05	--	4	--	579	6	4.6	2259	16.7	1500	24	--
		09/07/05	--	4	--	618	6	4.7	1923	18.6	2300	31	51.7
		03/22/06	--	4	--	549	5.6	4.8	2390	17.3	2200	23	31
		09/19/06	--	4	--	487	6	4.8	2161	18.3	1300	26	--
		03/06/07	--	4	--	307	5.2	4.9	2408	17.7	2400	22	--
		09/19/07	--	4	--	513	5.9	4.7	2192	18.3	2100	30	--
		03/12/08	--	4	--	516	5.4	4.6	2543	17.6	1600	32	--
		03/12/08	--	--	--	--	--	--	--	--	1600	35	--
		09/16/08	--	8	--	539	5.8	4.7	2259	18.5	1800	11	--
		03/10/09	--	8	--	524	4.8	4.7	2685	18.9	1900	10	--
		03/10/09	--	--	--	--	--	--	--	--	2000	8.4	--
		09/15/09	--	4	--	365	5.5	4.6	2603	19.6	2000	17	--
		03/10/10	--	8	--	548	5.5	4.7	2950	18.1	1800	30	--
		09/14/10	--	8	--	317	5.6	4.7	2539	19.2	2800	16	--
		03/15/11	--	8	--	350	5.3	4.6	3304	15.8	2500	16	--
		03/15/11	--	--	--	--	--	--	--	--	2600	14	--

Well ID	Historical Well ID Ref.	Date	General Chemistry										
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-B13 (cont.)	B-13	09/13/11	--	8	--	367	5.4	4.8	2909	21.5	2100	21	--
		03/20/12	--	6	--	563	0.3	4.7	3511	24.2	2300	9.5	23.3
		03/20/12	--	--	--	--	--	--	--	--	2400	7.6	--
		09/18/12	--	12	--	522	5.5	4.9	3198	19.9	--	7.8	15.1
		03/19/13	--	8	--	554	5.2	4.7	3873	18.8	2300	5.3	8
		09/24/13	--	8	--	468	5.4	4.8	3346	21	--	6.4	8.9
		03/11/14	--	8	--	496	5.3	4.7	3367	21.6	2100	3.6	8.2
		03/11/14	--	--	--	--	--	--	--	--	2100	3	--
		09/08/14	--	12	--	546	5.4	4.7	3086	19.7	--	<2.5	4.7
		03/17/15	--	6	--	415	5.4	4.7	3763	21.5	--	<2.5	5.1
		09/22/15	--	6	--	--	--	--	--	--	--	3	5.2
		03/21/16	--	8	--	493	5.1	4.8	3476	19.9	--	3.6	9.4
		09/20/16	--	2	--	529	6.1	5.14	3222	19.9	2550	6.4	13.1
JOF-B14	94-B14	05/17/94	--	0	--	555	3.9	4.29	217	18	--	--	--
		03/21/95	--	0	--	464	--	4.21	314	17.6	--	--	--
		09/07/95	--	0	--	482	--	4.38	324	17.8	--	--	--
		04/02/96	--	0	--	593	--	4.24	312	--	--	--	--
		09/25/96	--	0	--	673	--	4.16	314	18.1	--	--	--
JOF-B15	94-B15	05/17/94	--	0	--	475	2.3	4.76	765	15.8	--	--	--
		03/21/95	--	0	--	366	--	4.21	757	17.1	--	--	--
		09/07/95	--	0	--	482	--	4.52	688	16.8	--	--	--
		04/02/96	--	0	--	612	--	4.08	811	--	--	--	--
		09/25/96	--	0	--	664	--	4.3	629	18.1	--	--	--
JOF-B16	94-B16	05/17/94	--	0	--	510	4.3	5.82	1364	14.6	--	--	--
		03/21/95	--	41	--	369	--	5.96	1265	13	--	--	--
		09/07/95	--	38	--	445	--	5.95	1129	19	--	--	--
		04/02/96	--	76	--	474	--	6.13	1015	--	--	--	--
		09/25/96	--	50	--	565	--	5.84	831	19.5	--	--	--
		09/13/99	--	40	--	412	4.58	5.72	645	18.44	550	72	--
		12/14/99	--	36	--	595	3.97	5.69	618	13.89	450	11	--
		03/07/00	--	68	--	603	7.29	5.99	624	14.5	540	67	--
		06/07/00	--	50	--	496	4.53	6.22	722	14.38	610	35	--
		09/20/00	--	44	--	590	3.96	5.56	540	19.19	490	92	--
		03/21/01	--	72	--	533	5.86	5.92	694	12.49	440	26	--
		09/19/01	--	40	--	596	3.33	5.8	646	18.06	540	110	--
		03/12/02	--	72	--	590	6.73	6.13	731	13.5	590	29	--
		09/11/02	--	68	--	486	5.3	5.81	674	19.86	500	82	--
JOF-B17	94-B17	05/17/94	--	0	--	605	3.1	4.06	763	14.5	--	--	--
		03/21/95	--	0	--	434	--	3.93	855	14.3	--	--	--
		09/07/95	--	0	--	516	--	4.1	682	18.6	--	--	--
		04/02/96	--	0	--	646	--	3.93	701	--	--	--	--
		09/25/96	--	0	--	687	--	3.96	608	18.2	--	--	--
JOF-B18	99-B18	12/14/99	--	4	--	610	4.97	4.88	281	15.35	190	47	--
		03/07/00	--	8	--	650	5.94	4.81	287	17.2	170	180	--
		06/07/00	--	6	--	606	3.9	4.88	293	15.12	200	54	--
		03/21/01	--	0	--	580	3.42	4.52	388	15.65	240	570	--
		03/12/02	--	0	--	621	5.5	4.54	539	15.4	380	460	--
JOF-B19	99-B19	09/13/99	--	8	--	470	1.18	4.94	239	18.69	180	17	--
		12/14/99	--	12	--	571	3.17	5.01	238	14.26	180	37	--
		03/08/00	--	4	--	672	6.66	4.63	229	15.77	160	80	--

Well ID	Historical Well ID Ref.	Date	General Chemistry										
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-B19 (cont.)	99-B19	06/07/00	--	8	--	594	2.45	4.71	336	14.67	260	74	--
		09/20/00	--	0	--	654	2.57	4.18	448	19.09	370	46	--
		03/21/01	--	4	--	550	5.86	4.62	389	15.12	230	33	--
		09/19/01	--	0	--	606	1.7	4.33	778	19.24	450	18	--
		03/12/02	--	4	--	622	2.22	4.55	951	13.97	700	12	--
		09/11/02	--	0	--	503	1.32	4.31	1137	19.15	710	6	--
JOF-B2	B-2	09/02/92	--	261	--	82	1.3	5.9	1970	20	1800	12000	--
		12/15/92	--	240	--	195	0.2	5.9	1960	19.4	1400	12000	--
		03/16/93	--	78	--	229	0.6	5.6	2261	16.6	2400	2800	--
		06/08/93	--	84	--	162	0.6	6.01	1636	21.4	1700	7600	--
		09/22/93	--	79	--	258	0.3	6.01	2169	17.9	2100	2800	--
		03/08/94	--	59	--	234	0.6	5.87	2067	17	2400	2000	--
		09/21/94	--	7	--	342	0.4	4.29	2510	19.5	2200	1700	--
JOF-B20A	99-B20A	12/14/99	--	32	--	443	4.51	6.65	229	14.73	190	13	--
		03/07/00	--	32	--	606	4.63	5.87	195	18.17	160	8	--
		06/07/00	--	40	--	568	2.79	5.92	213	16.27	140	1	--
		09/20/00	--	36	--	608	3.49	5.5	144.6	18.99	190	67	--
		03/21/01	--	36	--	520	2.62	5.85	174	16.84	160	<1	--
		09/19/01	--	40	--	599	3.04	5.63	166	17.92	150	16	--
		03/12/02	--	28	--	593	5.05	5.65	180	16.32	180	22	--
		09/11/02	--	32	--	520	3.84	5.62	195	18.17	140	10	--
JOF-B3	B-3	12/15/92	--	5	--	378	0.7	5.1	167	18.2	30	260	--
		03/17/93	--	7	--	581	1.1	4.9	165	15.3	90	140	--
		06/08/93	--	5	--	358	1.3	4.92	170	21.6	120	18	--
		09/22/93	--	6	--	492	0.9	4.82	181	20.3	70	370	--
		03/08/94	--	5	--	469	0.7	4.91	174	14.5	180	300	--
		09/21/94	--	6	--	410	0.5	4.51	176	20.3	120	150	--
		03/22/95	--	4	--	403	0.7	4.85	163	17.3	100	47	--
		09/05/95	--	--	--	--	--	--	--	--	90	29	--
		09/05/95	--	--	--	--	--	--	--	--	100	15	--
		03/21/96	--	6	--	587	0.7	4.77	164	15.3	70	12	--
		09/23/96	--	2	--	627	0.4	4.72	168	21.3	120	28	--
		03/26/97	--	12	--	537	0.3	4.83	168	16.6	120	16	--
		09/09/97	--	12	--	555	0.3	4.85	165	19.7	90	9	--
JOF-B30	B-30	08/10/11	--	42	--	225	0.2	6.4	115	20.8	--	--	--
		08/10/11	--	--	--	--	--	--	--	--	84	8.4	--
		08/10/11	--	--	--	--	--	--	--	--	83	8.6	--
		10/13/11	--	36	--	254	0.2	6.3	126	17	--	--	--
		10/13/11	--	--	--	--	--	--	--	--	85	5.1	--
		10/13/11	--	--	--	--	--	--	--	--	84	2.9	--
		11/30/11	--	36	--	358	0.4	6.3	124	18.3	--	--	19.1
		03/19/13	--	36	--	327	1	6.1	124	21.2	74	<1	0
JOF-B4	B-4	12/15/92	--	42	--	532	0.4	5.4	527	18.1	90	4400	--
		03/17/93	--	54	--	573	0.8	5.5	414	17.2	250	160	--
		06/08/93	--	51	--	334	0.8	5.59	596	21.3	580	1900	--
		09/22/93	--	37	--	501	0.3	5.45	690	19.7	320	260	--
		03/08/94	--	39	--	364	0.6	5.46	696	18	510	520	--
		09/20/94	--	40	--	139	0.6	5.25	624	21.6	340	630	--

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JOF-B5	B-5	03/13/90	--	56	--	637	3.2	5.7	254	14	270	12000	--
		03/13/90	--	--	--	--	--	--	--	--	260	2400	--
		12/11/90	--	19	--	208	1.9	5.4	408	13.5	220	1000	--
		03/05/91	--	19	--	382	4.2	4.8	199	13.3	210	820	--
		06/24/91	--	10	--	401	264	5.2	264	16.2	200	120	--
		09/23/91	--	2	--	381	2.6	5.2	249	15.3	300	6000	--
		12/03/91	--	14	--	568	3.5	5.4	261	14.1	270	1000	--
		12/03/91	--	--	--	--	--	--	--	--	430	2000	--
		03/17/92	--	10	--	346	3.4	5.2	252	14.4	110	1900	--
		06/09/92	--	10	--	568	3.9	5.14	272	16.1	240	3200	--
		09/02/92	--	10	--	334	3.5	5.2	270	15.4	230	300	--
		12/14/92	--	21	--	577	3.2	5.4	255	15.3	200	150	--
		06/08/93	--	6	--	401	3.6	5.09	250	15.8	170	160	--
		03/09/94	--	9	--	457	3.7	5.02	290	14.1	160	60	--
		05/16/94	--	22	--	531	3.6	5.18	261	16	--	--	--
		07/20/94	--	15	--	616	2.5	4.94	272	15.1	--	--	--
		09/20/94	--	10	--	443	3.7	4.86	272	14.7	130	4	--
		03/22/95	--	6	--	408	3.3	5.1	274	15.1	120	8	--
		09/05/95	--	8	--	551	3.6	5.11	274	15.2	120	6	--
		03/21/96	--	12	--	604	3.7	4.96	270	14.6	130	13	--
		03/21/96	--	--	--	--	--	--	--	--	130	15	--
		09/23/96	--	7	--	683	3.4	5.02	273	15.2	170	14	--
		03/26/97	--	12	--	566	3.8	5	266	15.2	170	7	--
		09/10/97	--	10	--	569	3.9	5.07	274	14.8	160	32	--
		03/17/98	--	8	--	591	3.8	5.06	268	14.8	150	22	--
		09/16/98	--	14	--	527	3.5	5.02	255	15.3	130	40	--
		03/09/99	--	20	--	525	3.86	5.06	261	14.3	--	--	--
		09/10/99	--	16	--	124	3.58	5.08	263	14.28	160	38	--
		03/08/00	--	16	--	499	3.63	4.85	261	15.89	160	14	--
		09/19/00	--	12	--	606	3.49	4.73	249	16.27	170	17	--
		03/20/01	--	16	--	583	3.48	5.07	271	14.42	170	31	--
		09/18/01	--	16	--	639	2.97	5.02	278	17.43	170	22	--
		03/12/02	--	20	--	621	3.33	4.97	269	15.26	240	14	--
		09/10/02	--	12	--	523	3.32	4.93	289	16.13	170	15	--
		03/11/03	--	16	--	543	3.55	4.96	284	15.36	190	16	--
		09/09/03	--	--	--	--	--	--	--	--	180	8	--
		03/09/04	--	20	--	549	3.8	5	273	15.2	160	12	--
		09/14/04	--	18	--	623	3.8	5.1	262	15.8	160	6	--
		09/14/04	--	--	--	--	--	--	--	--	150	6	--
		03/08/05	--	12	--	604	3.6	4.9	265	15.18	160	4	--
		09/07/05	--	12	--	519	3.8	4.8	272	16.3	160	4	3.2
		03/22/06	--	16	--	528	3.7	5.1	278	15.3	170	17	9.3
		05/24/06	--	12	--	562	3.7	4.9	280	15.6	--	--	--
		09/19/06	--	16	--	542	3.6	5.1	289	15.6	170	5	--
		03/06/07	--	20	--	301	3.3	5.3	284	15.7	180	6	--
		09/19/07	--	16	--	364	2.9	5	301	16.1	190	8.8	--
		03/12/08	--	16	--	505	3	4.9	297	16.1	180	13	--
		09/16/08	--	14	--	515	2.8	4.9	308	16.1	200	4.8	--
		09/16/08	--	--	--	--	--	--	--	--	200	5	--
		03/10/09	--	24	--	500	2.5	5.3	306	16.4	180	10	--
		09/15/09	--	12	--	338	2.5	4.7	308	16.5	200	45	--
		03/10/10	--	12	--	521	2.8	5	315	16	190	11	--

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JOF-B5 (cont.)	B-5	09/14/10	--	12	--	266	2.5	4.8	298	19.1	190	13	--
		09/14/10	--	--	--	--	--	--	--	--	170	25	--
		03/16/11	--	48	--	375	2.7	4.9	298	15.6	180	33	--
		09/14/11	--	12	--	337	2.7	5	307	15.9	190	15	--
		11/30/11	--	16	--	393	2.7	5	313	15	--	--	4.7
		03/21/12	--	40	--	565	0.1	5	314	16.3	190	5.4	4.9
		09/18/12	--	32	--	510	2.6	5	325	16.5	--	9.2	0.8
		09/18/12	--	--	--	--	--	--	--	--	--	9	--
		03/19/13	--	12	--	572	2.7	5	323	15.4	180	5.4	2.7
JOF-B6	B-6	03/18/92	--	10	--	149	0.6	5.46	861	14.8	460	4000	--
		06/09/92	--	17	--	430	1.8	5.49	571	20.1	100	13000	--
		09/01/92	--	14	--	361	1.4	5.7	594	21.6	230	4500	--
		12/14/92	--	14	--	332	0.7	5.4	719	19.5	470	2900	--
		03/16/93	--	32	--	325	0.8	5.6	567	14.4	330	2600	--
		06/09/93	--	7	--	292	0.6	5.51	700	18.5	560	480	--
		09/21/93	--	10	--	450	0.2	5.26	1092	19.8	710	2700	--
		03/08/94	--	17	--	380	1	5.48	795	13.1	480	630	--
		05/18/94	--	33	--	308	0.7	5.56	523	14.2	--	--	--
		07/20/94	--	16	--	529	0.4	5.21	1022	19.6	--	--	--
		09/20/94	--	10	--	371	0.7	5.03	1179	20.7	600	260	--
		03/22/95	--	12	--	367	0.3	5.37	891	18.3	740	9	--
		09/06/95	--	8	--	453	0.2	5.31	1328	22	890	5	--
		03/25/96	--	8	--	536	0.3	5.01	1648	14.8	1100	15	--
		09/24/96	--	6	--	517	0.1	5.03	1598	20.1	1300	6	--
		09/24/96	--	--	--	--	--	--	--	--	1300	10	--
		03/26/97	--	9	--	450	0.5	5.44	1066	16.6	820	4	--
		09/09/97	--	10	--	364	0.2	5.23	1333	19.6	1100	3	--
		03/18/98	--	10	--	340	0.3	5.35	1222	14.5	1000	<1	--
		09/15/98	--	12	--	332	0.2	5.06	1240	21.4	1000	2	--
		03/09/99	--	8	--	402	0.32	5.1	1432	14.12	--	--	--
		09/13/99	--	8	--	397	0.34	5.08	1363	18.69	1300	--	--
		03/08/00	--	12	--	482	0.3	5.1	1430	15.75	1200	2	--
		09/20/00	--	8	--	522	1.2	5.05	1312	21.35	1300	65	--
		03/21/01	--	12	--	460	1.89	5.19	1213	13.64	1000	<1	--
		09/19/01	--	12	--	511	0.39	5.11	1317	19.81	1100	<1	--
		03/12/02	--	20	--	488	0.61	5.87	1047	13.92	980	1	--
		09/10/02	--	12	--	459	0.27	5.18	1100	20.69	880	1	--
		03/12/03	--	16	--	454	1.23	5.38	710	15.24	520	36	--
		09/09/03	--	--	--	--	--	--	--	--	400	<1	--
		03/09/04	--	20	--	458	0.5	5.4	513	14.2	380	12	--
		09/14/04	--	20	--	584	0.4	5.5	848	19	650	3	--
		03/08/05	--	20	--	506	0.4	5.3	568	14.8	470	2	--
		03/08/05	--	--	--	--	--	--	--	--	510	3	--
		09/07/05	--	20	--	394	0.6	5.2	673	20.3	520	<1	154
		03/22/06	--	28	--	395	1.6	5.6	441	13.7	310	11	23.7
		09/19/06	--	--	--	--	--	--	--	--	620	14	--
		09/19/06	--	24	--	355	0.3	5.4	782	19.7	--	--	--
		03/06/07	--	36	--	279	1	5.8	293	14.9	200	3	--
		09/19/07	--	20	--	350	0.3	5.2	781	20.2	660	2.7	--
		03/12/08	--	28	--	378	1.6	5.5	301	14.8	230	4.2	--

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			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-B6 (cont.)	B-6	09/16/08	--	28	--	358	0.4	5.3	715	19.5	600	1	--
		03/10/09	--	30	--	354	1	5.7	289	15.6	210	<1	--
		03/10/09	--	--	--	--	--	--	--	--	210	1.2	--
		09/15/09	--	20	--	313	0.2	5.5	561	22.1	500	2.6	--
		03/10/10	--	16	--	360	0.6	5.5	477	16.4	380	1.1	--
		09/14/10	--	16	--	307	0.2	5.3	635	22.4	560	1.5	--
		03/16/11	--	16	--	349	0.7	5.4	266	15	220	<1	--
		03/16/11	--	--	--	--	--	--	--	--	210	1	--
		09/13/11	--	16	--	354	0.2	5.3	642	22.8	470	<1	--
		11/30/11	--	22	--	381	2.6	5.5	342	17.4	--	--	1
		03/21/12	--	16	--	469	0.1	5.4	402	17.3	300	<1	--
		09/19/12	--	16	--	365	0.2	5.5	384	20.7	--	<1	0
		03/20/13	--	16	--	556	0.6	5.5	248	15	210	<1	--
		03/20/13	--	--	--	--	--	--	--	--	200	1.3	--
JOF-B6R	B-6R	03/20/13	--	12	--	506	0.8	5.3	732	16.6	540	3.1	7.2
		09/25/13	--	16	--	506	1.8	5.2	673	20.8	--	2.8	6.8
		03/11/14	--	4	--	510	0.9	5.1	675	20.9	450	3	11.6
		09/09/14	--	16	--	552	2.3	4.9	681	20.6	--	<2.5	5
		03/17/15	--	10	--	510	2.9	5	547	18.7	--	<2.5	4.4
		09/23/15	--	--	--	--	--	--	--	--	--	<2.5	--
		03/22/16	--	20	--	520	1.1	5.2	616	15.3	--	<2.5	4.6
		09/21/16	--	--	--	--	--	5.29	--	--	475	<2.5	--
		09/21/16	--	12	--	540	2.5	4.9	650	24.1	--	--	4.3
		09/21/16	--	--	--	--	--	5.47	--	--	475	<2.5	--
JOF-B7	B-7	12/15/92	--	112	--	523	1.6	7.1	242	15.9	90	72	--
		03/16/93	--	112	--	275	0.9	6.9	233	14.8	270	2300	--
		06/08/93	--	114	--	258	0.6	6.86	246	20.7	420	12000	--
		09/21/93	--	121	--	446	0.2	6.98	285	18	280	16000	--
		03/09/94	--	95	--	273	2	6.84	222	13.2	180	64	--
		05/18/94	--	98	--	301	0.7	6.72	121	15.6	--	--	--
		07/20/94	--	134	--	354	1.6	6.71	297	23.7	--	--	--
		09/20/94	--	135	--	250	1.5	6.93	296	17.2	180	81	--
		03/21/95	--	110	--	278	0.7	6.9	271	18.4	120	10	--
		09/06/95	--	120	--	388	0.3	6.86	114	24.7	160	45	--
		03/26/96	--	128	--	374	0.7	6.84	285	15.2	190	39	--
		09/25/96	--	26	--	448	1.1	6.88	301	17.1	190	32	--
		03/26/97	--	29	--	372	3.8	7.08	279	18.1	220	60	--
		09/09/97	--	140	--	107	0.3	7	305	17.4	230	150	--
		03/18/98	--	122	--	335	1.2	6.96	302	18.4	210	43	--
		03/18/98	--	120	--	266	0.5	6.97	303	18.3	220	60	--
		09/16/98	--	120	--	142	0.8	6.8	283	24.1	160	85	--
		09/16/98	--	112	--	122	0.3	6.83	287	24.4	180	260	--
		03/09/99	--	116	--	312	2.23	6.84	277	13.42	--	--	--
		03/09/99	--	128	--	207	0.45	6.88	289	16.89	--	--	--
		09/13/99	--	128	--	146	4.01	6.8	298	18.91	170	30	--
		03/08/00	--	124	--	536	2.03	6.73	283	19.27	210	87	--
		09/20/00	--	132	--	212	0.64	6.74	268	22.88	220	120	--
		03/21/01	--	128	--	463	6.7	6.78	252	13.29	190	79	--
		09/18/01	--	112	--	520	3.39	6.92	273	26.56	200	110	--
		03/12/02	--	128	--	543	4.59	6.67	232	14.48	180	53	--
		09/10/02	--	108	--	401	0.96	6.84	289	24.47	160	130	--

Well ID	Historical Well ID Ref.	Date	General Chemistry										
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-B8	B-8	03/18/92	--	20	--	312	0.5	5.27	1370	17.1	720	45000	--
		06/10/92	--	12	--	481	3	4.93	1534	17	1300	47000	--
		09/02/92	--	3	--	497	1.2	4.3	1442	17.6	1300	40000	--
		12/14/92	--	17	--	570	0.6	5	1480	17.5	1200	20000	--
		03/16/93	--	0.5	--	373	2	4.9	1475	14.4	1300	42000	--
		06/09/93	--	0.2	--	377	1.1	4.87	1306	19.1	1300	1700	--
		09/21/93	--	3	--	583	0.5	4.85	1598	18	1400	4000	--
		03/08/94	--	4	--	474	1	4.78	1660	15	1400	1000	--
		05/18/94	--	12	--	367	1.9	4.71	1405	15.8	--	--	--
		07/20/94	--	12	--	596	0.6	4.7	1525	22.1	--	--	--
		09/20/94	--	2	--	429	0.8	4.54	1566	18.7	980	770	--
		03/22/95	--	2	--	405	0.4	4.65	1545	21.1	1300	63	--
		09/06/95	--	6	--	450	0.3	4.99	1545	23.2	880	32	--
		03/25/96	--	0	--	520	0.6	4.48	1577	17.9	1100	61	--
		09/24/96	--	3	--	586	0.7	4.73	1613	18.9	1300	38	--
		03/26/97	--	2	--	485	0.3	4.87	1673	18.7	1300	12	--
		09/10/97	--	2	--	493	0.7	4.76	1645	19.2	1600	26	--
		03/18/98	--	2	--	483	0.5	4.75	1573	18	1300	21	--
		09/16/98	--	3	--	527	0.7	4.65	1439	24.3	1300	140	--
		03/09/99	--	2	--	475	0.51	4.66	1465	16.91	--	--	--
		09/10/99	--	2	--	460	1.36	4.73	1423	18.68	1200	110	--
		03/08/00	--	2	--	441	0.69	4.74	1380	20.69	1300	35	--
		09/20/00	--	2	--	610	1.47	4.71	1280	21.78	1200	280	--
		03/20/01	--	2	--	536	2.24	4.73	1429	15.5	1200	8	--
		09/18/01	--	10	--	570	2.08	4.84	1394	24.93	1200	35	--
		09/18/01	--	--	--	--	--	--	--	--	1200	24	--
		03/12/02	--	2	--	549	1.03	4.78	1373	16.86	1300	74	--
		09/10/02	--	8	--	492	0.91	4.7	1454	21.17	1200	39	--
		03/11/03	--	0	--	542	0.88	4.4	1534	16.42	1300	53	--
		09/09/03	--	--	--	--	--	--	--	--	1400	36	--
		03/09/04	--	2	--	531	0.5	4.6	1533	16.7	1400	47	--
		09/14/04	--	8	--	600	0.9	5	1730	18	1500	45	--
		03/08/05	--	4	--	500	0.6	4.6	1760	16.6	1700	20	--
		09/07/05	--	8	--	472	1.4	4.6	1833	19.7	1700	14	--
		09/07/05	--	--	--	--	--	--	--	--	1700	13	19.6
		03/22/06	--	2	--	535	1.6	4.6	1788	16.8	1500	30	41.5
		09/19/06	--	12	--	393	0.6	4.7	1829	18.6	1700	51	--
		03/06/07	--	4	--	295	0.5	4.9	1661	17.5	1500	26	--
		09/19/07	--	12	--	415	0.7	4.7	1667	20.5	1500	45	--
		03/12/08	--	0	--	542	0.5	4.5	1632	18.4	1400	24	--
		09/16/08	--	4	--	522	0.9	4.6	1780	20	1700	7	--
		03/10/09	--	4	--	534	0.4	4.6	1731	18.8	1500	18	--
		09/15/09	--	4	--	350	0.4	4.7	1795	20.1	1700	12	--
		09/15/09	--	--	--	--	--	--	--	--	1800	12	--
		03/10/10	--	8	--	518	0.5	4.7	1909	18	1700	67	--
		09/14/10	--	8	--	317	0.4	4.6	1811	21.7	1800	6.8	--
		03/16/11	--	4	--	373	0.5	4.6	1711	15.8	1500	4.6	--
		09/13/11	--	10	--	372	0.8	4.6	1767	21.5	1600	4.3	--
		11/30/11	--	0	--	442	0.6	4.5	1772	16.2	--	--	9.4
		03/21/12	--	4	--	551	0.1	4.6	1767	18.7	1600	3.5	5.6
		09/19/12	--	12	--	507	0.7	4.8	1796	18	--	3	2.7
		03/20/13	--	4	--	646	0.6	4.7	1717	15.7	1400	1.4	--

Well ID	Historical Well ID Ref.	Date	General Chemistry										
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-B8R	B-8R	03/20/13	--	20	--	551	3.3	5.5	269	12.5	160	3	7.3
		09/25/13	--	16	--	447	2.6	5.3	283	20.2	--	3.4	6.2
		03/11/14	--	20	--	464	3.5	5.3	263	22.1	138	<2	7
		03/11/14	--	--	--	--	--	--	--	--	142	<2	--
		09/08/14	--	12	--	535	1.6	4.9	287	21.6	--	<2.5	5.1
		03/17/15	--	10	--	494	3.9	5.3	255	15.6	--	<2.5	5
		09/22/15	--	8	--	--	--	--	--	--	--	<2.5	3.7
		03/22/16	--	74	--	452	4.1	5.9	297	10.4	--	<2.5	4.4
		09/21/16	--	--	--	--	--	5.61	--	--	184	<2.5	--
		09/21/16	--	14	--	478	2.3	5	285	24.4	--	--	1.4
JOF-B9	B-9	03/12/90	--	51	--	388	6.4	6.1	98	16	240	3700	--
		06/19/90	--	47	--	377	6.5	5.8	76	17.9	160	860	--
		06/19/90	--	49	--	--	--	--	--	--	150	790	--
		09/04/90	--	39	--	209	6.1	5.7	74	20	70	31	--
		12/11/90	--	30	--	407	7.5	5.7	67	14.9	40	150	--
		03/05/91	--	61	--	390	7.8	5.8	56	14.1	110	54	--
		06/25/91	--	55	--	400	7.2	6.1	110	17.2	250	250	--
		06/25/91	--	--	--	--	--	--	--	--	250	220	--
		09/24/91	--	38	--	454	6.5	5.8	90	15.9	150	39	--
		12/04/91	--	38	--	400	7.1	5.9	89	14.4	110	100	--
		03/17/92	--	45	--	340	6.2	6	77	17.1	100	90	--
		06/08/92	--	33	--	549	6	6.43	71	17.5	140	28	--
		09/02/92	--	29	--	319	6.8	5.9	68	16.1	70	130	--
		06/07/93	--	38	--	309	6	5.9	59	16.3	60	18	--
		03/09/94	--	23	--	478	6.4	5.56	62	14.9	50	5	--
		05/16/94	--	27	--	502	6	5.86	54	16.1	--	--	--
		07/20/94	--	26	--	599	4.3	5.67	56	15.8	--	--	--
		09/20/94	--	30	--	411	6.6	5.7	56	15.3	40	<1	--
		03/21/95	--	22	--	401	6.2	5.85	56	15.4	40	3	--
		09/05/95	--	20	--	538	6.5	5.75	56	15.6	40	2	--
		03/26/96	--	22	--	621	6.4	5.66	56	14.7	40	7	--
		09/23/96	--	25	--	621	6.3	5.84	57	15.7	60	3	--
		03/25/97	--	29	--	437	6.8	5.81	56	15.7	50	5	--
		09/10/97	--	27	--	590	7.4	5.83	57	15.3	60	8	--
		03/18/98	--	24	--	520	6.5	5.79	57	15.2	80	6	--
		09/15/98	--	24	--	578	6.8	5.78	55	15.9	40	5	--
		03/10/99	--	28	--	480	7.2	5.7	55.6	14.37	--	--	--
		09/09/99	--	32	--	548	6.99	5.73	63	18.3	120	56	--
		03/07/00	--	24	--	607	7.07	5.71	62.4	16.26	70	20	--
		09/19/00	--	36	--	591	6.85	5.61	56.4	16.4	40	6	--
		03/20/01	--	28	--	471	6.6	5.8	62.5	14.47	70	<1	--
		09/18/01	--	24	--	610	6.08	5.73	61.9	18	50	4	--
		03/12/02	--	28	--	602	6.56	5.69	62.7	15.15	120	20	--
		03/12/02	--	--	--	--	--	--	--	--	130	22	--
		09/10/02	--	28	--	466	6.58	5.77	63.9	17.02	70	18	--
		03/11/03	--	32	--	485	6.83	5.99	65.1	14.04	110	36	--
		09/09/03	--	--	--	--	--	--	--	--	100	35	--

Well ID	Historical Well ID Ref.	Date	General Chemistry										
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-B9 (cont.)	B-9	03/09/04	--	36	--	407	7	6.1	63.9	15.4	100	38	--
		09/14/04	--	32	--	601	7.1	6	64.4	7.6	70	11	--
		03/08/05	--	32	--	499	6.8	6.2	64.5	14.8	80	8	--
		09/07/05	--	24	--	602	6.8	5.5	65.9	17	50	8	25.9
		03/22/06	--	28	--	432	6.5	5.9	68	14.4	80	10	23.2
		09/19/06	--	28	--	497	6.8	5.5	66	16	60	10	--
		03/06/07	--	32	--	183	6	6.2	66	14.7	70	8	--
		09/19/07	--	28	--	516	6.8	5.8	65	16.3	52	3.2	--
		03/12/08	--	32	--	370	6.5	5.9	67	14.6	54	9.8	--
		09/16/08	--	28	--	400	6.8	5.8	68	16	23	2.1	--
		03/10/09	--	36	--	386	5.5	6.1	67	16	59	6.9	--
		09/15/09	--	4	--	318	6.5	5.4	69	18.1	38	7.2	--
		03/10/10	--	32	--	442	6.7	5.9	72	15.7	90	25	--
		03/10/10	--	--	--	--	--	--	--	--	80	21	--
		09/14/10	--	28	--	260	6.6	5.6	63	18	81	30	--
		03/15/11	--	24	--	308	6.7	5.6	62	14.1	57	17	--
		09/13/11	--	32	--	309	6.1	5.8	6.5	16.6	37	3.9	--
		11/30/11	--	28	--	401	6.7	5.7	63	15	--	--	8.9
		03/20/12	--	26	--	552	0.1	5.8	66	18.3	45	4.5	8.1
		03/20/12	--	--	--	--	--	--	--	--	45	3.9	--
		09/18/12	--	32	--	470	6.6	5.8	63	16.5	--	4.2	2.2
		03/19/13	--	24	--	471	6.7	5.8	64	11	40	4.5	6.4
		09/24/13	--	24	--	419	6.6	5.9	60	17.9	--	6.4	19.4
		03/11/14	--	24	--	423	6.6	5.6	62	17	36	2.2	7.4
		09/08/14	--	24	--	475	6.6	5.4	59	17.3	--	<2.5	4.9
		03/17/15	--	22	--	459	7.8	5.7	60	17.2	--	4.1	4.5
		09/22/15	--	24	--	--	--	--	--	--	--	<2.5	4.4
		03/21/16	--	32	--	364	6.7	5.8	61	14.4	--	<2.5	4.1
		09/20/16	--	28	--	500	7.4	5.5	66	20.5	--	--	8.5
		09/20/16	--	--	--	--	--	6.27	--	--	53	5.3	--
JOF-C1	C-1	03/12/90	--	42	--	99	2.1	6.9	2030	17.8	2800	1200	--
		06/19/90	--	41	--	84	1.7	6.3	3170	21	3200	620	--
		09/04/90	--	43	--	175	0.5	6.8	3220	21.3	3300	460	--
		12/10/90	--	35	--	-126	1.1	6.8	3020	19.5	2800	310	--
		03/06/91	--	42	--	190	1.2	7.2	2985	18	3000	520	--
		06/25/91	--	66	--	74	1	6.9	2920	17.7	2800	1900	--
		09/23/91	--	57	--	-29	0.5	7	2910	18.2	2900	210	--
		12/03/91	--	34	--	220	1.2	7.1	2920	16.6	2800	600	--
		03/17/92	--	75	--	-104	0.4	6.7	2690	18.8	2600	130	--
		06/09/92	--	39	--	181	0.8	6.58	2742	18.9	2800	220	--
		12/15/92	--	64	--	100	0.3	6.7	2630	17.8	2600	220	--
		06/08/93	--	47	--	122	0.5	6.65	2055	20.3	2500	200	--
		03/08/94	--	55	--	128	0.4	6.75	2841	14.3	2500	160	--
		09/21/94	--	62	--	361	0.2	5.93	464	17.6	2000	79	--
JOF-C2	C-2	03/13/90	--	146	--	151	1.1	10.5	1910	17.5	1800	1300	--
		06/20/90	--	161	--	125	1.2	10.1	1373	19.4	2000	200	--
		09/04/90	--	118	--	-27	1.9	10.1	2160	22	2000	1100	--
		12/10/90	--	118	--	-90	1.3	10.5	2110	18.4	1900	830	--
		03/06/91	--	133	--	45	1.1	12.4	2350	18.2	2200	170	--
		03/06/91	--	--	--	--	--	--	--	--	2200	410	--

Well ID	Historical Well ID Ref.	Date	General Chemistry										
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-C2 (cont.)	C-2	06/25/91	--	125	--	21	1.5	10.4	2300	19	2100	270	--
		09/23/91	--	131	--	-93	0.6	10.5	2320	18.2	2100	280	--
		12/04/91	--	125	--	91	1.5	10.4	2250	14.6	2000	390	--
		09/02/92	--	131	--	42	1.2	10.5	1082	21.4	1800	460	--
		12/15/92	--	124	--	27	0.4	10.6	1850	18.6	1600	120	--
		06/08/93	--	138	--	62	0.8	10.44	2075	21.4	1900	850	--
		03/08/94	--	128	--	50	0.6	10.4	2465	15.3	2200	45	--
		09/21/94	--	111	--	251	0.3	8.66	1385	22.5	2400	59	--
JOF-C3	C-3	03/13/90	--	155	--	218	1.1	10.6	1880	17.4	1900	2000	--
		06/20/90	--	142	--	128	1.5	9.7	557	19.6	630	16	--
		09/04/90	--	149	--	-120	1.1	10.1	866	22.2	680	27	--
		12/10/90	--	65	--	18	1.2	8.2	737	18.1	550	18	--
		03/06/91	--	135	--	65	1.2	11.7	910	17.8	670	7	--
		06/25/91	--	82	--	86	2.2	9.8	1031	18.8	660	95	--
		09/23/91	--	132	--	-65	0.6	9.9	1170	18.1	910	61	--
		12/04/91	--	133	--	122	1.5	9.5	1224	15.3	940	37	--
		12/15/92	--	142	--	-62	0.4	9.9	989	17.6	760	14	--
		06/08/93	--	158	--	78	0.9	9.79	901	22.5	740	5	--
		03/08/94	--	130	--	-30	0.6	9.91	939	15.1	660	10	--
		09/21/94	--	127	--	92	0.3	8.67	378	24.9	650	4	--
JOF-C4	C-4	03/12/90	--	82	--	194	0.3	5.7	310	17.2	170	2000	--
		06/19/90	--	50	--	66	1.4	5.5	311	22	180	8400	--
		09/04/90	--	33	--	40	1	5.6	265	21.4	310	3000	--
		12/10/90	--	38	--	143	0.8	5.6	261	18.7	130	2600	--
		03/06/91	--	30	--	291	0.9	6.2	273	17.7	210	12000	--
		06/25/91	--	31	--	282	1.2	5.5	262	17.7	170	7400	--
		09/23/91	--	25	--	186	0.7	5.4	252	17.7	180	3800	--
		12/03/91	--	20	--	295	1.2	5.5	262	15.8	120	2000	--
		03/16/93	--	21	--	294	0.4	5.4	238	15.3	140	1900	--
		09/22/93	--	22	--	322	0.3	5.45	252	17.3	<10	1400	--
		03/08/94	--	18	--	257	0.3	5.41	266	14.7	180	500	--
		09/21/94	--	26	--	292	0.3	5.41	127	21	110	66	--
JOF-C5	C-5	03/13/90	--	52	--	312	1	8.9	996	17	790	58	--
		06/20/90	--	52	--	202	5.2	8.5	930	18.5	800	910	--
		09/04/90	--	120	--	-114	1.1	10.8	1199	22.2	910	280	--
		12/10/90	--	67	--	-173	1.1	10.9	1249	18.1	860	500	--
		03/06/91	--	112	--	108	1.3	12.6	1220	17.1	920	420	--
		06/25/91	--	141	--	17	1.6	11.1	1269	18.3	860	1200	--
		09/23/91	--	121	--	-116	0.5	11.1	1263	17.8	860	240	--
		12/04/91	--	135	--	311	1.2	11.2	1200	14.9	870	950	--
		03/17/93	--	131	--	222	0.7	11.1	979	15.5	650	230	--
		09/22/93	--	129	--	97	0.3	11.04	906	17.5	300	5500	--
		03/08/94	--	144	--	43	--	11.22	1018	12.5	650	760	--
		09/21/94	--	152	--	22	--	10.85	964	20.7	500	6100	--
JOF-C6	C-6	03/13/90	--	72	--	275	2	8.8	1259	17.4	1000	260	--
		06/20/90	--	86	--	186	5	8.8	1260	20.7	1100	1300	--
		09/04/90	--	93	--	-120	1	9.5	1303	20.6	1000	2100	--
		12/10/90	--	83	--	-67	0.7	9.6	1162	17.6	960	580	--
		03/06/91	--	91	--	1080	1.6	10.2	167	17.2	860	840	--
		06/25/91	--	246	--	125	1.3	7	854	18.9	560	950	--

Well ID	Historical Well ID Ref.	Date	General Chemistry										
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-C6 (cont.)	C-6	09/23/91	--	210	--	18	2.8	7	810	18.2	610	3000	--
		12/04/91	--	190	--	244	1.5	7.9	905	13.2	1200	1400	--
		03/17/92	--	372	--	-57	0.8	6.6	638	18.2	370	1700	--
		06/09/92	--	280	--	176	0.9	6.4	732	20.3	230	700	--
		09/02/92	--	307	--	83	0.7	6.5	483	24.5	560	270	--
		03/17/93	--	287	--	235	0.7	6.4	662	15.3	210	760	--
		09/22/93	--	200	--	328	1.2	6.46	706	18.9	420	8100	--
		03/08/94	--	283	--	143	1.4	6.48	692	11.8	380	1500	--
		09/21/94	--	302	--	142	0.6	6.25	618	25.9	280	61	--
JOF-JSP1	JSP-1	09/02/92	--	72	--	270	--	8.6	287	25.8	190	13	--
JOF-JSP2	JSP-2	03/05/91	--	0	--	509	--	3.4	759	10.3	--	--	--
JOF-JSP4	JSP-4	03/05/91	--	50	--	331	--	6.2	293	10.7	--	--	--
		06/24/91	--	98	--	257	--	7.4	415	29.5	290	10	--
JOF-JSP5	JSP-5	03/05/91	--	--	--	282	9.4	7.3	55	10.1	--	--	--
		06/24/91	--	104	--	229	--	8.1	410	29.3	270	25	--
JOF-JSP7	JSP-7	06/24/91	--	21	--	257	--	7.9	2350	27.8	1500	4	--
JOF-SS13	SS-13	04/23/86	--	150	--	--	--	6.3	350	18	280	--	50
		08/11/88	--	107	--	44	1.8	6	319	20	210	--	--
		12/11/90	--	113	--	109	--	6.3	361	18.1	250	58	--
		03/06/91	--	103	--	216	--	6.7	1820	16.8	240	33	--
		06/24/91	--	115	--	279	1.9	6	404	20.5	310	1700	--
		09/23/91	--	118	--	315	0.7	5.9	352	17.4	240	450	--
		12/03/91	--	98	--	408	1.2	5.4	379	15.9	260	390	--
		03/16/92	--	113	--	98	6.4	6.3	400	17.9	80	1900	--
		06/09/92	--	85	--	454	1.3	5.8	304	18.7	290	3100	--
		09/02/92	--	99	--	380	1	5.7	287	19.2	170	780	--
		12/15/92	--	105	--	340	0.5	5.8	295	16.5	190	1100	--
		06/08/93	--	82	--	255	1.2	5.79	297	22	280	1900	--
		03/09/94	--	61	--	284	2.9	5.78	254	12.1	160	440	--
		09/21/94	--	57	--	239	0.2	5.69	256	26.9	110	1300	--
JOF-SS15	SS-15	04/23/86	--	117	--	--	--	6.3	500	19	390	--	80
		12/11/90	--	--	--	290	--	5.3	501	18	340	300	--
		03/06/91	--	0	--	287	--	4.9	499	17.5	380	140	--
		06/24/91	--	15	--	338	2	5	495	19.6	400	2000	--
		09/23/91	--	4	--	367	1.2	4.7	480	18.1	340	440	--
		12/03/91	--	14	--	515	6	4.8	462	16.1	330	140	--
		03/16/92	--	15	--	198	1.1	5.1	451	17.9	270	630	--
		06/09/92	--	8	--	464	5.3	4.69	457	19.2	340	360	--
		09/02/92	--	3	--	431	1.3	4.6	446	19.3	320	100	--
		06/08/93	--	4	--	338	1.7	4.74	448	23.3	310	68	--
		03/08/94	--	4	--	422	1.5	4.78	464	11.7	310	81	--
		09/21/94	--	3	--	314	0.4	4.24	414	20.9	260	67	--
		03/20/95	--	2	--	303	0.8	4.7	412	16.7	280	51	--
		09/07/95	--	1	--	449	--	5.14	417	--	230	46	--
		03/25/96	--	2	--	485	2.3	4.66	405	16.8	260	63	--
		09/24/96	--	0	--	694	--	4.56	392	18.2	300	23	--
		03/26/97	--	1	--	526	--	4.65	412	17.3	290	8	--
		09/10/97	--	1	--	478	--	4.83	407	17.7	280	3	--

Well ID	Historical Well ID Ref.	Date	General Chemistry										
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-SS16	SS-16	04/23/86	--	71	--	--	--	6.3	1250	18	1300	--	--
		12/11/90	--	--	--	218	--	6.9	1470	18.3	1700	27	--
		03/06/91	--	49	--	115	6.4	6.4	382	17.5	2100	14	--
		06/24/91	--	58	--	229	1.3	6.9	2120	19.5	1600	160	--
		09/23/91	--	40	--	303	1.6	6.8	2370	18.8	2200	180	--
		12/03/91	--	42	--	416	4.7	6.5	2110	16.3	1900	38	--
		03/16/92	--	44	--	-64	0.8	7.1	2340	18.6	2100	310	--
		06/09/92	--	34	--	340	1.2	6.88	2186	19.1	2000	44	--
		09/02/92	--	31	--	381	2.6	6.3	2120	20.1	2100	62	--
		12/15/92	--	37	--	436	1.6	6.3	2170	19	2000	180	--
		03/16/93	--	42	--	293	1.3	6.2	2125	16.9	2000	44	--
		06/08/93	--	32	--	286	1.3	6.12	1941	21.6	2300	110	--
		09/21/93	--	23	--	506	3.6	6.13	2131	19.7	2000	85	--
		03/09/94	--	26	--	274	1.4	6.23	2256	9.3	1800	18	--
		09/21/94	--	30	--	306	0.9	5.88	2150	19.3	1200	13	--
		03/26/97	--	27	--	161	0.5	7.01	2116	21.2	--	--	--
JOF-WP1	WP-1	06/27/91	--	--	--	203	1.8	9.2	1375	21	--	--	--
		07/10/91	--	77	--	138	4.7	9.3	1670	25.5	--	--	--
		07/11/91	--	80	--	145	1.8	9.3	1505	30	1500	<1	--
		04/15/92	--	122	--	474	6.9	8.4	1278	15.6	770	<1	--
		03/26/96	--	82	--	357	--	9.18	1184	11	--	--	--
JOF-WP2	WP-2	06/27/91	--	--	--	231	2.7	8.6	938	26.5	--	--	--
		07/10/91	--	130	--	124	4.7	9.1	979	34.9	--	--	--
		07/11/91	--	127	--	167	0.7	8.2	0	33.9	1300	<1	--
		04/15/92	--	128	--	327	3.1	8.6	942	18.6	1000	<1	--
JOF-WP3	WP-3	06/27/91	--	--	--	241	0.6	7.9	957	26.2	--	--	--
		07/11/91	--	--	--	205	2.3	7.9	1132	31.8	770	<1	--
		04/15/92	--	114	--	441	3.2	7.2	547	21.8	440	<1	--
JOF-WP4	WP-4	06/27/91	--	--	--	213	0.8	8.7	391	23.6	--	--	--
		07/10/91	--	95	--	80	3.1	8.6	440	34	--	--	--
		07/11/91	--	90	--	220	0.9	7	350	32.5	320	<1	--
		04/15/92	--	274	--	340	3.7	8	800	17.8	999	--	--
		04/15/92	--	274	--	340	3.7	8	800	17.8	550	<1	--
JOF-WP5	WP-5	06/27/91	--	--	--	243	0.3	8.4	505	21	--	--	--
		07/10/91	--	74	--	71	3.4	9.4	651	28.1	--	--	--
		07/11/91	--	--	--	--	--	--	--	--	500	<1	--
		04/15/92	--	92	--	210	0.3	8.1	620	13.2	760	1	--
		03/26/97	--	65	--	--	--	9.5	--	--	430	<1	--

-- no data
°C - degrees Celsius
cm - centimeters
cont. - continued
mg/L - milligrams per liter
mV - millivolts
Ref. - reference
NTU - Nephelometric Turbidity Unit

Groundwater Elevation Data

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-10-AP1	10-AP1	03/16/11	362.57	48.75	8.46
		09/14/11	357.81	48.75	13.22
		03/21/12	355.38	48.75	15.42
		09/19/12	356.33	48.75	14.47
		03/20/13	356.04	48.75	14.76
		09/25/13	356.33	48.75	14.47
		03/12/14	355.45	48.75	15.35
		09/09/14	353.35	48.75	17.45
		03/22/16	354.63	48.75	16.17
		09/21/16	355.12	48.98	15.68
JOF-10-AP2	10-AP2	03/16/11	362.60	44.49	11.02
		09/14/11	358.14	44.49	15.49
		03/21/12	355.45	44.49	17.88
		09/19/12	356.43	44.49	16.90
		03/20/13	355.94	44.49	17.39
		09/25/13	356.46	44.49	16.86
		03/12/14	355.22	44.49	18.11
		09/09/14	355.87	44.49	17.45
JOF-10-AP3	10-AP3	03/16/11	362.47	47.21	5.25
		04/21/11	359.55	47.21	8.17
		09/14/11	358.04	47.21	9.68
		03/21/12	355.58	47.21	11.98
		09/19/12	356.43	47.21	11.12
		03/20/13	356.14	47.21	11.09
		09/25/13	356.50	47.21	11.06
		03/12/14	355.35	47.21	12.20
		09/09/14	355.97	47.21	11.58
		03/22/16	354.82	47.21	12.73
		09/22/16	355.31	47.47	12.24
JOF-A1	A-1	02/11/82	384.94	105.81	29.53
		03/24/82	385.07	105.81	29.40
		04/13/82	380.77	110.10	33.69
		05/25/82	380.68	110.10	33.79
		06/20/90	380.77	109.61	33.69
		09/04/90	379.95	109.61	34.51
		12/11/90	380.28	109.61	34.19
		03/05/91	378.87	109.61	35.60
		06/25/91	381.27	109.61	33.20
		09/24/91	380.18	109.61	34.28
		12/04/91	380.48	100.59	33.99
		03/17/92	381.17	109.81	33.30
		06/10/92	380.87	109.81	33.60
		09/01/92	379.63	109.81	34.84
		12/14/92	380.05	109.81	34.42
		03/15/93	380.91	109.78	33.56

Groundwater Elevation Data

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-A1(cont.)	A-1(cont.)	06/07/93	381.17	109.78	33.30
		09/20/93	380.02	--	34.45
		03/07/94	381.30	109.78	33.17
		09/19/94	380.18	109.78	34.28
		09/20/94	380.18	109.78	34.28
		03/20/95	381.33	--	33.14
		09/05/95	380.38	109.78	34.09
		03/20/96	381.46	109.78	33.01
		09/17/96	380.28	109.78	34.19
		03/24/97	382.38	109.78	32.09
		03/25/97	382.38	109.78	32.09
		09/08/97	380.71	109.78	33.76
		03/17/98	381.50	109.78	32.97
		03/19/98	381.50	109.78	32.97
		09/14/98	380.68	109.78	33.79
		09/15/98	380.68	109.78	33.79
		03/08/99	380.68	109.78	33.79
		03/10/99	381.46	109.78	33.01
		09/09/99	380.02	109.78	34.45
		09/10/99	380.02	109.78	34.45
		03/07/00	380.41	109.78	34.06
		09/19/00	379.49	109.78	34.97
		03/20/01	379.86	109.78	34.61
JOF-A2	A-2	02/11/82	384.12	69.09	3.58
		03/24/82	384.42	68.40	3.28
		04/13/82	380.02	73.49	7.68
		05/25/82	379.89	73.49	7.81
		03/18/92	380.45	73.19	7.25
		06/09/92	380.05	73.29	7.64
		09/01/92	378.94	73.29	8.76
		12/14/92	379.00	73.29	8.69
		03/16/93	380.02	73.29	7.68
		06/09/93	380.18	73.29	7.51
		09/20/93	379.04	--	8.66
		09/21/93	379.00	73.29	8.69
		03/07/94	380.51	73.19	7.19
		03/08/94	380.51	73.29	7.19
		09/19/94	379.00	73.29	8.69
		09/20/94	379.00	73.29	8.69
		03/20/95	380.54	73.29	7.15
		03/22/95	380.48	73.29	7.22
		09/05/95	379.56	73.29	8.14
		09/06/95	379.56	73.29	8.14

Groundwater Elevation Data

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-A2 (cont.)	A-2	03/20/96	380.71	73.29	6.99
		03/21/96	380.71	73.29	6.99
		09/17/96	379.30	73.29	8.40
		09/24/96	379.36	73.29	8.33
		03/24/97	381.69	73.29	6.00
		03/26/97	381.59	73.29	6.10
		09/08/97	379.79	73.29	7.91
		09/09/97	379.79	73.29	7.91
		03/17/98	380.81	73.29	6.89
		03/18/98	380.81	73.29	6.89
		09/14/98	379.82	73.29	7.87
		09/15/98	379.82	73.29	7.87
		03/08/99	380.54	73.29	7.15
		03/09/99	380.81	73.29	6.89
		09/09/99	379.07	73.29	8.63
		09/13/99	379.07	73.29	8.63
		03/07/00	379.53	73.29	8.17
		09/19/00	378.61	73.29	9.09
		09/20/00	378.61	73.29	9.09
		03/20/01	379.17	73.29	8.53
JOF-A3	A-3	02/11/82	384.71	81.69	19.42
		03/24/82	384.78	81.79	19.36
		04/13/82	380.41	86.09	23.72
		05/25/82	380.28	86.09	23.85
		03/18/92	380.87	87.01	23.26
		06/08/92	380.74	87.01	23.39
		09/01/92	379.56	87.01	24.57
		12/14/92	379.59		24.54
		03/15/93	380.51	99.18	23.62
		09/20/93	379.69		24.44
		09/21/93	379.66	98.00	24.48
		03/07/94	380.84	98.00	23.29
		09/19/94	379.76	98.00	24.38
		09/20/94	379.76	98.00	24.38
		03/20/95	380.87		23.26
		09/05/95	379.92	98.00	24.21
		03/20/96	381.20	98.00	22.93
		09/17/96	379.86	98.00	24.28
		03/24/97	381.99	98.00	22.18
		09/08/97	380.31	98.00	23.85
		03/17/98	381.14	98.00	23.03
		09/14/98	380.22	98.00	23.95
		03/08/99	381.10	98.00	23.06
		09/09/99	379.59	98.00	24.57

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B1	B-1	03/12/90	359.45	--	27.40
		06/19/90	362.34	41.70	24.51
		09/04/90	359.35	41.70	27.49
		12/10/90	357.84	41.70	29.00
		03/06/91	360.43	41.70	26.41
		06/25/91	362.24	41.70	24.61
		09/23/91	358.86	41.70	27.99
		12/04/91	360.86	41.70	25.98
		03/17/92	358.30	41.70	28.54
		06/09/92	362.70	41.70	24.15
		09/02/92	358.46	41.70	28.38
		12/15/92	358.33	41.70	28.51
		03/17/93	357.15	41.70	29.69
		06/08/93	361.61	41.70	25.23
		09/20/93	358.17	--	28.67
		09/21/93	358.14	41.70	28.71
		03/07/94	360.24	41.70	26.61
		03/08/94	360.27	41.70	26.57
		09/19/94	358.86	41.70	27.99
		09/20/94	358.86	41.70	27.99
		03/20/95	357.61	41.70	29.23
		09/05/95	358.92	41.70	27.92
		03/20/96	358.60	--	28.25
		03/21/96	358.60	41.70	28.25
		09/17/96	359.35	--	27.49
		09/23/96	358.99	41.70	27.85
		03/24/97	365.19	--	21.65
		03/26/97	363.48	41.70	23.36
		09/08/97	358.60	--	28.25
		09/09/97	358.63	41.70	28.22
		03/17/98	358.46	--	28.38
		09/14/98	358.40	--	28.44
		03/08/99	358.14	--	28.71
		09/09/99	358.37	--	28.48
JOF-B10	89-B10	03/12/90	380.91	41.99	23.59
		06/19/90	378.81	41.99	25.69
		09/04/90	377.49	41.99	27.00
		12/12/90	378.51	41.99	25.98
		03/05/91	379.99	41.99	24.51
		06/26/91	378.90	41.99	25.59
		09/24/91	377.40	41.99	27.10
		12/04/91	378.81	41.99	25.69
		03/17/92	379.69	41.99	24.80

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B10 (cont.)	89-B10	06/10/92	379.10	41.99	25.39
		09/01/92	377.53	41.99	26.97
		12/14/92	377.59	41.99	26.90
		03/15/93	379.07	41.99	25.43
		09/20/93	377.59	--	26.90
		09/21/93	377.56	41.99	26.94
		03/07/94	380.18	41.99	24.31
		03/09/94	380.22	41.99	24.28
		05/16/94	380.05	41.99	24.44
		05/16/94	380.05	41.99	24.44
		07/20/94	378.51	41.34	25.98
		09/19/94	377.69	41.99	26.80
		09/20/94	377.69	41.99	26.80
		03/20/95	379.63	--	24.87
		03/21/95	379.63	41.90	24.87
		09/05/95	378.08	41.99	26.41
		09/06/95	378.08	41.90	26.41
		03/20/96	380.45	41.90	24.05
		03/26/96	380.48	41.99	24.02
		09/17/96	377.89	41.90	26.61
		09/24/96	378.35	41.90	26.15
		03/24/97	380.77	41.90	23.72
		09/08/97	378.18	41.90	26.31
		09/10/97	378.12	41.90	26.38
		03/17/98	380.22	41.90	24.28
		03/19/98	380.09	41.90	24.41
		03/19/98	380.09	41.90	24.41
		09/14/98	378.12	41.90	26.38
		09/15/98	378.12	41.90	26.38
		03/08/99	380.22	41.90	24.28
		03/10/99	380.22	41.90	24.38
		09/09/99	377.49	41.90	27.00
		09/10/99	377.49	41.90	27.00
		03/07/00	378.97	41.90	25.52
		09/19/00	377.20	41.90	27.30
		11/28/00	379.49	41.96	26.80
		03/20/01	379.53	41.90	24.97
		09/18/01	377.72	41.90	26.77
		03/12/02	379.13	41.90	25.36
		09/10/02	377.72	41.90	26.77
		03/11/03	380.81	41.90	23.69

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B10 (cont.)	89-B10	09/09/03	380.71	41.90	23.79
		03/09/04	380.31	41.90	24.18
		09/14/04	378.51	41.90	25.98
		03/08/05	380.25	41.90	24.25
		09/07/05	378.22	41.90	26.28
		03/22/06	380.18	41.90	24.31
		09/19/06	377.62	41.90	26.87
		03/06/07	379.66	41.90	24.84
		09/19/07	377.07	41.90	27.43
		03/12/08	380.41	41.90	24.08
		09/16/08	377.56	41.90	26.94
		03/10/09	379.72	41.90	24.77
		09/15/09	378.28	41.90	26.21
		03/10/10	379.43	41.90	25.07
		09/14/10	377.79	41.90	26.71
		03/15/11	380.09	41.90	24.41
		09/13/11	377.56	41.90	26.94
		03/20/12	379.79	41.90	24.70
		09/18/12	377.33	41.90	27.17
		03/19/13	380.22	41.90	24.28
		09/24/13	378.81	41.90	25.69
		03/11/14	380.22	41.90	24.28
		09/08/14	377.99	41.90	26.51
		03/17/15	380.22	41.90	24.28
		03/21/16	380.15	41.90	24.34
		09/20/16	378.28	42.36	26.21
JOF-B11	B-11	03/13/90	381.50	36.81	20.01
		06/19/90	380.51	36.81	21.00
		09/04/90	379.20	36.81	22.31
		12/12/90	379.30	36.81	22.21
		03/06/91	380.91	36.81	20.60
		06/25/91	380.31	36.81	21.19
		09/23/91	378.90	36.81	22.60
		12/04/91	378.81	36.81	22.70
		03/18/92	380.45	36.81	21.06
		06/09/92	379.86	36.81	21.65
		09/02/92	379.10	36.71	22.41
		12/14/92	379.13	--	22.38
		03/17/93	380.09	36.74	21.42
		09/20/93	379.17	--	22.34
		09/22/93	379.20	36.74	22.31
		03/07/94	380.94	36.74	20.57
		03/08/94	380.91	36.74	20.60
		05/16/94	381.17	36.74	20.34
		07/20/94	380.25	36.74	21.26
		09/19/94	379.49	36.74	22.01

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B11 (cont.)	B-11	09/20/94	379.49	36.74	22.01
		03/20/95	380.64	--	20.87
		03/22/95	380.61	36.61	20.90
		09/05/95	379.79	36.74	21.72
		09/06/95	379.79	36.61	21.72
		03/20/96	380.84	36.58	20.67
		03/21/96	380.84	36.58	20.67
		09/17/96	379.40	36.58	22.11
		09/23/96	379.56	36.58	21.95
		03/24/97	382.15	36.58	19.36
		03/26/97	382.15	36.58	19.36
		09/08/97	379.92	36.61	21.59
		09/09/97	379.89	36.61	21.62
		03/17/98	381.17	36.61	20.34
		03/19/98	381.14	36.61	20.37
		09/14/98	379.79	36.61	21.72
		09/16/98	379.79	36.61	21.72
		03/08/99	380.81	36.61	20.70
		03/09/99	380.81	36.61	20.54
		09/09/99	378.97	36.61	22.54
		09/14/99	378.97	36.61	22.60
		03/07/00	379.63	36.61	21.88
		03/08/00	379.63	36.61	21.88
		09/19/00	378.84	36.61	22.67
		09/20/00	378.84	36.61	22.67
		03/20/01	380.77	36.61	20.73
		03/21/01	380.77	36.61	20.73
		09/18/01	379.33	36.61	22.18
		09/19/01	379.33	36.61	22.18
		03/12/02	380.54	36.61	20.96
		09/10/02	379.36	36.61	22.15
		09/11/02	379.36	36.61	22.15
		03/11/03	381.50	36.61	20.01
		03/12/03	381.50	36.61	20.01
		09/09/03	381.59	36.61	19.91
		03/09/04	381.73	36.61	19.78
		09/14/04	380.31	36.61	21.19
		03/08/05	381.46	36.61	20.05
		09/07/05	379.95	36.61	21.56
		03/22/06	380.87	36.61	20.64
		09/19/06	379.43	36.61	22.08
		03/06/07	380.25	36.61	21.26
		09/19/07	378.77	36.61	22.74
		03/12/08	381.79	36.61	19.72
		09/16/08	379.30	36.61	22.21
		03/10/09	380.84	36.61	20.67

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B11 (cont.)	B-11	09/15/09	380.12	36.61	21.39
		03/10/10	381.17	36.61	20.34
		09/14/10	379.53	36.61	21.98
		03/15/11	381.30	36.61	20.21
		09/13/11	379.30	36.61	22.21
		03/20/12	381.27	--	20.24
		09/18/12	379.10	36.61	22.41
		03/19/13	381.56	36.61	19.95
		09/24/13	380.51	36.61	21.00
		03/11/14	381.69	36.61	19.82
		09/08/14	379.82	36.61	21.69
		03/17/15	381.69	36.61	19.36
		03/22/16	381.69	36.61	19.82
		09/21/16	380.25	36.71	21.26
JOF-B12	B-12	03/12/90	381.73	36.81	11.91
		06/19/90	380.74	36.81	12.89
		09/04/90	379.53	36.81	14.11
		12/11/90	379.53	36.81	14.11
		03/05/91	380.94	36.81	12.70
		06/24/91	380.68	36.81	12.96
		09/24/91	379.04	36.81	14.60
		12/04/91	379.04	36.81	14.60
		03/17/92	380.48	36.81	13.16
		06/10/92	380.18	36.81	13.45
		09/01/92	379.33	36.81	14.30
		12/15/92	379.27	36.81	14.37
		03/15/93	380.18	36.78	13.45
		09/20/93	379.40	--	14.24
		09/21/93	379.40	36.78	14.24
		03/07/94	381.23	36.78	12.40
		03/09/94	381.20	36.78	12.43
		05/16/94	381.53	36.78	12.11
		07/20/94	380.51	36.71	13.12
		09/19/94	379.66	36.74	13.98
		09/20/94	379.66	36.74	13.98
		03/20/95	380.94	--	12.70
		03/22/95	380.87	36.74	12.76
		09/05/95	379.99	36.74	13.65
		03/20/96	381.17	36.68	12.47
		03/26/96	381.07	36.68	12.57
		09/17/96	379.63	36.68	14.01
		09/24/96	379.82	36.68	13.81
		03/24/97	382.55	36.68	11.09
		03/26/97	382.38	36.68	11.25
		09/08/97	380.12	36.68	13.52
		09/10/97	380.05	36.68	13.58

Groundwater Elevation Data

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B12 (cont.)	B-12	03/17/98	381.46	36.68	12.17
		09/14/98	379.92	36.71	13.71
		09/16/98	379.92	36.68	13.71
		03/08/99	381.17	36.71	12.47
		03/10/99	381.17	36.68	12.57
		09/09/99	379.20	36.71	14.44
		09/10/99	379.20	36.68	14.44
		03/07/00	379.79	36.68	13.85
		09/19/00	379.00	36.68	14.63
		03/20/01	381.07	36.71	12.57
		03/21/01	381.07	36.68	12.57
		09/18/01	379.56	36.71	14.07
		03/12/02	380.77	36.71	12.86
		03/13/02	380.77	36.68	12.86
		09/10/02	379.63	36.68	14.01
		03/11/03	381.69	36.68	11.94
		09/09/03	381.82	36.68	11.81
		03/09/04	381.63	36.68	12.01
		09/14/04	380.61	36.68	13.02
		03/08/05	381.79	36.68	11.84
		09/07/05	380.18	36.68	13.45
		03/22/06	381.17	36.68	12.47
		09/19/06	379.66	36.68	13.98
		03/06/07	380.45	36.68	13.19
		09/19/07	378.94	36.68	14.70
		03/12/08	382.09	36.68	11.55
		09/16/08	379.49	36.68	14.14
		03/10/09	381.10	36.68	12.53
		09/15/09	380.35	36.68	13.29
		03/10/10	381.40	36.68	12.24
		09/14/10	379.72	36.68	13.91
		03/15/11	381.66	36.68	11.98
		09/13/11	379.49	36.68	14.14
		03/20/12	381.63	36.68	12.01
		09/18/12	379.36	36.68	14.27
		03/19/13	381.99	36.68	11.65
		09/24/13	380.91	36.68	12.73
		03/11/14	382.09	36.68	11.55
		09/08/14	380.18	36.68	13.45
		03/17/15	382.09	36.68	11.42
		03/21/16	381.96	36.71	11.68
		09/21/16	380.54	36.81	13.09

Groundwater Elevation Data

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B13	B-13	03/12/90	381.99	43.90	28.51
		06/19/90	381.40	43.90	29.10
		09/04/90	379.99	43.90	30.51
		12/11/90	379.69	43.90	30.81
		03/05/91	381.23	43.90	29.27
		06/24/91	381.00	43.90	29.49
		09/24/91	379.69	43.90	30.81
		12/04/91	379.20	43.90	31.30
		03/17/92	380.61	43.90	29.89
		06/10/92	380.18	43.90	30.31
		09/01/92	379.66	43.90	30.84
		12/14/92	379.53	--	30.97
		03/15/93	380.81	43.90	29.69
		09/20/93	379.92	--	30.58
		09/21/93	379.89	43.90	30.61
		03/07/94	381.46	43.90	29.04
		03/08/94	381.46	43.90	29.04
		05/16/94	381.96	43.90	28.54
		07/20/94	380.81	43.96	29.69
		09/19/94	380.15	43.96	30.35
		09/20/94	380.15	43.96	30.35
		03/20/95	381.36	--	29.13
		03/21/95	381.36	43.96	29.13
		09/05/95	380.51	43.96	29.99
		03/20/96	381.40	43.83	29.10
		09/17/96	380.12	43.83	30.38
		09/24/96	380.15	43.83	30.35
		03/24/97	382.74	43.83	27.76
		09/08/97	380.64	43.83	29.86
		09/10/97	380.58	43.83	29.92
		03/17/98	381.76	43.83	28.74
		09/14/98	380.71	43.83	29.79
		09/15/98	380.71	43.83	29.79
		03/08/99	381.46	43.83	29.04
		03/10/99	381.46	43.83	29.20
		09/09/99	379.82	43.83	30.68
		03/07/00	379.82	43.83	30.68
		09/19/00	379.59	43.83	30.91
		03/20/01	381.14	43.83	29.36
		03/21/01	381.14	43.83	29.36
		09/18/01	379.99	43.83	30.51
		03/12/02	381.20	43.83	29.30
		03/13/02	381.20	43.83	29.30
		09/10/02	379.92	43.83	30.58
		03/11/03	382.05	43.83	28.44
		03/11/03	382.05	43.83	28.44
		09/09/03	381.69	43.83	28.81
		03/09/04	382.05	43.83	28.44

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B13 (cont.)	B-13	09/14/04	381.04	43.83	29.46
		03/08/05	382.22	43.83	28.28
		09/07/05	380.45	43.83	30.05
		03/22/06	381.27	43.83	29.23
		09/19/06	380.05	43.83	30.45
		03/06/07	380.64	43.83	29.86
		09/19/07	379.36	43.83	31.14
		03/12/08	382.05	43.83	28.44
		09/16/08	379.95	43.83	30.54
		03/10/09	381.23	43.83	29.27
		09/15/09	380.84	43.83	29.66
		03/10/10	381.86	43.83	28.64
		09/14/10	380.18	43.83	30.31
		03/15/11	381.10	43.83	29.40
		09/13/11	379.89	43.83	30.61
		03/20/12	381.43	43.83	29.07
		09/18/12	379.46	43.83	31.04
		03/19/13	381.53	43.83	28.97
		09/24/13	380.71	43.83	29.79
		03/11/14	381.82	43.83	28.67
		09/08/14	380.28	43.83	30.22
		03/17/15	381.82	43.83	28.97
		03/21/16	381.92	43.83	28.58
		09/20/16	368.50	43.86	41.99
JOF-B14	94-B14	05/16/94	377.69	46.29	31.00
		05/17/94	377.69	46.29	31.00
		03/20/95	377.30	45.64	31.40
		03/21/95	377.30	45.64	31.40
		09/05/95	376.05	45.64	32.64
		09/07/95	376.05	45.64	32.64
		03/20/96	378.41	44.95	30.28
		04/02/96	378.02	45.60	30.68
		09/17/96	376.84	44.95	31.86
		09/25/96	377.03	44.95	31.66
		03/24/97	379.33	44.95	29.36
		09/08/97	377.13	44.95	31.56
		03/17/98	378.22	44.95	30.48
		09/14/98	377.03	44.95	31.66
		03/08/99	377.59	44.95	31.10
JOF-B15	94-B15	05/16/94	378.15	39.50	24.61
		05/17/94	378.15	39.50	24.61
		03/20/95	377.76	38.81	25.00
		03/21/95	377.99	38.81	24.77
		09/05/95	377.13	38.81	25.62
		09/07/95	377.13	38.81	25.62
		03/20/96	378.54	38.81	24.21
		04/02/96	378.74	38.39	24.02

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B15 (cont.)	94-B15	09/17/96	376.90	38.81	25.85
		09/25/96	377.10	38.81	25.66
		03/24/97	379.46	38.81	23.29
		09/08/97	377.17	38.81	25.59
		03/17/98	378.38	38.81	24.38
		09/14/98	377.30	38.81	25.46
		03/08/99	378.08	38.81	24.67
JOF-B16	94-B16	05/16/94	377.59	26.08	13.06
		05/17/94	377.59	26.08	13.06
		03/20/95	377.53	25.98	13.12
		03/21/95	377.46	25.98	13.19
		09/05/95	376.57	25.98	14.07
		09/07/95	376.57	25.98	14.07
		03/20/96	377.53	25.98	13.12
		04/02/96	378.38	25.89	12.27
		09/17/96	376.41	25.98	14.24
		09/25/96	376.71	25.98	13.94
		03/24/97	378.84	25.98	11.81
		09/08/97	376.67	25.98	13.98
		03/17/98	377.85	25.98	12.80
		09/14/98	376.74	25.98	13.91
		03/08/99	377.92	25.98	12.73
		09/09/99	377.92	25.98	12.73
		09/13/99	377.92	25.98	14.47
		12/14/99	376.90	25.98	13.75
		12/14/99	376.90	25.98	13.75
		03/07/00	377.00	25.98	13.65
		06/07/00	377.03	25.98	13.62
		09/19/00	375.85	25.98	14.80
		09/20/00	375.85	25.98	14.80
		03/20/01	377.49	25.98	13.16
		03/21/01	377.49	25.98	13.16
		09/18/01	376.48	25.98	14.17
		09/19/01	376.48	25.98	14.17
		03/12/02	377.17	25.98	13.48
		03/12/02	377.17	25.98	13.48
		09/10/02	376.57	25.98	14.07
		09/11/02	376.57	25.98	14.07
		03/11/03	378.28	25.98	12.37
JOF-B17	94-B17	05/16/94	379.20	23.39	16.90
		05/17/94	379.20	23.39	16.90
		03/20/95	378.84	22.80	17.26
		03/21/95	378.74	22.80	17.36
		09/05/95	377.56	22.80	18.54
		09/07/95	377.56	22.80	18.54
		03/20/96	378.97	22.64	17.13

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B17 (cont.)	94-B17	04/02/96	379.23	22.67	16.86
		09/17/96	377.17	22.64	18.93
		09/25/96	377.36	22.64	18.73
		03/24/97	379.79	22.64	16.31
		09/08/97	377.46	22.64	18.64
		03/17/98	378.90	22.64	17.19
		09/14/98	377.56	22.64	18.54
		03/08/99	378.77	22.64	17.32
JOF-B18	99-B18	12/14/99	376.84	22.38	21.56
		12/14/99	376.84	22.31	21.56
		03/07/00	376.71	22.31	21.69
		06/07/00	377.07	22.31	21.33
		03/20/01	377.43	22.31	20.96
		03/21/01	377.43	22.31	20.96
		09/18/01	376.21	22.31	22.18
		09/19/01	376.21	22.31	22.18
		03/12/02	376.87	22.31	21.52
		09/10/02	376.21	22.31	22.18
		03/11/03	378.12	22.31	20.28
JOF-B19	99-B19	09/09/99	377.69	27.72	17.52
		09/13/99	--	27.66	17.59
		12/14/99	377.46	27.72	17.19
		03/07/00	377.69	27.72	16.96
		03/08/00	377.69	27.66	16.96
		06/07/00	378.02	27.72	16.63
		09/19/00	376.87	27.72	17.78
		09/20/00	376.90	27.66	17.75
		03/20/01	378.51	27.72	16.14
		03/21/01	378.51	27.66	16.14
		09/18/01	377.30	27.72	17.36
		09/19/01	377.30	27.66	17.36
		03/12/02	378.08	27.72	16.57
		09/10/02	377.33	27.72	17.32
		09/11/02	377.33	27.66	17.32
		03/11/03	379.04	27.72	15.62
JOF-B2	B-2	09/02/92	359.81	36.09	25.30
		12/15/92	358.50	36.09	26.61
		03/16/93	358.76	36.09	26.35
		06/08/93	362.17	36.09	22.93
		09/20/93	359.97	36.09	25.13
		09/22/93	360.01	36.09	25.10

Groundwater Elevation Data

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B2 (cont.)	B-2	03/07/94	362.34	36.09	22.77
		03/08/94	362.37	36.09	22.74
		09/19/94	360.40	36.09	24.70
		09/21/94	360.40	36.09	24.70
		03/20/95	358.92	36.09	26.18
		09/05/95	360.86	36.09	24.25
		03/20/96	360.17	36.09	24.93
		09/17/96	360.53	35.96	24.57
		03/24/97	365.75	35.96	19.36
		09/08/97	359.81	35.96	25.30
		03/17/98	359.97	35.96	25.13
		09/14/98	360.01	35.96	25.10
		03/08/99	360.76	35.96	24.34
		09/09/99	360.50	35.96	24.61
JOF-B20A	99-B20A	09/09/99	378.44	35.92	30.54
		09/14/99	--	35.92	30.54
		12/14/99	377.56	35.92	30.91
		12/14/99	377.56	35.92	30.91
		03/07/00	378.44	35.92	30.02
		06/07/00	379.00	35.92	29.46
		09/19/00	377.62	35.92	30.84
		09/20/00	377.62	35.92	30.84
		03/20/01	379.46	35.92	29.00
		03/21/01	379.46	35.92	29.00
		09/18/01	378.08	35.92	30.38
		09/19/01	378.08	35.92	30.38
		03/12/02	379.33	35.92	29.13
		09/10/02	378.05	35.92	30.41
		09/11/02	378.05	35.92	30.41
		03/11/03	380.18	35.92	28.28
JOF-B3	B-3	09/02/92	378.67	--	13.12
		12/15/92	378.02	31.99	13.78
		03/17/93	379.27	31.99	12.53
		06/08/93	379.69	31.99	12.11
		09/20/93	378.67	--	13.12
		09/22/93	378.67	31.99	13.12
		03/07/94	380.22	31.99	11.58
		03/08/94	380.25	31.99	11.55
		09/19/94	378.94	31.99	12.86
		09/21/94	378.94	31.99	12.86
		03/20/95	379.99	--	11.81
		03/22/95	379.92	31.99	11.88
		09/05/95	379.27	31.99	12.53
		03/20/96	380.15	31.99	11.65

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B3 (cont.)	B-3	03/21/96	380.18	31.99	11.61
		09/17/96	378.81	31.99	12.99
		09/23/96	379.07	31.99	12.73
		03/24/97	381.50	31.99	10.30
		03/26/97	381.43	31.99	10.37
		09/08/97	379.33	31.99	12.47
		09/09/97	379.33	31.99	12.47
		03/17/98	380.58	31.99	11.22
		09/14/98	379.13	31.99	12.66
		03/08/99	380.09	31.99	11.71
JOF-B30	B-30	08/10/11	--	58.40	27.92
		10/13/11	--	58.40	29.40
		11/30/11	--	58.40	24.11
		03/19/13	394.52	58.40	21.26
JOF-B3A	99-B3A	12/14/99	377.03	27.59	21.13
		03/07/00	377.76	27.59	20.41
		06/07/00	378.18	27.59	19.98
		09/19/00	376.97	27.59	21.19
		03/20/01	378.61	27.59	19.55
		09/18/01	377.40	27.59	20.77
JOF-B4	B-4	09/02/92	382.41	--	26.44
		12/15/92	361.35	47.51	31.10
		03/17/93	361.35	47.51	29.04
		09/20/93	384.28	47.51	24.57
		09/22/93	360.76	48.10	24.64
		03/07/94	362.04	46.82	27.62
		03/08/94	362.04	46.82	27.62
		09/19/94	362.04	46.82	27.13
		09/20/94	362.04	46.82	27.13
		03/20/95	379.76	46.82	29.10
		09/05/95	362.04	46.82	25.43
		03/20/96	361.48	47.37	28.44
		09/17/96	361.48	47.37	26.41
		03/24/97	362.11	47.37	21.98
		09/08/97	356.92	47.37	27.17
		03/17/98	355.38	47.37	28.71
		09/14/98	356.92	47.37	27.17
		03/08/99	355.22	47.37	28.87
		09/09/99	356.20	47.37	27.89
JOF-B5	B-5	03/13/90	370.37	36.19	15.29
		12/11/90	363.98	36.19	21.69
		03/05/91	371.06	36.19	14.60
		06/24/91	369.75	36.19	15.91
		09/23/91	365.45	36.19	20.21
		12/03/91	364.17	36.19	21.49
		03/17/92	368.08	36.19	17.59

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B5 (cont.)	B-5	06/09/92	367.13	36.19	18.54
		09/02/92	364.63	36.19	21.03
		12/14/92	363.19	36.19	22.47
		03/15/93	369.42	--	16.24
		06/08/93	368.54	36.19	17.13
		09/20/93	364.50	--	21.16
		03/07/94	369.19	36.19	16.47
		03/09/94	369.19	36.19	16.47
		05/16/94	370.47	36.19	15.19
		07/20/94	368.44	36.19	17.22
		09/19/94	366.60	36.19	19.06
		09/20/94	366.60	36.19	19.06
		03/20/95	369.32	--	16.34
		03/22/95	369.23	36.19	16.44
		09/05/95	366.67	36.19	19.00
		09/05/95	366.67	36.19	19.00
		03/20/96	369.72	--	15.94
		03/21/96	369.72	36.19	15.94
		09/17/96	365.72	36.19	19.95
		09/23/96	365.58	36.19	20.08
		03/24/97	374.38	--	11.29
		03/26/97	373.69	36.19	11.98
		09/08/97	366.47	--	19.19
		09/10/97	366.37	36.19	19.29
		03/17/98	369.36	--	16.31
		09/14/98	363.48	36.19	22.18
		09/16/98	363.48	36.19	22.18
		03/08/99	367.95	36.19	17.72
		03/09/99	367.95	36.19	17.72
		09/09/99	364.60	36.19	21.06
		09/10/99	364.60	36.19	21.06
		03/07/00	364.60	36.19	21.06
		03/08/00	364.60	36.19	21.06
		09/19/00	364.11	36.19	21.56
		03/20/01	367.39	36.19	18.27
		09/18/01	364.50	36.19	21.16
		09/18/01	364.50	36.19	21.16
		03/12/02	368.14	36.19	17.52
		09/10/02	364.60	36.19	21.06
		03/11/03	371.10	36.19	14.57

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B5 (cont.)	B-5	09/09/03	369.72	36.19	15.94
		03/09/04	369.23	36.19	16.44
		09/14/04	366.60	36.19	19.06
		03/08/05	370.90	36.19	14.76
		09/07/05	365.58	36.19	20.08
		03/22/06	367.75	36.19	17.91
		05/24/06	--	36.19	17.29
		09/19/06	364.70	36.19	20.96
		03/06/07	366.01	36.19	19.65
		09/19/07	363.45	36.19	22.21
		03/12/08	370.87	36.19	14.80
		09/16/08	364.67	36.19	21.00
		03/10/09	367.75	36.19	17.91
		09/15/09	366.80	36.19	18.86
		03/10/10	369.16	36.19	16.50
		09/14/10	365.26	36.19	20.41
		03/16/11	368.47	36.19	17.16
		09/14/11	365.49	36.19	20.18
		11/30/11	364.60	36.19	21.06
		03/21/12	368.27	36.19	17.39
		09/18/12	363.85	36.19	21.82
		03/19/13	368.90	36.19	16.77
JOF-B6	B-6	03/18/92	379.30	27.59	11.71
		06/09/92	379.27	27.59	11.75
		09/01/92	378.54	27.59	12.47
		12/14/92	378.48	27.99	12.53
		03/16/93	378.87	27.99	12.14
		06/09/93	379.17	27.99	11.84
		09/20/93	378.81	--	12.20
		09/21/93	378.77	27.99	12.24
		03/07/94	379.56	27.99	11.45
		03/08/94	379.53	27.99	11.48
		05/16/94	378.94	27.99	12.07
		05/18/94	378.94	27.99	12.07
		07/20/94	379.30	27.99	11.71
		07/20/94	379.30	27.99	11.71
		09/19/94	378.87	27.99	12.14
		09/20/94	378.87	27.99	12.14
		03/20/95	379.36	--	11.65
		03/22/95	379.33	27.99	11.68
		09/05/95	379.00	27.99	12.01
		09/06/95	379.00	27.99	12.01

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B6 (cont.)	B-6	03/20/96	382.38	27.43	8.63
		03/25/96	382.32	27.43	8.69
		09/17/96	381.20	27.43	9.81
		09/24/96	379.59	--	11.42
		03/24/97	379.99	27.43	11.02
		03/26/97	379.92	27.43	11.09
		09/08/97	379.10	27.43	11.91
		09/09/97	379.10	27.43	11.91
		03/17/98	379.53	27.43	11.48
		03/18/98	379.56	27.43	11.45
		09/14/98	381.07	27.43	9.94
		09/15/98	381.07	27.43	9.94
		03/08/99	380.71	27.43	10.30
		03/09/99	380.71	27.43	10.27
		09/09/99	380.25	27.43	10.76
		09/13/99	373.36	27.43	10.83
		03/07/00	379.53	27.43	11.48
		03/08/00	379.53	27.43	11.48
		09/19/00	378.87	27.43	12.14
		09/20/00	378.87	27.43	12.14
		03/20/01	379.04	27.43	11.98
		03/21/01	379.04	27.43	11.98
		09/18/01	378.44	27.43	12.57
		09/19/01	378.44	27.43	12.57
		03/12/02	378.77	27.43	12.24
		09/10/02	378.44	27.43	12.57
		03/11/03	378.87	27.43	12.14
		03/12/03	378.87	27.43	12.14
		09/09/03	379.00	27.43	12.01
		03/09/04	378.90	27.43	12.11
		09/14/04	378.54	27.43	12.47
		03/08/05	378.77	27.43	12.24
		09/07/05	378.48	27.43	12.53
		03/22/06	379.00	27.43	12.01
		09/19/06	378.38	27.56	12.63
		03/06/07	378.87	27.43	12.14
		09/19/07	378.12	27.43	12.89
		03/12/08	379.27	27.43	11.75
		09/16/08	378.15	27.43	12.86
		03/10/09	378.90	27.43	12.11
		09/15/09	378.44	27.43	12.57
		03/10/10	378.67	27.43	12.34
		09/14/10	378.22	27.43	12.80
		03/16/11	378.90	27.43	12.04

Groundwater Elevation Data

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B6 (cont.)	B-6	09/13/11	378.18	27.43	12.83
		11/30/11	379.33	27.43	11.68
		03/21/12	378.84	27.43	12.17
		09/19/12	378.25	27.43	12.76
		03/20/13	379.10	27.43	11.91
JOF-B6A	99-B6A	12/14/99	377.03	35.30	31.27
		03/07/00	377.66	35.37	30.64
		06/07/00	377.85	35.30	30.45
		09/19/00	376.67	35.37	31.63
		03/20/01	378.35	35.37	29.95
		09/18/01	377.17	35.37	31.14
JOF-B6R	B-6R	03/20/13	378.44	21.06	17.75
		09/25/13	378.22	21.06	17.88
		03/11/14	378.48	21.06	17.72
		09/09/14	378.15	21.06	18.04
		03/17/15	378.48	21.06	17.52
		03/22/16	378.38	21.06	17.81
		09/21/16	378.15	21.29	18.04
JOF-B7	B-7	09/02/92	379.33	--	11.15
		12/15/92	378.90	36.81	11.58
		03/16/93	381.56	36.81	8.92
		06/08/93	381.27	36.81	9.22
		09/20/93	381.04	--	9.45
		09/21/93	381.07	36.81	9.42
		03/07/94	381.73	36.81	8.76
		03/09/94	381.76	36.81	8.73
		05/16/94	381.63	36.81	8.86
		05/18/94	381.63	36.81	8.86
		07/20/94	380.97	36.74	9.51
		09/19/94	380.25	36.74	10.24
		09/20/94	380.25	36.81	10.24
		03/20/95	381.46	--	9.02
		03/21/95	381.46	36.81	9.02
		09/05/95	380.54	36.81	9.94
		09/06/95	380.54	36.81	9.94
		03/20/96	381.96	36.81	8.53
		03/26/96	381.96	39.34	8.53
		09/17/96	380.68	39.34	9.81
		09/25/96	380.94	39.34	9.55
		03/24/97	382.02	39.34	8.63
		03/26/97	379.10	39.34	11.38
		09/08/97	381.10	36.71	9.55
		09/09/97	380.94	36.71	9.55
		03/17/98	381.43	36.71	9.22
		03/18/98	381.27	36.71	9.22
		09/14/98	381.86	36.71	8.79

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B7 (cont.)	B-7	09/16/98	381.69	36.71	8.79
		03/08/99	381.82	36.71	8.83
		03/09/99	381.82	36.71	8.76
		09/09/99	381.27	36.71	9.38
		09/13/99	381.27	36.71	9.38
		03/07/00	379.17	36.71	11.48
		03/08/00	381.30	36.71	9.35
		09/19/00	381.07	36.71	9.58
		09/20/00	381.07	36.71	9.58
		03/20/01	380.97	36.71	9.68
		03/21/01	380.97	36.71	9.68
		09/18/01	379.82	36.71	10.83
		03/12/02	380.94	36.71	9.71
		09/10/02	379.76	36.71	10.89
JOF-B8	B-8	03/18/92	380.97	36.91	27.89
		06/10/92	380.25	36.91	28.61
		09/02/92	379.43	36.91	29.43
		12/14/92	379.49	37.99	29.36
		03/16/93	380.41	37.99	28.44
		06/09/93	380.38	37.99	28.48
		09/20/93	379.66	--	29.20
		09/21/93	379.63	37.99	29.23
		03/07/94	381.10	37.99	27.76
		03/08/94	381.10	37.99	27.76
		05/16/94	380.48	37.99	28.38
		05/18/94	380.48	37.99	28.38
		07/20/94	380.28	37.99	28.58
		09/19/94	379.59	37.99	29.27
		09/20/94	379.59	37.99	29.27
		03/20/95	380.41	--	28.44
		03/22/95	380.28	37.99	28.58
		09/05/95	379.56	37.99	29.30
		09/06/95	379.56	37.99	29.30
		03/20/96	382.19	36.81	26.67
		03/25/96	382.05	36.81	26.80
		09/17/96	379.72	36.81	29.13
		09/24/96	379.86	36.81	29.00
		03/24/97	381.27	36.81	27.59
		03/26/97	381.17	36.81	27.69
		09/08/97	379.66	36.81	29.20
		09/10/97	379.63	36.81	29.23

Groundwater Elevation Data

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B8 (cont.)	B-8	03/17/98	380.51	36.81	28.35
		03/18/98	380.45	36.81	28.41
		09/14/98	380.41	36.81	28.44
		09/16/98	380.38	36.81	28.48
		03/08/99	381.10	36.81	27.76
		03/09/99	381.10	36.81	27.76
		09/09/99	380.09	36.81	28.77
		09/10/99	380.09	36.81	28.77
		03/07/00	380.05	36.81	28.81
		03/08/00	380.05	36.81	28.81
		09/19/00	379.30	36.81	29.56
		09/20/00	379.30	36.81	29.56
		03/20/01	379.99	36.81	28.87
		09/18/01	379.07	36.81	29.79
		03/12/02	379.99	36.81	28.87
		09/10/02	379.20	36.81	29.66
		03/11/03	380.31	36.81	28.54
		09/09/03	380.18	36.81	28.67
		03/09/04	380.45	36.81	28.41
		09/14/04	379.49	36.81	29.36
		03/08/05	380.22	36.81	28.64
		09/07/05	379.40	36.81	29.46
		03/22/06	380.38	36.81	28.48
		09/19/06	379.33	36.81	29.53
		03/06/07	380.15	36.81	28.71
		09/19/07	379.20	36.81	29.66
		03/12/08	381.14	36.81	27.72
		09/16/08	379.36	36.81	29.49
		03/10/09	380.61	36.81	28.25
		09/15/09	379.92	36.81	28.94
		03/10/10	380.51	36.81	28.35
		09/14/10	379.53	36.81	--
		09/14/10	--	36.81	29.33
		03/16/11	380.51	36.81	28.28
		09/13/11	379.49	36.81	29.36
		11/30/11	380.28	36.81	28.58
		03/21/12	380.61	36.81	28.25
		09/19/12	379.36	36.81	29.49
		03/20/13	380.97	36.81	27.89
JOF-B8A	99-B8A	12/14/99	377.62	31.73	23.23
		03/07/00	378.38	31.73	22.47
		06/07/00	379.00	31.73	21.85
		09/19/00	377.62	31.73	23.23
		03/20/01	379.43	31.73	21.42
		09/18/01	378.08	31.73	22.77

Groundwater Elevation Data

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B8R	B-8R	03/20/13	381.17	16.83	10.73
		09/25/13	380.94	16.83	10.96
		03/11/14	381.07	16.83	10.83
		09/08/14	379.76	16.83	12.14
		03/17/15	381.07	16.83	10.79
		03/22/16	380.81	16.83	11.09
		09/21/16	379.76	17.06	12.14
JOF-B9	B-9	03/12/90	406.23	50.10	18.41
		06/19/90	402.95	50.10	21.69
		06/19/90	402.95	50.10	21.69
		09/04/90	397.74	50.10	26.90
		12/11/90	399.05	50.10	25.59
		03/05/91	404.04	50.10	20.60
		06/25/91	407.25	50.10	17.39
		09/24/91	402.85	50.10	21.78
		12/04/91	402.03	50.20	22.60
		03/17/92	404.99	50.20	19.65
		06/08/92	403.41	50.20	21.23
		09/02/92	398.95	50.20	25.69
		12/14/92	397.90	--	26.74
		03/15/93	410.53	--	14.11
		06/07/93	403.51	50.20	21.13
		09/20/93	397.64	--	27.00
		03/07/94	404.99	50.20	19.65
		03/09/94	405.02	50.20	19.62
		05/16/94	404.40	46.29	20.24
		07/20/94	402.85	46.29	21.78
		09/19/94	399.74	46.29	24.90
		09/20/94	399.74	46.29	24.90
		03/20/95	403.67	--	20.96
		03/21/95	403.67	50.00	20.96
		09/05/95	401.05	50.00	23.59
		03/20/96	407.35	--	17.29
		03/26/96	407.22	50.00	17.42
		09/17/96	401.41	--	23.23
		09/23/96	401.57	50.00	23.06
		03/24/97	405.18	--	19.46
		03/25/97	405.28	50.00	19.36
		09/08/97	401.28	--	23.36
		09/10/97	401.25	50.00	23.39
		03/17/98	403.84	--	20.80
		03/18/98	403.87	50.00	20.77
		09/14/98	402.69	--	21.95
		09/15/98	402.69	50.00	21.95
		03/08/99	406.20	--	18.44
		03/10/99	406.20	50.00	18.18

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-B9 (cont.)	B-9	09/09/99	404.53	--	20.11
		03/07/00	403.67	50.00	20.96
		09/19/00	398.39	50.00	26.25
		03/20/01	401.31	50.00	23.33
		09/18/01	396.65	50.00	27.99
		03/12/02	400.75	50.00	23.88
		09/10/02	394.91	50.00	29.72
		03/11/03	401.08	50.00	23.56
		09/09/03	400.95	50.00	23.69
		03/09/04	402.20	50.00	22.44
		09/14/04	398.92	50.00	25.72
		03/08/05	402.36	50.00	22.28
		09/07/05	396.19	50.00	28.44
		03/22/06	400.62	50.00	24.02
		09/19/06	395.21	50.00	29.43
		03/06/07	398.88	50.00	25.75
		09/19/07	392.26	50.00	32.38
		03/12/08	400.00	50.00	24.64
		09/16/08	392.72	50.00	31.92
		03/10/09	398.59	50.00	26.05
		09/15/09	396.85	50.00	27.79
		03/10/10	400.39	50.00	24.25
		09/14/10	393.64	50.00	31.00
		03/15/11	398.46	50.00	26.18
		09/13/11	392.72	50.00	31.92
		11/30/11	395.28	50.00	29.36
		03/20/12	398.88	50.00	25.75
		09/18/12	391.90	50.00	32.74
		03/19/13	398.88	50.00	25.75
		09/24/13	396.03	50.00	28.61
		03/11/14	400.52	50.00	24.11
		09/08/14	394.59	50.00	30.05
		03/17/15	400.52	50.00	24.48
		03/21/16	399.84	50.00	24.80
		09/20/16	395.08	50.00	29.56
JOF-C1	C-1	03/12/90	372.11	36.91	12.99
		06/19/90	369.91	36.91	15.19
		09/04/90	368.50	36.91	16.60
		12/10/90	369.00	36.91	16.11
		03/06/91	369.72	36.91	15.39
		06/25/91	369.72	36.91	15.39
		09/23/91	368.50	36.91	16.60
		12/03/91	368.90	36.91	16.21
		03/17/92	368.96	36.91	16.14
		06/09/92	369.52	36.91	15.58
		09/02/92	367.95	--	17.16
		12/15/92	367.88	36.91	17.22

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-C1 (cont.)	C-1	03/15/93	368.44	--	16.67
		06/08/93	369.29	36.91	15.81
		09/20/93	368.04	--	17.06
		03/07/94	370.08	36.91	15.03
		03/08/94	370.08	36.91	15.03
		09/19/94	368.34	36.88	16.77
		09/21/94	368.21	36.88	16.90
		03/20/95	368.77	--	16.34
		09/05/95	368.70	36.88	16.40
		03/20/96	369.19	36.81	15.91
		09/17/96	368.01	36.81	17.09
		03/24/97	371.49	36.81	13.62
		09/08/97	368.04	36.81	17.06
		03/17/98	369.36	36.81	15.75
		09/14/98	368.34	36.81	16.77
		03/08/99	369.26	36.81	15.85
		09/09/99	367.55	36.81	17.55
JOF-C2	C-2	03/13/90	357.84	35.89	19.09
		06/20/90	357.84	35.89	19.82
		09/04/90	357.84	35.89	20.60
		12/10/90	357.84	35.89	20.01
		03/06/91	357.84	35.89	19.49
		06/25/91	357.84	35.89	20.21
		09/23/91	357.84	35.89	21.29
		12/04/91	357.84	35.89	21.00
		06/11/92	373.23	--	20.51
		09/02/92	357.84	35.89	21.13
		12/15/92	357.84	35.89	21.29
		03/15/93	373.26	--	20.47
		06/07/93	373.43	--	20.31
		06/08/93	357.84	35.89	20.37
		09/20/93	372.80	--	20.93
		03/07/94	357.84	35.89	19.09
		03/08/94	357.84	35.89	19.09
		09/19/94	357.91	35.83	20.67
		09/21/94	357.91	35.83	20.77
		03/20/95	373.52	--	20.21
		09/05/95	357.91	35.83	20.37
		03/20/96	357.91	35.83	21.33
		09/17/96	357.91	35.83	21.46
		03/24/97	374.84	35.83	18.90
		09/08/97	372.70	35.83	21.03
		03/17/98	374.34	35.83	19.39
		09/14/98	373.20	35.83	20.54
		03/08/99	374.08	35.83	19.65
		09/09/99	372.05	35.83	21.69

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-C3	C-3	03/13/90	380.58	36.09	20.01
		06/20/90	375.00	36.09	25.59
		09/04/90	374.08	36.09	26.51
		12/10/90	374.80	36.09	25.79
		03/06/91	375.49	36.09	25.10
		06/25/91	374.38	36.09	26.21
		09/23/91	373.49	36.09	27.10
		12/04/91	373.29	46.10	27.30
		06/11/92	373.95	--	26.64
		09/02/92	373.46	--	27.13
		12/15/92	373.36	46.10	27.23
		03/15/93	374.08	--	26.51
		06/07/93	374.34	--	26.25
		06/08/93	374.34	46.10	26.25
		09/20/93	373.59	--	27.00
		03/07/94	375.52	46.10	25.07
		03/08/94	375.52	46.10	25.07
		09/19/94	373.95	46.26	26.64
		09/21/94	373.85	46.26	26.74
		03/20/95	374.38	--	26.21
		09/05/95	374.34	46.26	26.25
		03/20/96	374.64	46.00	25.95
		09/17/96	373.13	46.00	27.46
		03/24/97	375.52	46.00	25.07
		09/08/97	373.29	46.00	27.30
		03/17/98	375.26	46.00	25.33
		09/14/98	374.18	46.00	26.41
		03/08/99	374.87	46.00	25.72
		09/09/99	373.13	46.00	27.46
JOF-C4	C-4	03/12/90	373.36	36.81	10.79
		06/19/90	372.34	36.81	11.81
		09/04/90	371.56	36.81	12.60
		12/10/90	372.34	36.81	11.81
		03/06/91	372.77	36.81	11.38
		06/25/91	372.51	36.81	11.65
		09/23/91	371.56	36.81	12.60
		12/03/91	372.44	36.81	11.71
		06/11/92	372.47	--	11.68
		09/02/92	372.05	--	12.11
		12/14/92	371.72	--	12.43
		03/16/93	372.24	36.81	11.91
		06/07/93	372.47	--	11.68
		09/20/93	368.70	--	15.45
		09/22/93	368.73	36.81	15.42
		03/07/94	373.00	36.81	11.15
		03/08/94	373.00	36.81	11.15
		09/19/94	372.01	36.81	12.14

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-C4 (cont.)	C-4	09/21/94	371.98	36.81	12.17
		03/20/95	372.34	--	11.81
		09/05/95	372.01	36.81	12.14
		03/20/96	372.87	39.34	11.29
		09/17/96	371.29	39.34	12.86
		03/24/97	373.69	39.34	10.47
		09/08/97	371.19	39.34	12.96
		03/17/98	372.93	39.34	11.22
		09/14/98	371.49	39.34	12.66
		03/08/99	372.83	39.34	11.32
		09/09/99	370.05	39.34	14.11
JOF-C5	C-5	03/13/90	375.56	32.41	16.40
		06/20/90	375.56	32.41	16.40
		09/04/90	374.77	32.41	17.19
		12/10/90	375.85	32.41	16.11
		03/06/91	375.10	32.41	16.86
		06/25/91	374.41	32.41	17.55
		09/23/91	373.75	32.41	18.21
		12/04/91	373.95	34.42	18.01
		06/11/92	374.11	--	17.85
		09/02/92	373.72	--	18.24
		12/14/92	373.62	--	18.34
		03/17/93	374.25	32.97	17.72
		06/07/93	374.25	--	17.72
		09/20/93	374.15	--	17.81
		09/22/93	373.85	32.97	18.11
		03/07/94	374.97	32.97	16.99
		03/08/94	375.00	32.97	16.96
		09/19/94	373.98	31.66	17.98
		09/21/94	373.92	31.66	18.04
		03/20/95	374.02	--	17.95
		09/05/95	373.98	30.35	17.98
		03/20/96	374.57	32.32	17.39
		09/17/96	373.16	32.32	18.80
		03/24/97	375.30	32.32	16.67
		09/08/97	373.59	32.32	18.37
		03/17/98	374.84	32.32	17.13
		09/14/98	373.75	32.32	18.21
		03/08/99	374.77	32.32	17.19
		09/09/99	372.38	32.32	19.59
JOF-C6	C-6	03/13/90	378.41	36.81	19.39
		06/20/90	377.69	36.81	20.11
		09/04/90	377.20	36.81	20.60
		12/10/90	377.89	36.81	19.91
		03/06/91	376.80	36.81	21.00
		06/25/91	376.02	36.81	21.78
		09/23/91	375.49	36.81	22.31

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-C6 (cont.)	C-6	12/04/91	375.20	36.81	22.60
		03/17/92	376.21	36.81	21.59
		06/09/92	375.69	36.81	22.11
		09/02/92	375.39	36.81	22.41
		12/14/92	375.33	--	22.47
		03/17/93	376.02	36.81	21.78
		06/07/93	376.08	--	21.72
		09/20/93	375.56	--	22.24
		09/22/93	375.56	36.81	22.24
		03/07/94	376.87	22.24	20.93
		03/08/94	376.87	36.81	20.93
		09/19/94	375.75	36.74	22.05
		09/21/94	375.75	36.74	22.05
		03/20/95	376.18	--	21.62
		09/05/95	375.75	36.74	22.05
		03/20/96	376.25	36.71	21.56
		09/17/96	375.00	36.71	22.80
		03/24/97	377.10	36.71	20.70
		09/08/97	374.97	36.71	22.83
		03/17/98	376.57	36.71	21.23
		09/14/98	375.52	36.71	22.28
		03/08/99	376.28	36.71	21.52
		09/09/99	374.54	36.71	23.26
JOF-D1	D-1	09/02/92	363.52	--	26.25
		12/14/92	361.71	--	28.05
		03/15/93	363.25	--	26.51
		06/07/93	365.16	--	24.61
		09/20/93	364.14	--	25.62
		09/19/94	364.17	--	25.59
		03/20/95	367.55	--	22.21
		09/05/95	370.73	--	19.03
		03/20/96	366.77	--	23.00
		03/24/97	371.92	--	17.85
		09/08/97	367.03	--	22.74
		03/17/98	368.80	28.25	20.96
		09/14/98	367.81	28.25	21.95
		03/08/99	366.93	28.25	22.83
		09/09/99	367.85	28.25	21.92
JOF-D10	D-10	03/07/94	374.90	--	9.19
		09/19/94	374.25	--	9.84
JOF-D11	D-11	06/11/92	359.81	--	24.34
		09/02/92	358.79	--	25.36
		12/14/92	356.69	--	27.46
		03/15/93	356.69	--	27.46
		06/07/93	360.66	--	23.49
		09/20/93	359.55	--	24.61
		03/07/94	359.61	--	24.54
		09/17/96	359.48	--	24.67

Groundwater Elevation Data

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-D11 (cont.)	D-11	03/24/97	363.81	--	20.34
		09/08/97	359.22	--	24.93
		03/17/98	358.01	--	26.15
		09/14/98	359.38	--	24.77
		03/08/99	357.38	--	26.77
		09/09/99	358.01	--	26.15
JOF-D13	D-13	03/07/94	375.72	--	9.38
		09/19/94	375.26	--	9.84
		03/20/95	375.10	--	10.01
		09/17/96	374.80	--	10.30
		03/24/97	375.59	--	9.51
		09/08/97	374.54	--	10.56
		03/17/98	375.59	--	9.51
		09/14/98	373.62	--	11.48
		03/08/99	375.03	--	10.07
		09/09/99	373.98	--	11.12
JOF-D2	D-2	09/17/96	367.16	--	22.64
		09/08/97	368.21	--	21.59
		03/17/98	370.05	27.36	19.75
		09/14/98	368.96	27.36	20.83
		03/08/99	368.11	27.36	21.69
		09/09/99	365.32	27.36	24.48
JOF-D3	D-3	06/11/92	378.84	--	10.76
		09/02/92	378.05	--	11.55
		12/14/92	376.21	--	13.39
		03/15/93	377.56	--	12.04
		06/07/93	377.95	--	11.65
		09/20/93	376.48	--	13.12
		09/19/94	376.54	--	13.06
		03/20/95	377.89	--	11.71
JOF-D8	D-8	06/11/92	373.03	--	23.56
		09/02/92	372.18	--	24.41
		12/14/92	378.05	--	18.54
		03/15/93	378.77	--	17.81
		06/07/93	378.87	--	17.72
		09/20/93	377.99	--	18.60
		03/07/94	379.53	--	17.06
		09/19/94	378.22	--	18.37
		03/20/96	374.77	--	21.82
JOF-JSP1	JSP-1	03/05/91	374.34	--	15.26
		06/25/91	374.02	--	15.58
		06/11/92	384.94	--	4.66
		09/02/92	384.88	--	4.72
		12/14/92	384.09	--	5.51
		06/07/93	385.27	--	4.33
		09/20/93	385.27	--	4.33
		03/07/94	385.17	--	4.43

Groundwater Elevation Data

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-JSP1 (cont.)	JSP-1	09/09/94	385.30	--	4.30
		03/20/95	385.17	--	4.43
		09/05/95	385.20	--	4.40
		03/20/96	385.27	--	4.33
		09/17/96	385.24	--	4.36
		03/24/97	385.20	--	4.40
		09/08/97	385.10	--	4.49
		03/17/98	385.17	--	4.43
		09/14/98	385.20	--	4.40
		03/08/99	385.14	--	4.46
		09/09/99	385.20	--	4.40
		03/20/01	385.30	--	4.30
		09/18/01	385.24	--	4.36
JOF-JSP2	JSP-2	03/05/91	364.11	--	15.58
		06/25/91	365.06	--	14.63
		06/11/92	374.05	--	5.64
		09/02/92	374.51	--	5.18
		12/14/92	375.07	--	4.63
		06/07/93	375.20	--	4.49
		09/20/93	374.93	--	4.76
		03/07/94	374.80	--	4.89
		09/09/94	373.79	--	5.91
		03/20/95	375.39	--	4.30
		09/05/95	375.13	--	4.56
		03/20/96	375.30	--	4.40
		09/17/96	374.93	--	4.76
		03/24/97	375.26	--	4.43
		09/08/97	375.30	--	4.40
		03/17/98	375.16	--	4.53
		09/14/98	374.84	--	4.86
		03/08/99	374.64	--	5.05
		09/09/99	375.03	--	4.66
		03/20/01	374.54	--	5.15
		09/18/01	374.77	--	4.92
JOF-JSP4	JSP-4	03/05/91	374.05	--	15.91
		06/25/91	374.28	--	15.68
		06/11/92	383.99	--	5.97
		09/02/92	381.56	--	8.40
		12/14/92	381.14	--	8.83
		06/07/93	385.07	--	4.89
		09/20/93	385.04	--	4.92
		03/07/94	385.14	--	4.82
		09/09/94	383.04	--	6.92
		03/20/95	385.10	--	4.86
		09/05/95	383.50	--	6.46
		03/20/96	385.20	--	4.76
		09/17/96	383.86	--	6.10

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-JSP4 (cont.)	JSP-4	03/24/97	384.38	--	5.58
		09/08/97	383.63	--	6.33
		03/17/98	384.42	--	5.54
		09/14/98	385.14	--	4.82
		03/08/99	384.06	--	5.91
		09/09/99	385.10	--	4.86
		03/20/01	385.10	--	4.86
		09/18/01	383.40	--	6.56
JOF-JSP5	JSP-5	03/05/91	403.08	--	2.46
		06/25/91	403.90	--	1.64
		06/11/92	403.64	--	1.90
		09/02/92	404.36	--	1.18
		12/14/92	404.23	--	1.31
		06/07/93	404.89	--	0.66
		09/20/93	404.36	--	1.18
		03/07/94	405.54	--	--
		09/09/94	404.46	--	1.08
		03/20/95	403.94	--	1.61
		03/20/96	404.46	--	1.08
		03/24/97	403.58	--	1.97
		03/17/98	404.10	--	1.44
		03/08/99	405.94	--	1.28
		09/09/99	406.79	--	0.43
JOF-JSP6	JSP-6	03/05/91	293.67	--	91.21
		06/25/91	301.71	--	83.17
		06/11/92	359.45	--	25.43
		09/02/92	355.61	--	29.27
		12/14/92	354.27	--	30.61
		06/07/93	358.63	--	26.25
		09/20/93	356.00	--	28.87
		03/07/94	358.46	--	26.41
		09/09/94	356.27	--	28.61
		03/20/95	354.04	--	30.84
		09/05/95	356.69	--	28.18
		09/17/96	356.79	--	28.08
		03/24/97	362.27	--	22.60
		09/08/97	355.25	--	29.63
		03/17/98	354.95	--	29.92
		09/14/98	355.12	--	29.76
		03/08/99	355.94	--	28.94
		09/09/99	355.68	--	29.20
		03/20/01	354.53	--	30.35
		09/18/01	355.61	--	29.27
JOF-JSP7	JSP-7	06/25/91	356.99	--	31.50
		06/11/92	383.33	--	5.15
		09/02/92	382.64	--	5.84
		12/14/92	378.31	--	10.17

Groundwater Elevation Data

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-JSP7 (cont.)	JSP-7	06/07/93	383.50	--	4.99
		09/20/93	382.87	--	5.61
		03/07/94	377.00	--	11.48
		09/09/94	382.35	--	6.14
		03/20/95	384.55	--	3.94
		09/05/95	375.03	--	13.45
		03/20/96	380.77	--	7.71
		09/17/96	382.15	--	6.33
		03/24/97	368.14	--	20.34
		09/08/97	378.77	--	9.71
		03/17/98	382.81	--	5.68
		09/14/98	380.94	--	7.55
		03/08/99	383.83	--	4.66
		09/09/99	383.27	--	5.22
		03/20/01	383.73	--	4.76
		09/18/01	383.40	--	5.09
JOF-JSP8	N/A	06/07/93	405.61	--	8.96
		09/20/93	410.47	--	4.10
		03/07/94	410.70	--	3.87
		03/20/95	410.17	--	4.40
		03/20/96	410.24	--	4.33
		03/17/98	409.88	--	4.69
		09/14/98	400.69	--	13.88
		03/08/99	409.68	--	4.89
		09/09/99	397.83	--	16.73
		03/20/01	412.04	--	2.53
JOF-SS13	SS-13	12/11/90	353.58	45.21	24.21
		03/06/91	357.45	45.21	20.34
		06/24/91	359.58	45.21	18.21
		09/23/91	355.58	45.21	22.21
		12/03/91	357.48	45.31	20.31
		03/16/92	356.43	45.31	21.36
		06/09/92	359.45	45.31	18.34
		09/02/92	355.58	45.31	22.21
		12/15/92	354.49	45.31	23.29
		06/07/93	358.63	--	19.16
		06/08/93	358.53	45.28	19.26
		09/20/93	355.91	--	21.88
		03/07/94	358.50	45.28	19.29
		03/09/94	358.53	45.28	19.26
		09/19/94	356.14	45.21	21.65
		09/21/94	355.94	45.21	21.85
		03/20/95	354.49	--	23.29
		09/05/95	356.50	45.21	21.29
		03/20/96	355.94	45.14	21.85
		09/17/96	355.94	45.14	21.85
		03/24/97	362.66	45.14	15.12

Groundwater Elevation Data

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-SS13 (cont.)	SS-13	09/08/97	355.41	45.14	22.38
		03/17/98	356.27	45.14	21.52
		09/14/98	355.15	45.14	22.64
		03/08/99	356.63	45.14	21.16
		09/09/99	355.61	45.14	22.18
JOF-SS15	SS-15	12/11/90	353.74	55.18	38.19
		03/06/91	358.17	55.18	33.76
		06/24/91	359.74	55.18	32.19
		09/23/91	355.64	55.18	36.29
		12/03/91	358.33	64.70	33.60
		03/16/92	355.64	54.89	36.29
		06/09/92	359.58	54.69	32.35
		09/02/92	355.77	54.69	36.15
		12/14/92	354.76	--	37.17
		03/15/93	354.49	--	37.43
		06/07/93	358.76	--	33.17
		06/08/93	358.76	54.69	33.17
		09/20/93	356.00	--	35.93
		03/07/94	358.76	54.69	33.17
		03/08/94	358.79	54.69	33.14
		09/19/94	356.27	54.69	35.66
		09/21/94	356.27	54.69	35.66
		03/20/95	354.86	--	37.07
		03/20/95	354.63	54.69	37.30
		09/07/95	356.73	54.69	35.20
		03/20/96	356.23	54.79	35.70
		03/25/96	355.97	54.79	35.96
		09/17/96	356.23	54.79	35.70
		09/24/96	356.30	54.79	35.63
		03/24/97	362.86	54.79	29.07
		03/26/97	360.76	54.79	31.17
		09/08/97	355.51	54.79	36.42
		09/10/97	355.61	54.79	36.32
		03/17/98	355.38	54.79	36.55
JOF-SS16	SS-16	04/23/86	393.60	--	--
		12/11/90	366.40	69.29	27.20
		03/06/91	370.01	69.29	23.59
		06/24/91	370.31	69.29	23.29
		09/23/91	368.50	69.29	25.10
		12/03/91	369.06	69.39	24.54
		03/16/92	368.50	69.39	25.10
		06/09/92	370.51	69.29	23.10
		09/02/92	368.41	69.29	25.20
		12/15/92	368.21	69.29	25.39
		03/16/93	368.11	66.04	25.49
		06/07/93	370.14	--	23.46

Groundwater Elevation Data

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-SS16 (cont.)	SS-16	06/08/93	370.14	69.32	23.46
		09/20/93	368.57	--	25.03
		09/21/93	368.60	69.32	25.00
		03/07/94	370.18	69.32	23.43
		03/09/94	370.21	69.32	23.39
		09/19/94	368.77	69.32	24.84
		09/21/94	368.77	69.32	24.84
		03/20/95	368.21	--	25.39
		09/05/95	369.26	69.32	24.34
		03/20/96	368.80	69.22	24.80
		09/17/96	368.80	69.22	24.80
		03/24/97	373.03	69.22	20.57
		03/26/97	372.41	69.19	21.19
		09/08/97	369.39	69.22	24.21
		03/17/98	369.46	69.22	24.15
		09/14/98	369.55	69.22	24.05
		03/08/99	369.98	69.22	23.62
		09/09/99	368.90	69.22	24.70
JOF-WP1	WP-1	06/27/91	--	--	14.99
		07/10/91	--	25.00	8.01
		07/11/91	--	25.00	10.89
		04/15/92	351.28	23.00	8.17
		03/20/96	--	21.59	5.09
		03/26/96	--	21.59	5.12
JOF-WP2	WP-2	06/27/91	--	--	2.69
		07/10/91	--	--	2.69
		07/11/91	--	--	3.90
		04/15/92	376.90	21.49	2.79
JOF-WP3	WP-3	04/15/92	373.79	24.02	15.75
JOF-WP4	WP-4	07/10/91	--	--	16.60
		07/11/91	--	--	11.15
		04/15/92	372.83	22.51	17.13
		04/15/92	373.39	22.51	16.57
JOF-WP5	WP-5	07/10/91	--	--	8.01
		07/11/91	--	--	8.99
		04/15/92	--	15.09	11.55
		03/26/97	--	15.19	8.40
		09/08/97	403.02	15.19	6.92
		03/17/98	403.41	15.19	6.53

-- no data
cont. - continued
ft amsl = feet above mean sea level
ft = feet
GW = groundwater
Ref. - reference

TVA Johnsonville Fossil Plant
Existing Monitoring Well Construction Details

Well ID	Program	Function	Well Installation Date	Facility / Location	Screened Formation	Current Status	Screened Interval (ft btoc)	TN State Plane Northing NAD 27 (ft)	TN State Plane Easting NAD 27 (ft)	TN State Plane Northing NAD 83 (ft)	TN State Plane Easting NAD 83 (ft)	Top of Casing Elevation (ft NGVD 29)	Ground Surface Elevation (ft NGVD 29)	Well Inside Diameter (in)	Well Depth (ft btoc)	Existing Stickup Height (ft ags)	Pump Intake Depth (ft btoc)	Pump Intake Elevation (ft NGVD29)
10-AP1	CCR-STA	WQC-WQS	11/3/2010	Active Ash Pond 2	Alluvium: Sands and Gravels	Existing Well	39.0 - 49.1	600071.014800	1409558.200700	621448.86	1378064.10	370.51	367.9	2.0	49.5	2.6	47.0	323.5
10-AP3	CCR-STA	WQC-WQS	11/4/2010	Active Ash Pond 2	Alluvium: Sands and Gravels	Existing Well	37.4 - 47.5	600075.735500	1410884.493800	621453.55	1379390.32	367.27	364.2	2.0	47.6	3.1	45.5	321.8
89-B10	STA	WQS	8/19/1989	DuPont Dredge Cell	Alluvium: Sands and Gravels	Active Compliance	32.0 - 40.3	602130.103700	1415236.018200	623507.71	1383741.62	401.19	400.4	2.0	40.4	0.8	40.0	361.2
94-B16	STA	WLS	9/26/1993	West of Dupont Dredge Cell	Alluvium: Sands and Gravels	Existing Well	16.2 - 26.2	601879.668800	1414143.077700	623257.31	1382648.74	390.53	387.1	2.0	26.2	3.4	No Pump	NA
99-B19	STA	WLS	8/24/1999	West of Dupont Dredge Cell	Alluvium: Sands and Gravels/ Shale Bedrock	Existing Well	12.6 - 27.7	602647.369700	1413416.885600	624024.98	1381922.61	394.50	391.7	2.0	27.7	2.8	No Pump	NA
99-B20A	STA	WQS	8/25/1999	DuPont Dredge Cell	Alluvium: Sands and Gravels	Existing Well	21.6 - 36.5	602538.789200	1414926.143800	623916.38	1383431.77	408.88	405.6	2.0	36.6	3.3	35.0	373.9
B-6R	STA	WQS	12/12/2012	South Rail Loop Area 4	Alluvium: Sands and Gravels	Active Compliance	18.2 - 21.2	600018.039500	1414450.329800	621395.79	1382955.94	395.57	392.2	2.0	21.3	3.4	20.5	375.1
B-8R	STA	WQS	12/12/2012	South Rail Loop Area 4	Alluvium: Sands and Gravels	Active Compliance	13.8 - 16.8	598782.675200	1414577.644100	620160.50	1383083.22	391.04	388.0	2.0	17.1	3.0	16.0	375.0
B-9	CCR-STA	WQC-WQS	8/17/1989	South Rail Loop Area 4	Alluvium: Silts and Clays	Active Background Compliance	40.5 - 50.0	600048.309900	1417118.088500	621426.01	1385623.54	423.88	420.7	2.0	50.6	3.2	48.0	375.9
B-11	STA	WQS	8/15/1989	DuPont Dredge Cell	Alluvium: Sands and Gravels	Active Compliance	26.7 - 36.7	603818.961600	1414404.387100	625196.49	1382910.07	400.67	398.1	2.0	36.7	2.6	35.0	365.7
B-12	STA	WQS	8/17/1989	DuPont Dredge Cell	Alluvium: Sands and Gravels	Active Compliance	26.8 - 36.9	604447.335100	1414455.708100	625824.82	1382961.40	393.03	390.6	2.0	36.9	2.4	35.0	358.0
B-13	STA	WQS	8/16/1989	DuPont Dredge Cell	Alluvium: Sands and Gravels	Active Background Compliance	33.8 - 43.9	603359.523000	1415281.171300	624737.06	1383786.80	409.87	407.9	2.0	43.9	2.0	42.0	367.9
JOF-101	CCR-STA	WQC-WQS	2/12/2016	Background - South Rail Loop Area 4, Active Ash Disposal Area 2	Alluvium: Sands and Gravels	Proposed Background Well	43.6 - 53.2	599749.727000	1417389.228500	621127.4371	1385894.66	424.59	420.7	4.0	54.1	3.9	52.0	372.6
JOF-102	STA	WQS	2/12/2016	South Rail Loop Area 4	Alluvium: Sands and Gravels	Existing Well	23.6 - 33.9	598706.888000	1416052.436700	620084.686	1384557.93	407.64	403.7	4.0	33.9	3.9	32.0	375.6
JOF-103	CCR-STA	WQC-WQS	2/11/2016	Active Ash Disposal Area 2 (The Island)	Alluvium: Sands and Gravels	Active Compliance	41.9 - 52.1	601959.880000	1411092.407000	623337.579	1379598.26	374.24	370.7	4.0	52.3	3.5	50.5	323.7

TVA Johnsonville Fossil Plant
Existing Monitoring Well Construction Details

Well ID	Program	Function	Well Installation Date	Facility / Location	Screened Formation	Current Status	Screened Interval (ft btoc)	TN State Plane Northing NAD 27 (ft)	TN State Plane Easting NAD 27 (ft)	TN State Plane Northing NAD 83 (ft)	TN State Plane Easting NAD 83 (ft)	Top of Casing Elevation (ft NGVD 29)	Ground Surface Elevation (ft NGVD 29)	Well Inside Diameter (in)	Well Depth (ft btoc)	Existing Stickup Height (ft ags)	Pump Intake Depth (ft btoc)	Pump Intake Elevation (ft NGVD29)
JOF-104	CCR-STA	WQC-WQS	2/18/2016	Active Ash Disposal Area 2 (The Island)	Alluvium: Sands and Gravels	Active Compliance	48.4 - 58.6	601826.863500	1410175.069800	623204.588	1378680.97	379.44	375.3	4.0	58.8	4.1	57.0	322.4
JOF-105	STA	WQS	2/19/2016	DuPont Dredge Cell	Alluvium: Sands and Gravels	Existing Well	23.4 - 33.7	602697.123300	1414336.013600	624074.716	1382841.68	406.15	402.3	4.0	33.7	3.8	32.5	373.7
A-3	STA	WLS	1/29/1980	South Rail Loop Area 4	Chattanooga Shale/Camden Formation	Existing Well	66.1 - 86.1	598554.588400	1415503.418800	619932.406	1384008.94	403.73	402.7	3.0	86.1	1.0	No Pump	NA

Well construction depths based on video logging performed by Stantec.
Ground surface elevations are based on survey datum and/or well completion data.

Abbreviations:

CCR	CCR Rule compliance well
CCR-STA	CCR and State compliance well
D M S	Degrees, Minutes, Seconds
ft	feet
ft btoc	feet below top of casing
ft ags	feet above ground surface
ft NGVD 29	Feet North American Vertical Datum 1929
in	inches
NAD27	North American Datum of 1927
NAD83	North American Datum of 1983
STA	State compliance well
WLS	water level measurement
WQS	water quality sample

TVA Johnsonville Fossil Plant
Closed Monitoring Well Construction Details

Well ID	Well Type	Facility / Location	Installation Date	Well Closed	TN State Plane Northing NAD 27 (ft)	TN State Plane Easting NAD 27 (ft)	Top of Casing (ft-amsl)	Top of Ground (ft-amsl)	Well Depth (ft btoc)	Existing Stickup Height (ft ags)	Well Inside Diameter (in)	Screened Formation	Screened Interval (ft btoc)	Rationale
JOF-10-AP2	Monitoring Well	Ash Disposal Area 2	11/10/2010	3/7/2016	603629.39	1410863.73	373.30	370.40	41.50	2.90	2	Alluvium: Sands and Gravels	31.5-41.5	Well not located in primary groundwater pathway.
JOF-A1	Monitoring Well	North/South Rail Loop Area	1/30/1980	3/8/2016	600694.38	1416475.32	414.46	412.59	28.13	1.90	3	Camden Formation	92.1-112.1	Well screen location not suitable for current groundwater monitoring networks.
JOF-A2	Monitoring Well	North/South Rail Loop Area	1/30/1980	2/23/2016	599792.45	1414422.22	388	386.97	60.67	1.00	3	Chattanooga Shale/Camden Formation	46.51-66.52	Well screen location not suitable for current groundwater monitoring networks.
JOF-B1	Monitoring Well	Coal Yard & Parking Area	8/22/1990	3/7/2016	603391.8	1412234.52	385.69	382.54	NA	NA	2	Alluvium: Silts and Clays	25.6-35.6	Well screen location not suitable for current groundwater monitoring networks.
JOF-B14	Monitoring Well	Inert Landfill	9/24/1993	10/13/1999	602103.79	1413797.15	409.15	405.80	45.01	3.35	2	Clay	30-45	Well located in footprint of disposal area.
JOF-B15	Monitoring Well	Inert Landfill	9/24/1993	10/13/1999	602139.24	1414053.96	402.72	400.19	38.29	2.49	2	Clay	23.3-38.3	Well located in footprint of disposal area.
JOF-B17	Monitoring Well	Inert Landfill	9/25/1993	10/13/1999	601999.04	1414162.52	396.09	393.11	19.68	2.95	2	Clay	4.6-19.7	Well located in footprint of disposal area.
JOF-B18	Monitoring Well	North/South Rail Loop Area	8/25/1999	3/7/2016	602060.6	1413443.70	398.80	395.70	19.70	3.10	2	Alluvium: Sands	4.7-19.7	No information available.
JOF-B2	Monitoring Well	Coal Yard	8/22/1990	3/7/2016	604543.92	1412076.97	385.09	382.19	32.10	2.89	2	Alluvium: Silts and Clays	19.22-29.22	Well screen location not suitable for current groundwater monitoring networks.
JOF-B3	Monitoring Well	Gas Turbines	8/15/1989	10/13/1999	604322.76	1413698.80	388.77	385.79	29.00	3.00	2	Terrace deposits	19-29	Well located in footprint of disposal area.
JOF-B30	Monitoring Well	North/South Rail Loop Area	7/7/2011	3/8/2016	600736.4	1416447.29	415.77	413.08	56.90	2.69	2	Alluvium: Silts and Clays	44.9-56.9	The well screen is located in the Chattanooga Shale known for leaching natural metals into groundwater.
JOF-B3A	Piezometer	Gas Turbines	8/28/1999	1999?	602628.4	1414119.30	398.29	395.20	25	3.09	2	NA	NA	Well was installed as temporary piezometer which was subsequently closed.
JOF-B4	Monitoring Well	Powerhouse	8/21/1989	3/8/2016	601373.39	1412374.98	384.10	382.08	48.00	2.00	2	Alluvium: Silts and Clays/ Sands and Gravels	36-46	Well location not suitable for current groundwater monitoring networks.
JOF-B5	Monitoring Well	North/South Rail Loop Area	8/18/1989	3/6/2016	599759.94	1413021.33	384.54	381.59	33.50	3.00	2	Clay (below Shale)	23.5-33.5	Well screen location not suitable for current groundwater monitoring networks.
JOF-B6	Monitoring Well	North/South Rail Loop Area	8/22/1989	2/23/2016	599802.93	1414426.52	387.79	384.58	24.75	3.20	2	Alluvial Silts and Clays/ Chattanooga Shale	14.8-24.8	The well screen is located in the Chattanooga Shale known for leaching natural metals into groundwater.
JOF-B6A	Piezometer	North/South Rail Loop Area	8/28/1999	1999?	602338.4	1414337.70	408.30	405.10	32.20	3.20	2	NA	NA	Well was installed as a temporary piezometer and was subsequently abandoned.

TVA Johnsonville Fossil Plant
Closed Monitoring Well Construction Details

Well ID	Well Type	Facility / Location	Installation Date	Well Closed	TN State Plane Northing NAD 27 (ft)	TN State Plane Easting NAD 27 (ft)	Top of Casing (ft-amsl)	Top of Ground (ft-amsl)	Well Depth (ft btoc)	Existing Stickup Height (ft ags)	Well Inside Diameter (in)	Screened Formation	Screened Interval (ft btoc)	Rationale
JOF-B7	Monitoring Well	North/South Rail Loop Area	8/21/1989	NA	600611.4	1415092.95	390.61	387.54	34.40	3.08	2	Shale	24.4-34.4	No information available.
JOF-B8	Monitoring Well	North/South Rail Loop Area	8/21/1989	3/6/2016	599317.47	1414708.20	408.87	405.15	34.28	3.71	2	Alluvium: Sands and Gravels/ Chattanooga Shale	24.28-34.28	The well screen is located in the Chattanooga Shale known for leaching natural metals into groundwater.
JOF-B8A	Piezometer	North/South Rail Loop Area	8/26/1999	NA	603105.2	1414266.40	400.84	397.90	28.60	2.94	2	NA	NA	Well not be found. Location not suitable for current groundwater monitoring networks.
JOF-C1	Monitoring Well	Ash Disposal Area 1	8/20/1989	9/14/2011	605142.48	1412220.93	385.11	382.11	34.00	3.00	2	Ash	29-34	Wellhead in poor conditions.
JOF-C2	Monitoring Well	Ash Disposal Area 1	8/19/1989	9/14/2011	605074.59	1412453.64	393.72	390.74	32.70	2.99	2	Ash	27.7-32.7	Wellhead in poor conditions.
JOF-C3	Monitoring Well	Ash Disposal Area 1	8/19/1989	9/15/2011	605035.79	1412645.20	400.59	397.59	43.00	3.00	2	Ash	38-43	Wellhead in poor conditions.
JOF-C4	Monitoring Well	Ash Disposal Area 1	8/20/1989	9/13/2011	605590.16	1412229.74	384.15	380.96	33.80	3.20	2	Ash	28.8-33.8	Wellhead in poor conditions.
JOF-C5	Monitoring Well	Ash Disposal Area 1	8/19/1989	9/15/2011	605397.73	1412639.31	391.96	388.46	29.50	3.50	2	Ash	24.5-29.5	Wellhead in poor conditions.
JOF-C6	Monitoring Well	Ash Disposal Area 1	8/20/1989	9/15/2011	605305.04	1412800.93	397.76	394.30	34.50	3.50	2	Ash	29.5-34.5	Wellhead in poor conditions.
JOF-D1	Monitoring Well	North/South Rail Loop Area	6/27/1990	3/8/2016	602221.84	1413332.62	389.77	389.77	29.00	NA	2	Alluvium: Sands and Gravels/ Weathered Bedrock	19-29	Well location not suitable for current groundwater monitoring networks.
JOF-D10	Monitoring Well	Powerhouse	6/30/1990	12/19/2006	601871.73	1412602.53	384.14	384.14	19.00	NA	2	Fill Material/ Weathered Bedrock	5-19	Wellhead in poor conditions, top cover was cracked.
JOF-D11	Monitoring Well	Powerhouse	7/1/1990	NA	601820.28	1412565.02	384.12	384.12	45.50	NA	2	Fill Material/ Weathered Bedrock	8.5-45.5	Well reported as closed. No information available.
JOF-D13	Monitoring Well	Powerhouse	7/2/1990	3/16/2016	601887.44	1412749.48	385.10	385.10	19.00	NA	2	Fill Material/ Weathered Bedrock	5-19	No information available.
JOF-D2	Monitoring Well	North/South Rail Loop Area	6/29/1990	3/8/2016	602100.52	1413259.98	389.79	389.79	29.00	NA	2	Weathered Bedrock	19-29	Well location not suitable for current groundwater monitoring networks.
JOF-D3	Monitoring Well	Central Plant Area	6/30/1990	3/8/2016	602274.98	1413020.84	389.59	389.59	19.00	NA	2	Fill Material/ Weathered Bedrock	9-19	Well location not suitable for current groundwater monitoring networks.
JOF-D8	Monitoring Well	Powerhouse	6/29/1990	NA	602264.04	1413432.79	396.60	396.60	24.00	NA	2	Fill Material/ Weathered Bedrock	9-19	No information available.

TVA Johnsonville Fossil Plant
Closed Monitoring Well Construction Details

Well ID	Well Type	Facility / Location	Installation Date	Well Closed	TN State Plane Northing NAD 27 (ft)	TN State Plane Easting NAD 27 (ft)	Top of Casing (ft-amsl)	Top of Ground (ft-amsl)	Well Depth (ft btoc)	Existing Stickup Height (ft ags)	Well Inside Diameter (in)	Screened Formation	Screened Interval (ft btoc)	Rationale
JOF-JSP1	Monitoring Well	Ash Disposal Area 2	NA	NA	598972.12	1409835.26	389.60	NA	NA	NA	NA	NA	NA	No information available.
JOF-JSP2	Monitoring Well	Coal Yard	NA	NA	604512.36	1412593.63	379.69	NA	NA	NA	NA	NA	NA	No information available.
JOF-JSP4	Monitoring Well	North/South Rail Loop Area	NA	NA	600595.12	1415237.61	389.96	NA	NA	NA	NA	NA	NA	No information available.
JOF-JSP5	Monitoring Well	North/South Rail Loop Area	NA	NA	600340.45	1416046.99	405.54	NA	NA	NA	NA	NA	NA	No information available.
JOF-JSP6	Monitoring Well	Powerhouse	NA	NA	600756.99	1412988.61	384.88	NA	NA	NA	NA	NA	NA	No information available.
JOF-JSP7	Monitoring Well	East of Ash Disposal Area 2	NA	NA	600780.73	1411341.79	388.48	NA	NA	NA	NA	NA	NA	No information available.
JOF-JSP8	Monitoring Well	West of DuPond Road Dredge Cell	NA	NA	602796.54	1414818.89	414.57	NA	NA	NA	NA	NA	NA	No information available.
JOF-SS13	Piezometer	Ash Disposal Area 2	3/13/1986	NA	600206.257	1410522.58	377.79	376.00	39.44	1.80	2	Silt	34.4-39.4	Well reported as closed. No information available.
JOF-SS15	Piezometer	Ash Disposal Area 2	3/20/1986	NA	599014.941	1410142.74	391.89	390.00	57.48	1.94	2	Sand	52.5-57.5	Well reported as closed. No information available.
JOF-SS16	Piezometer	Ash Disposal Area 2	3/24/1986	NA	600271.6481	1410182.01	393.60	390.00	57.48	3.60	2	Clay	52.5-57.5	Well reported as closed. No information available.
JOF-WP1	Drive Point	Ash Disposal Area 2	6/5/1991	NA	602845	1410671.00	NA	NA	27.56	4.00	2	Ash	23.6-27.6	No information available.
JOF-WP2	Drive Point	Ash Disposal Area 2	6/5/1991	NA	599747	1409676.00	NA	NA	21.19	3.51	2	Ash	17.2-21.2	No information available.
JOF-WP3	Drive Point	RR Loop	6/5/1991	NA	599124	1416195.00	NA	NA	18.90	8.40	2	Ash	14.9-18.9	No information available.
JOF-WP4	Drive Point	RR Loop	6/5/1991	NA	599136	1416921.00	NA	NA	26.97	11.38	2	Ash	22.9-26.9	No information available.
JOF-WP5	Drive Point	RR Loop	6/5/1991	NA	600430	1416336	NA	NA	20.18	4.99	2	Ash	16.2-20.2	No information available.

Well construction depths based on video logging performed by Stantec.
Ground surface elevations are based on survey datum and/or well completion data.

Abbreviations:

ft-amsl	feet above mean sea level
ft	feet
ft btoc	feet below top of casing
ft ags	feet above ground surface
ft NGVD 29	Feet North American Vertical Datum 1929
in	inches
NA	Not Available
NAD27	North American Datum of 1927

Project Number	175565317	Location	N36°01'14.33", W87°58'29.18" (NAD83)
Project Name	TVA - JOF Well Installations	Boring No.	JOF-102
		Total Depth	31.5 ft
County	Humphreys, TN	Surface Elevation	403.7 ft (NGVD29)
Project Type	Well Installations	Date Started	2/11/16
		Completed	2/12/16
Supervisor	B. Bryant	Depth to Water	17.9 ft
Driller	G. Thompson	Date/Time	2/11/16
Logged By	J. Andrew	Depth to Water	15.5 ft
		Date/Time	2/12/16

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
403.7	0.0	Top of Hole							
403.2	0.5	Topsoil							4" Diameter PVC Well Installed
		Lean Clay, reddish brown, damp to moist, stiff, with gravels		SPT-1	2.5 - 4.0	1.2	5-5-4	--	
				SPT-2	5.0 - 6.5	0.9	3-5-8	--	
397.2	6.5	Lean To Fat Clay, brown and gray, damp to moist, stiff		SPT-3	7.5 - 9.0	1.5	5-8-9	--	
				SPT-4	10.0 - 11.5	1.5	11-21-21	--	
				SPT-5	12.5 - 14.0	1.5	11-17-24	--	
388.7	15.0	Lean To Fat Clay, brown and gray, moist, very stiff to hard, with black mottling, gravel		SPT-6	15.0 - 16.5	1.5	6-15-15	--	
				SPT-7	17.5 - 19.0	1.5	8-26-47	--	
383.7	20.0	Clayey Sand, brown, wet, very dense, with gravels 3/8" to 3/4"		SPT-8	20.0 - 21.5	1.1	9-20-16	--	
				SPT-9	22.5 - 24.0	1.0	9-16-21	--	
				SPT-10	25.0 - 26.5	0.9	8-11-8	--	
				SPT-11	27.5 - 29.0	1.0	5-8-9	--	

SUBSURFACE LOG

Project Number	175565317	Location	N36°01'14.33", W87°58'29.18" (NAD83)
Project Name	TVA - JOF Well Installations	Boring No.	JOF-102
		Total Depth	31.5 ft

Lithology Elevation	Depth	Description	Overburden Rock Core	Sample # RQD	Depth Run	Rec. Ft. Rec. Ft.	Blows Rec. %	Mois.Cont. % Run Depth	Remarks
372.7	31.0			SPT-12	30.0 - 31.5	1.5	5-6-12	--	
372.2	31.5	Lean To Fat Clay, tan and light gray, moist, stiff							
		No Refusal / Bottom of Hole							

STANTEC/FMSM_LEGACY JOF PROJECT.GPJ FMSM-GRAPHIC LOG.GDT 9/21/16

SUBSURFACE LOG

Project Number	175565317	Location	N36°01'53.44", W87°58'51.05" (NAD83)
Project Name	TVA - JOF Well Installations	Boring No.	**JOF-105** Total Depth 34.0 ft
County	Humphreys, TN	Surface Elevation	402.3 ft (NGVD29)
Project Type	Well Installations	Date Started	2/19/16 Completed 2/19/16
Supervisor	B. Bryant Driller G. Thompson	Depth to Water	25.8 ft Date/Time 2/19/16
Logged By	J. Andrew	Depth to Water	23.2 ft Date/Time 2/19/16

Lithology Elevation	Lithology Depth	Description	Overburden / Rock Core	Sample # / RQD	Depth / Run	Rec. Ft. / Rec. Ft.	Blows / Rec. %	Mois.Cont. % / Run Depth	Remarks
402.3	0.0	Top of Hole							
401.8	0.5	Topsoil							4" Diameter PVC Well Installed
		Lean Clay, brown and gray, moist, soft to medium stiff, with red and black mottling		SPT-1	2.5 - 4.0	1.3	WOH-2-1	--	
				SPT-2	5.0 - 6.5	1.5	3-4-2	--	
394.8	7.5	Lean Clay, reddish brown, moist, stiff to very stiff, with black mottling		SPT-3	7.5 - 9.0	1.5	5-7-12	--	
				SPT-4	10.0 - 11.5	1.5	7-7-9	--	
				SPT-5	12.5 - 14.0	1.5	6-7-7	--	
386.3	16.0	Sand, reddish brown, moist, loose to dense, with black layers, trace of small gravel		SPT-6	15.0 - 16.5	1.5	5-6-14	--	
				SPT-7	17.5 - 19.0	1.5	19-22-21	--	Wet Zone Noted 18'
				SPT-8	20.0 - 21.5	1.5	4-4-4	--	
				SPT-9	22.5 - 24.0	1.5	2-6-19	--	
378.3	24.0	Sand, brown, wet, medium dense to dense, with cobbles and red and black mottling		SPT-10	25.0 - 26.5	1.4	10-15-18	--	
				SPT-11	27.5 - 29.0	0.1	6-7-19	--	

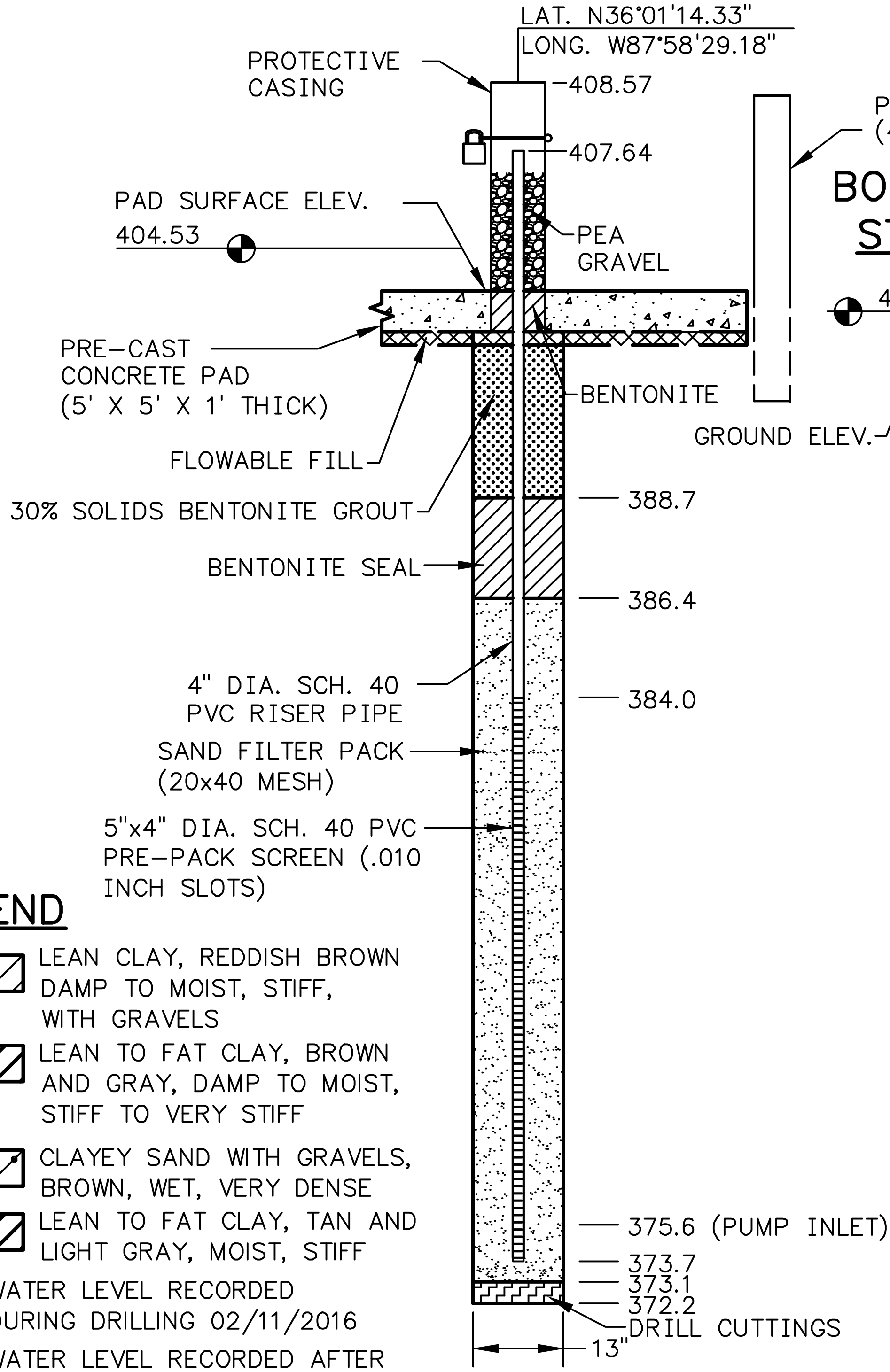
SUBSURFACE LOG

Project Number	175565317	Location	N36°01'53.44", W87°58'51.05" (NAD83)		
Project Name	TVA - JOF Well Installations	Boring No.	**JOF-105**	Total Depth	34.0 ft

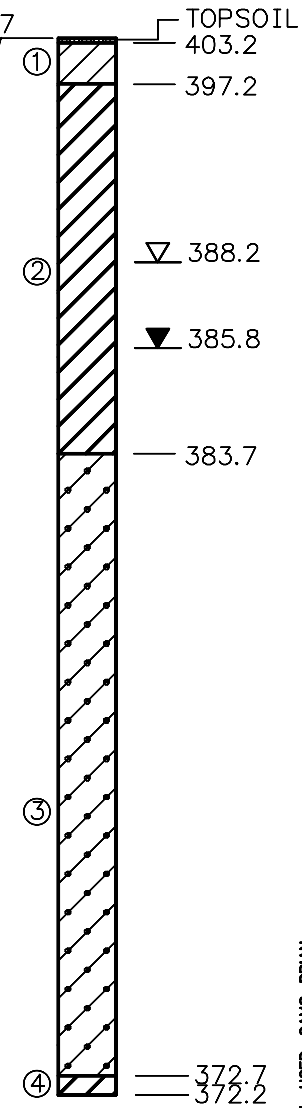
Lithology			Overburden	Sample #	Depth	Rec. Ft.	Blows	Mois.Cont. %	
Elevation	Depth	Description	Rock Core	RQD	Run	Rec. Ft.	Rec. %	Run Depth	Remarks
370.3	32.0			SPT-12	30.0 - 31.5	1.1	6-7-14	--	
368.3	34.0	Weathered Shale, black, moist, stiff		SPT-13	32.5 - 34.0	1.5	19-24-25	--	

No Refusal /
Bottom of Hole

Top of Rock = 32.0
Elevation (370.3)



BORING JOF-102 STRATIGRAPHY



LEGEND

① LEAN CLAY, REDDISH BROWN DAMP TO MOIST, STIFF, WITH GRAVELS

② LEAN TO FAT CLAY, BROWN AND GRAY, DAMP TO MOIST, STIFF TO VERY STIFF

③ CLAYEY SAND WITH GRAVELS, BROWN, WET, VERY DENSE

④ LEAN TO FAT CLAY, TAN AND LIGHT GRAY, MOIST, STIFF

▼ WATER LEVEL RECORDED DURING DRILLING 02/11/2016

▽ WATER LEVEL RECORDED AFTER DRILLING ON 02/12/2016

NOTES:

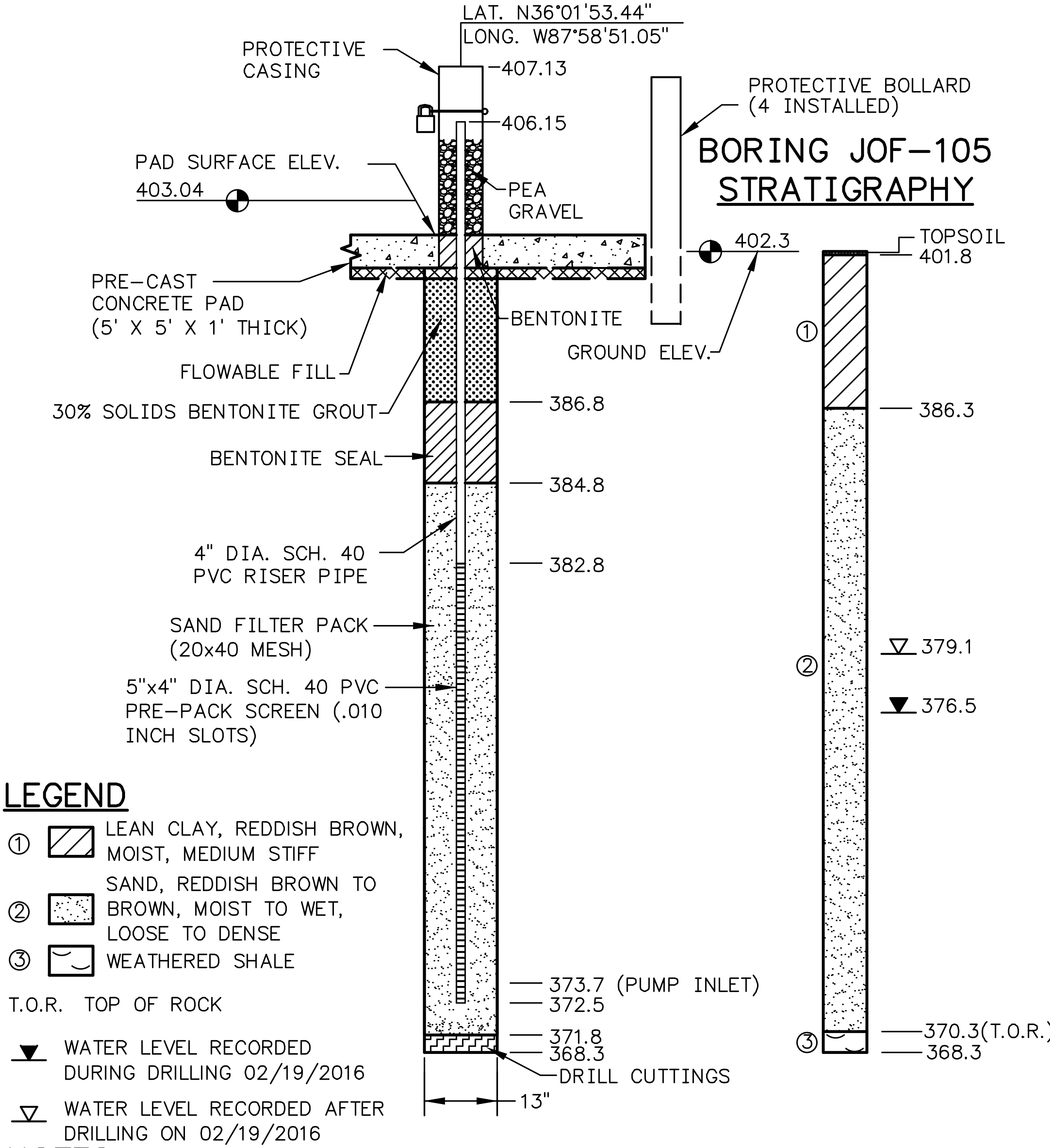
1. SUBSURFACE STRATIGRAPHY BASED ON BORING LOG JOF-102 BY STANTEC 02/12/2016.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 02/12/2016 BY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 11/10/2016).

JOF-102 MONITORING WELL INSTALLATION DETAIL
TVA JOHNSONVILLE FOSSIL PLANT
NEW JOHNSONVILLE, HUMPHREYS COUNTY, TN

Stantec

Stantec Consulting Services Inc.
3052 Beaumont Centre Circle
Lexington, Kentucky
40513
859-422-3000
www.stantec.com

DRAWN BY	MSJ	DATE	FEB., 2017	REVISED		SHEET
CHECKED BY	DRP	PROJ. NO.	175565317	1. NOV., 2017	3.	1 of 1
CHECKED BY	BLB	SCALE	NTS	2.	4.	



PLOT DATE: 02/24/2017 USER: SAMS, BRIAN
V:\1755\ACTIVE\175565317\GEOTECHNICAL\DRAWING\SHEET_FILES\GW_MON_WELLS\175565317 – INSTALL\WELL LOGS\65317-MWELL-LOG-JOF-105.DWG

NOTES:

1. SUBSURFACE STRATIGRAPHY BASED ON BORING LOG BY STANTEC 02/19/2016.
2. SURVEY INFORMATION PROVIDED BY STANTEC (NAD83/NGVD29 SHOWN).
3. WELL INSTALLED ON 02/19/2016 BY STANTEC.
4. SCREEN INTERVAL AND WELL DEPTH BASED ON VIDEO LOGGING (STANTEC, 11/10/2016).

JOF-105 MONITORING WELL INSTALLATION DETAIL
TVA JOHNSONVILLE FOSSIL PLANT
NEW JOHNSONVILLE, HUMPHREYS COUNTY, TN

Stantec

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DRAWN BY	MSJ	DATE	FEB., 2017	REVISED		SHEET
CHECKED BY	DRP	PROJ. NO.	175565317	1. JAN., 2018	3.	1 of 1
CHECKED BY	BLB	SCALE	NTS	2.	4.	

Stantec

Well Development Form

General Information TVA JOF GWMW Development 175565317 102 P. 1

Date: 03/01/2016

Well ID: 102

Facility: TVA-JOF

Well Depth: 30.3 ft

Developed By: Stantec

Water Quality Meter: OAKTON & PCSTestr 35

Oversight By: Jordan Matthews

Well Condition: New

Initial Measurements (Before Development)

Time: 9:00 a.m.

Depth to Water: 15.15 ft

Development/Collection Method: Pumped

Temp (°F): 61.3

Turbidity (NTU): 428

Specific Conductance (µS/cm): 269

pH: 6.0

Visual/Odor Observations: Muddy; Opaque; No Odor

During Development Pumping

Time: 9:20

Depth to Water: 16.8 ft

Development/Collection Method: Pumped

Temp (°F): 61.0

Turbidity (NTU): 262

Specific Conductance (µS/cm): 302

pH: 5.6

Visual/Odor Observations: Cloudy; Opaque

During Development Surged with Block, Pumping

Time: 10:00

Depth to Water: 16.8 ft

Development/Collection Method: Pumped

Temp (°F): 61.4

Turbidity (NTU): 196

Specific Conductance (µS/cm): 308

pH: 5.4

Visual/Odor Observations: Cloudy; Opaque

Stantec

Well Development Form

During Development Pumping 102 P. 2

Time: 10:40 Depth to Water: 17.0 ft

Development/Collection Method: Pumped Temp (°F): 60.8

Turbidity (NTU): 37.1 Specific Conductance (µS/cm): 307

pH: 5.0 Visual/Odor Observations: Clear

During Development Pumping

Time: 10:55 Depth to Water: 17.42 ft

Development/Collection Method: Pumped Temp (°F): 61.0

Turbidity (NTU): 17.99 Specific Conductance (µS/cm): 305

pH: 5.2 Visual/Odor Observations: Clear

Final Measurements

Time: 11:10 Depth to Water: 17.48 ft

Development/Collection Method: Pumped Temp (°F): 60.9

Turbidity (NTU): 8.86 Specific Conductance (µS/cm): 304

pH: 5.1 Visual/Odor Observations: Clear

Stantec

Well Development Form

General Information TVA JOF GWMW Development 175565317 JOF-105 P. 1

Date: 03/01/2016
Well ID: JOF-105
Facility: TVA-JOF
Well Depth: 30.0 ft
Developed By: Stantec
Water Quality Meter: OAKTON & PCSTestr 35
Oversight By: Jordan Matthews
Well Condition: New

Initial Measurements (Before Development)

Time: 4:30 p.m.
Depth to Water: 22.8 ft
Development/Collection Method: Pumped
Temp (°F): 61.2
Turbidity (NTU): 191
Specific Conductance (µS/cm): 1297
pH: 5.7
Visual/Odor Observations: Cloudy; Sl. Translucent

During Development Surged; Pumped nearly dry; Well to recharge overnight

03/03/2016 Time: 9:20 a.m.
Depth to Water: 22.9 ft
Development/Collection Method: Pumped
Temp (°F): 60.4
Turbidity (NTU): 19.38
Specific Conductance (µS/cm): 1601
pH: 5.7
Visual/Odor Observations: Clear

During Development Pumping

Time: 9:30 a.m.
Depth to Water: 25.3 ft
Development/Collection Method: Pumped
Temp (°F): 60.8
Turbidity (NTU): 14.69
Specific Conductance (µS/cm): 1589
pH: 5.8
Visual/Odor Observations: Clear

Stantec

Well Development Form

During Development Pumping

JOF-105 P. 2

Time: 12:00 p.m.

Depth to Water: 25.7 ft

Development/Collection Method: Pumped

Temp (°F): 60.8

Turbidity (NTU): 23.0

Specific Conductance (µS/cm): 1606

pH: 5.62

Visual/Odor Observations: Clear

During Development Pumping

Time: 12:10 p.m.

Depth to Water: 28.17 ft

Development/Collection Method: Pumped

Temp (°F): 60.6

Turbidity (NTU): 20.1

Specific Conductance (µS/cm): 1593

pH: 5.62

Visual/Odor Observations: Clear

During Development Pumping

Time: 2:30 p.m.

Depth to Water: 24.20 ft

Development/Collection Method: Pumped

Temp (°F): 61.4

Turbidity (NTU): 14.54

Specific Conductance (µS/cm): 1593

pH: 5.70

Visual/Odor Observations: Clear

Final Measurements Pumping

Time: 2:43 p.m.

Depth to Water: 26.90 ft

Development/Collection Method: Pumped

Temp (°F): 59.8

Turbidity (NTU): 13.76

Specific Conductance (µS/cm): 1588

pH: 5.68

Visual/Odor Observations: Clear

Well ID	Historical Well ID Ref.	Date	Inorganics																															Anions		
			Aluminum, total (ug/L)	Antimony, total (ug/L)	Arsenic, total (ug/L)	Barium, total (ug/L)	Beryllium, total (ug/L)	Boron, total (ug/L)	Cadmium, total (ug/L)	Calcium, total (mg/L)	Chromium, total (ug/L)	Cobalt, total (ug/L)	Copper, total (ug/L)	Iron, total (ug/L)	Lead, total (ug/L)	Lithium, total (ug/L)	Magnesium, total (mg/L)	Manganese, total (ug/L)	Mercury, total (ug/L)	Molybdenum, total (ug/L)	Nickel, total (ug/L)	Nitrite + Nitrate (mg/L)	Potassium, total (mg/L)	Selenium, total (ug/L)	Silicon, total (ug/L)	Silver, total (ug/L)	Strontium, total (ug/L)	Sodium, total (mg/L)	Thallium, total (ug/L)	Tin, total (ug/L)	Titanium, total (ug/L)	Vanadium, total (ug/L)	Zinc, total (ug/L)	Chloride, total (mg/L)	Fluoride, total (mg/L)	Sulfate, total (mg/L)
	MCLs	**TDEC**	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**-**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**100**	**10^**	**-**	**50**	**-**	**100**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
		EPA	**-**	**6**	**10**	**2000**	**4**	**-**	**5**	**-**	**100**	**-**	**1300~**	**-**	**15~**	**-**	**-**	**-**	**2**	**-**	**-**	**1^^**	**-**	**50**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**4**	**-**
JOF-102	JOF-102	03/14/17	0.092	<2	<1	24.4	<1	1090	<1	20.9	<2	<0.5	<2	74.9	<1	<5	--	182	<0.2	<5	7.87	0.415	0.96	<5	--	<1	81.4	20.6	<1	<5	--	<1	49.2	15	<0.1	95.9
		06/12/17	--	--	--	--	--	1040	--	18.7	--	--	--	--	--	<5	--	--	--	<5	--	--	--	--	--	--	--	--	--	--	--	--	--	13.6	--	96.4
		09/18/17	0.122	<2	<1	26.3	<1	1110	<1	21.1	<2	<0.5	2.86	95.7	<1	<5	--	192	<0.2	<5	6.8	0.493	1.08	<5	--	<1	73	21.2	<1	<5	--	<1	32.4	13	<0.1	95.8
		12/11/17	--	--	--	--	--	1030	--	20.9	--	--	--	--	--	<5	--	--	--	<5	--	--	--	--	--	--	--	--	--	--	--	--	--	14.5	--	95.2
JOF-105	JOF-105	03/14/17	0.09	<2	<1	155	<1	2250	<1	166	<2	12	<2	<50	<1	<5	--	694	<0.2	<5	15.4	0.346	2.45	<5	--	<1	547	74.4	<1	<5	--	<1	39.3	461	<0.1	100
		06/12/17	--	--	--	--	--	1950	--	153	--	--	--	--	--	<5	--	--	--	<5	--	--	--	--	--	--	--	--	--	--	--	--	--	415	--	99.4
		09/18/17	0.064	<2	<1	123	<1	2200	<1	146	<2	7.96	3.75	<50	<1	<5	--	546	0.201	<5	10.7	0.332	2.29	<5	--	<1	410	71.6	<1	<5	--	<1	28	387	<0.1	102
		12/11/17	--	--	--	--	--	2030	--	138	--	--	--	--	--	<5	--	--	--	<5	--	--	--	--	--	--	--	--	--	--	--	--	--	362	--	107

~ Action Level
^ nitrate TDEC MCL is listed since there is no MCL for nitrite
^^ nitrite MCL is listed since it is a more conservative value
-- no data
Bold numbers indicate that measured values exceed TDEC MCLs
cont. - continued
EPA - Environmental Protection Agency; MCLs established in 40 CFR Part 141 Appendix I
Grey cells indicat Grey cells indicate that measured values exceed EPA MCLs
MCL - Maximum Contaminant Level
mg/L - milligrams per liter
Ref. - reference
TDEC - Tennessee Department of Environment and Conservation; MCLs established in Rules of TDEC Solid Waste Management Appendix III
ug/L - micrograms per liter

Well ID	Historical Well ID Ref.	Date	General Chemistry										
			Alkalinity, Carbonate (mg/L)	Alkalinity, total (mg/L CaCO3)	Alkalinity, Bicarbonate (mg/L)	Oxygen-Reduction Potential (mV)	Oxygen, dissolved (mg/L)	pH	Specific Conductivity (micromhos/cm)	Temperature (°C)	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
JOF-102	JOF-102	03/14/17	--	32	--	613	3	4.7	277	13.2	176	0.7	0
		06/12/17	--	--	--	466	2.6	4.8	280	18.6	182	--	5.5
		09/18/17	--	28	<5	423	2.8	4.9	283	19.7	184	1	1.2
		12/11/17	--	32	--	557	2.5	4.8	273	15.3	171	--	0
JOF-105	JOF-105	03/14/17	--	104	--	601	2.4	4.7	1672	14.3	964	<0.5	0
		06/12/17	--	100	--	5.16	2	4.8	1592	22.2	1060	--	0
		09/18/17	--	100	<5	509	1.9	4.8	1445	21.6	959	<0.5	0.7
		12/11/17	--	60	--	592	1.9	4.8	1337	17.3	744	--	0.1

-- no data
°C - degrees Celsius
cm - centimeters
cont. - continued
mg/L - milligrams per liter
mV - millivolts
Ref. - reference
NTU - Nephelometric Turbidity Unit

Well ID	Well ID	Date	GW Elevation (ft amsl)	Well Depth (ft below TOC)	Water Level Depth (ft below TOC)
JOF-102	JOF-102	03/14/17	387.96	33.92	19.69
		06/12/17	387.99	33.90	19.65
		09/18/17	387.74	33.90	19.90
		12/11/17	387.51	33.90	20.13
JOF-105	JOF-105	03/14/17	378.77	33.69	27.36
		06/12/17	378.66	33.70	27.49
		09/18/17	378.74	33.70	27.41
		12/11/17	378.33	33.70	27.82

-- no data
cont. - continued
ft amsl = feet above mean sea level
ft = feet
GW = groundwater
Ref. - reference

APPENDIX Q
STABILITY SAP

Stability Sampling and Analysis Plan Johnsonville Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Johnsonville Fossil Plant
New Johnsonville, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 10, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	July 24, 2017
1	Addresses October 19, 2017 TDEC Review Comments and Issued for TDEC Review	January 12, 2018
2	Addresses March 9, 2018 TDEC Review Comments and Issued for TDEC Review	May 11, 2018
3	Addresses June 11, 2018 TDEC Review Comments and Issued for TDEC Review	July 20, 2018
4	Addresses comments and revisions from other EIPs and issued for TDEC review.	December 10, 2018

TITLE AND REVIEW PAGE

Title of Plan: Stability Sampling and Analysis Plan
Johnsonville Fossil Plant
Tennessee Valley Authority
New Johnsonville, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 10, 2018 Revision 4, Final

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager — Date: 12/6/18

TVA Investigation Field Lead — Date: 12/6/18

Health, Safety, and Environmental (HSE) Manager — Date: 12-05-2018

Investigation Project Manager — Date: 12/7/2018

Rock J. Vitale
Digitally signed by Rock J. Vitale
DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US
Date: 2018.12.03 11:53:04 -05'00'
QA Oversight Manager — Date

K. Ryan R. Jones
Laboratory Project Manager — Date: 12-05-18

Charles L. Head
TDEC Senior Advisor — Date

Robert Wilkinson
TDEC CCR Technical Manager — Date

Table of Contents

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order), to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Johnsonville Fossil Plant (JOF) on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residual (CCR) management at JOF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC submitted a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 24, 2017, TVA submitted JOF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

Through the various information requests, as well as TDEC comments, a need for several stability analyses at JOF (the Plant) has been identified. This Stability Sampling and Analysis Plan (SAP) has been prepared to outline the proposed analyses and the methods to be employed during the Investigation.

2.0 OBJECTIVES

The purpose of this Stability SAP is to outline the methods that will be used to execute the following activities:

- Develop slope stability models (including CCR material parameters) and perform slope stability analyses for selected CCR units.
- Document the analyses in the Environmental Assessment Report (EAR).

3.0 HEALTH AND SAFETY

Implementation of this SAP does not include field work. A Health and Safety Plan (HASP) is not required.

4.0 PLANT-SPECIFIC STABILITY ANALYSIS PLAN

The proposed stability analyses were selected to aid in addressing data gaps and supplementing existing data, as necessary to address information requests of the TDEC Multi-Site Order for JOF. Rationale for individual analyses are discussed below. Refer to Figures 1, 2, and 3 in Attachment A for a layout of proposed analysis cross section locations. The selected locations represent critical cross sections based on reviews of previous stability analysis results, subsurface stratigraphy, material properties, and structure geometry. For selection of analysis section(s) for post-earthquake stability, the location of potentially liquefiable materials is also considered. Proposed section locations may be adjusted based on the methodology in Section 5.1.

Table 1 provides the stability analyses (i.e., load cases) proposed for each CCR unit. In cases where new analyses are not proposed, existing analyses adequately address the load case(s) for the unit. For more information on these existing analyses, refer to summaries of existing geotechnical data provided as an appendix to the EIP.

Table 1. Stability Analyses Proposed for each CCR Unit

CCR Unit and Condition	Static Cases		Seismic Cases		
	Long-Term, Global	Long-Term, Veneer[2]	Pseudostatic[1], Global	Pseudostatic[1], Veneer[2]	Post-EQ[3], Global
Ash Disposal Area 1 (Closed Condition)	X	X	X	X	X
Active Ash Pond 2 (Existing Condition)		N/A		N/A	
DuPont Road Dredge Cell (Closed Condition)		X	X	X	X
South Rail Loop Area 4 (Closed Condition)	X	X	X	X	X

[1] Pseudostatic, correlated to a tolerable displacement.
[2] Veneer stability is the slope stability of the final cover.
[3] Post-earthquake (Post-EQ) analysis includes a preceding liquefaction triggering assessment.
N/A = Not applicable

The rationale for the proposed analyses is as follows:

- Ash Disposal Area 1 lacks documented static and seismic slope stability analyses for the current, closed geometry.
- Active Ash Pond 2 existing analyses are sufficient to address the necessary load cases. The veneer stability cases are not applicable because the existing conditions do not include a final cover.
- The DuPont Road Dredge Cell lacks documented static veneer, seismic veneer, and seismic global slope stability analyses for the current, closed geometry.
- South Rail Loop Area 4 lacks documented static and seismic slope stability analyses for the current, closed geometry.
- Other load cases that are not proposed in Table 1 have existing analyses that are representative.

Loading conditions and results from the analyses will be documented within the EAR. For proposed stability analyses, recent water levels, including those measured per the EIP will be considered. When existing stability analyses are to be leveraged, recent water levels will be compared to the modeled levels to confirm that the analyses are still suitable.

The closure design process for Active Ash Pond 2 is ongoing (and subject to TDEC approval), but static and seismic stability analyses have yet to be performed. The results from the closure design analyses will be provided in the EAR (if analyses are available at the time of EAR submittal). Documentation of the closure design will include discussion of the modeled pore water pressures (i.e., water levels) and potential deformations (if any). If the closure design analyses are not available at the time of EAR submittal, this documentation will be provided to TDEC as part of the closure process.

5.0 TECHNICAL APPROACH

This section provides a framework for the procedures that will be used to perform the proposed slope stability analyses. Within this framework, industry standard engineering practices will be employed to execute the work. Individual engineering decisions cannot be prescribed, as they are dependent on the site conditions, available information, type of analysis, and other factors. Details of each analysis, including engineering judgments, will be documented in the EAR.

5.1 ANALYSIS FRAMEWORK

5.1.1 Load Cases

The load cases to be evaluated in the stability analyses are based on conventional practice and appropriate industry standards for landfills and surface impoundments, as applicable.

- Static, long-term (i.e., normal operation conditions) global stability,
- Static, long-term veneer (i.e., final cover) stability,
- Seismic, pseudostatic global stability,
- Seismic, pseudostatic veneer stability,
- Seismic, post-earthquake global stability (includes a preceding liquefaction triggering assessment).

5.1.2 Phased Assessment and Acceptance Criteria

The stability analyses will be performed using a phased assessment process. Initial phases employ available site information, simplified analysis methods, and more conservative acceptance criteria. If acceptable performance is demonstrated, the analyses for the particular load case(s) are complete. If not, the next phase may include collection of additional site information and/or more advanced analysis methods. Less conservative acceptance criteria may be utilized, commensurate with the improved site characterization. The process may continue through multiple phases, as outlined below. The use of a phased approach is consistent with industry standard engineering practices.

The load cases and acceptance criteria presented herein (Table 2) apply specifically for the TDEC Order. The same CCR units may also be subject to other requirements (which may be more or less stringent) for compliance with other regulations such as state permitting, CCR Rule, etc.

Phase 1 Assessment

- Use available geotechnical data (Standard Penetration Testing (SPT), Cone Penetration Testing (CPT), lab testing, etc.)
    - Where geotechnical data is insufficient, collect supplemental CPT data
- Compute static, long-term factor of safety (global, FS_{static} and veneer, $FS_{static\text{-}veneer}$ slope stability)
- For seismic load cases, use site-specific design earthquake loading
    - If not already available, TVA will perform site-specific seismic hazards assessment (Section 0)
- Complete liquefaction triggering assessment based on SPT and CPT data
- Compute pseudostatic factor of safety (global, FS_{pseudo} and veneer, $FS_{pseudo\text{-}veneer}$ slope stability)
    - Using Newmark displacement analyses, compute displacements for range of yield accelerations
    - Select pseudostatic coefficient equal to yield acceleration that gives displacement of 3 feet in the Newmark analysis
    - Assign strengths considering results of liquefaction assessment
    - Compute pseudostatic FS_{pseudo} and $FS_{pseudo\text{-}veneer}$
- Compute static, post-earthquake factor of safety (global slope stability)
    - Assign pseudostatic coefficient equal to zero (static case)
    - Assign strengths considering results of liquefaction assessment
    - Compute post-earthquake $FS_{post\text{-}EQ}$
- Performance is acceptable if the following criteria are met
    - $FS_{static} \geq 1.5$
    - $FS_{static\text{-}veneer} \geq 1.5$
    - $FS_{pseudo} \geq 1.0$
    - $FS_{pseudo\text{-}veneer} \geq 1.0$
    - $FS_{post\text{-}EQ} \geq 1.1$

- If any load cases do not meet criteria, go to Phase 2
- During the Phase 1 stability assessment, TVA will work with TDEC to define criteria for acceptable performance that would be utilized during a potential Phase 4 (the final phase) of the proposed phased stability assessment. The factors that contribute to defining acceptable performance will be site-specific and related to the consequences of the predicted deformations. As more site-specific information becomes available after Phase 1, TVA and TDEC may need to revisit the acceptable performance criteria in light of the additional information.

Phase 2 Assessment

- Perform additional site explorations in targeted areas
    - Critical areas to be identified by parametric analyses
    - SPT using mud rotary drilling (or other suitable drilling method)
    - Seismic CPT soundings (companion to SPT locations)
    - Lab testing tailored to analysis needs (including triaxial and/or direct shear strength testing, as applicable)
- Compute static factor of safety
    - Update Phase 1 analyses with new site data
- Complete liquefaction triggering assessment
    - Update Phase 1 analyses with new site data
- Compute pseudostatic factor of safety
    - Update Phase 1 analyses with new site data
- Compute post-earthquake factor of safety
    - Update Phase 1 analyses with new site data
- Performance is acceptable if the following criteria are met
    - $FS_{static} \geq 1.5$
    - $FS_{static\text{-}veneer} \geq 1.5$
    - $FS_{pseudo} \geq 1.0$
    - $FS_{pseudo\text{-}veneer} \geq 1.0$

  - $FS_{post\text{-}EQ} \geq 1.0$ (lower criteria based on improved site characterization)

- If any load cases do not meet criteria, go to Phase 3

Phase 3 Assessment

- Perform a nonlinear deformation analysis (FLAC, OpenSees, or other appropriate code) to estimate displacements
- Performance is acceptable if representative displacement ≤ 3 feet
- If representative displacement > 3 feet, go to Phase 4

Phase 4 Assessment

- Consider the consequences (impacts to human health and/or environment) of the predicted deformations
- As more site-specific information becomes available after Phase 1, TVA and TDEC may need to revisit the acceptable performance criteria in light of the additional information.

Note that the tolerable displacement is subject to adjustment based on site-specific features and consequences of specific failure modes.

Table 2. Summary of Load Cases and Acceptance Criteria

Load Case	Pool Levels	Incipient Motion	Analysis	Soil Strengths	Pore Pressures	Acceptance Criteria
Static, Long-Term, Global and Veneer	Impoundment (where applicable): Normal Operating Pool Adjacent Reservoir: Winter Pool	Inboard (Impoundments Only) and Outboard	Drained	Drained Static	Seepage for Modeled Pool Levels and/or Piezometer Data	FS ≥ 1.5
Pseudostatic, Global and Veneer	Impoundment (where applicable): Normal Operating Pool Adjacent Reservoir: Winter Pool	Inboard (Impoundments Only) and Outboard	Undrained Seismic	Undrained Seismic	Seepage for Modeled Pool Levels and/or Piezometer Data	FS ≥ 1.0 (Correlated to tolerable displacement of 3 feet[1])
Post-Earthquake, Global	Impoundment (where applicable): Normal Operating Pool Adjacent Reservoir: Winter Pool	Inboard (Impoundments Only) and Outboard	Undrained Static	Undrained Seismic; Residual Strengths in Liquefied Materials	Seepage for Modeled Pool Levels and/or Piezometer Data	FS ≥ 1.1 (Phase 1); FS ≥ 1.0 (Phase 2); Representative displacement ≤ 3 feet[1] (Phase 3)

[1] Tolerable displacement subject to adjustment based on site-specific features and consequences of specific failure modes.

5.1.3 Basis for Load Cases and Acceptance Criteria

There are no established closure design criteria for certain categories of CCR units that are not regulated under the CCR Rule. The US Environmental Protection Agency (EPA) excluded from regulation inactive CCR landfills, § 257.50(d), as well as CCR surface impoundments that no longer impound water and that are "capped or otherwise maintained," 80 Fed. Reg. at 21343. EPA explained in its preamble that these exclusions are due to the lower risk associated with such units. Section VI.A.5 (page 21342) of the preamble states:

> "As noted, EPA's risk assessment shows that the highest risks are associated with CCR surface impoundments due to the hydraulic head imposed by impounded water. Dewatered CCR surface impoundments will no longer be subjected to hydraulic head so the risk of releases, including the risk that the unit will leach into the groundwater, would be no greater than those from CCR landfills."

To establish the closure design criteria presented herein, relevant standards from the landfill and embankment dam industries were considered. The following industries or agencies were considered when selecting the appropriate load cases and acceptance criteria:

- State of Tennessee solid waste landfill design guidance (TDEC, date unknown),
- EPA municipal solid waste landfill (i.e., RCRA Subtitle D) design guidance (Richardson et al. 1995),
- EPA CCR Rule requirements,
- US Army Corps of Engineers (USACE) embankment dam design guidance (Hynes-Griffin and Franklin 1984),
- TVA embankment dam design guidance (TVA 2016). (Note that the analysis load cases and acceptance criteria are based upon and generally consistent with other industry standards, such as the dam safety criteria of the USACE and the Federal Energy Regulatory Commission.)

5.1.3.1 Static Loading

For static loading, the landfill and embankment dam practices are generally in agreement that long-term (i.e., normal operating condition) loading should be analyzed for global slope stability. For landfills with a final cover that may consist of relatively thin layer(s) of materials, the long-term veneer stability should also be analyzed. The reviewed guidance documents generally agree that a static, long-term factor of safety of 1.5 for both global and veneer slope stability is appropriate, and this criterion is applied herein.

Other common static load cases, such as end-of-construction loading, flood loading and sudden drawdown loading are not applicable to existing landfills or surface impoundments that no longer impound water.

5.1.3.2 Seismic Loading

For seismic loading, the landfill and embankment dam practices are less consistent on the load cases to consider and the associated acceptance criteria. However, there is general consensus that because earthquake loading is less probable than static loading, that lower factors of safety and some permanent displacement can be accepted.

In the case of landfills, the tolerable displacement is typically related to the potential damage to components (liners, leachate collection pipes, covers, etc.) and the ability to make repairs after the earthquake. In the case of embankment dams, the tolerable displacement is typically related to preventing uncontrolled loss of pool, potential damage to internal components (sand filters, drainage pipes, etc.), and ability to make repairs after the earthquake.

Seismic loading is commonly evaluated by considering two scenarios:

- Stability during shaking, either using pseudostatic slope stability analyses or simplified displacement analyses,

- Stability immediately after shaking, using static, post-earthquake stability analyses that consider liquefaction potential and associated reductions in shear strength.

5.1.3.2.1 Pseudostatic Stability

There is general consensus that seismic-induced displacements are key to judging acceptable performance during and after the earthquake. However, the most common difference between various design guidance is whether to perform pseudostatic analyses (which can infer tolerable displacement) or to perform simplified displacement analyses (which estimate displacements directly). Depending on how the pseudostatic seismic coefficient is derived (i.e., the degree of conservatism), the slope stability analysis may or may not be a good index of displacement.

TDEC guidance for solid waste landfills judges acceptable performance based on results of simplified displacement analyses (Newmark sliding block or similar analysis). TDEC does not have acceptance criteria based on a pseudostatic slope stability factor of safety. Two acceptance criteria were established to "…insure that the landfill liner, leachate collection system and landfill appurtenances will remain functional when subjected to earthquake induced forces." The acceptance criteria are as follows:

- "Leachate collection systems and waste cells shall be designed to function without collection pipes for solid waste fill embankments that are predicted to undergo more than six inches of deformation."

- "No landfill shall be acceptable if the predicted seismic induced deformations within the waste fill exceed one-half the thickness of the clay liner component of the liner system."

In many cases, inactive CCR landfills and/or CCR surface impoundments that no longer impound water do not include leachate collection systems or engineered bottom liners, and can tolerate greater seismic displacements. As such, the above acceptance criteria are considered overly conservative and not applicable.

In contrast, CCR Rule has acceptance criteria based on a pseudostatic slope stability factor of safety of 1.0. The means to derive an appropriate pseudostatic seismic coefficient are not defined in the CCR Rule. In order to perform CCR Rule demonstrations, TVA has developed a method whereby the coefficient is correlated to a site-specific tolerable displacement. As a result, a factor of safety of 1.0 equates to the tolerable displacement. A factor of safety less than 1.0 would imply displacements that exceed the tolerable value.

EPA guidance for solid waste landfills and USACE and TVA guidance for embankment dams employ phased approaches. A pseudostatic slope stability analysis is performed, and if acceptance criteria ($FS_{pseudo} \geq 1.0$ for EPA and USACE; 1.1 or 1.0 for TVA depending on how well the site is characterized) are met it is implied that displacements are tolerable. The analysis methods recommended by EPA and USACE are correlated to tolerable displacements of 12 inches and 1 meter, respectively. If acceptance criteria are not met, a simplified displacement analysis is then performed. The estimated displacements are compared against tolerable displacement that is based on site-specific features and/or consequences.

In most cases, inactive CCR landfills and/or CCR surface impoundments that no longer impound water do not include leachate collection systems or engineered bottom liners and can tolerate greater seismic displacements. Therefore, for pseudostatic slope stability (global), an acceptable factor of safety of 1.0 ($FS_{pseudo} \geq 1.0$) which is correlated to a tolerable displacement of 3 feet will be employed. Based on a series of seismic displacement analyses for a variety of earthquakes and site conditions, Hynes-Griffin and Franklin (1984) conclude that if FS_{pseudo} is greater than or equal to one, that the slope deformations should be tolerable for an embankment dam (they define tolerable as displacements less than 1 meter, or about 3 feet). The tolerable displacement is subject to adjustment based on site-specific features and consequences of specific failure modes.

With respect to veneer (i.e., final cover) slope stability during an earthquake, there is consensus that more permanent displacement is tolerable because of the low probability of the earthquake and the ability to repair the final cover. For solid waste landfills, EPA still suggests an acceptable factor of safety of 1.0, but states:

> "For cover systems, where permanent seismic deformations may be observed in post-earthquake inspections and damage to components can be repaired, larger permanent deformations may be considered acceptable. In fact, some regulatory agencies consider seismic deformations of the landfill cover system primarily a maintenance problem."

Indeed, the TDEC guidance for solid waste landfills requires a factor of safety of 1.0 but acknowledges design flexibility for final cover displacements that occur due to the earthquake:

> "Presently, it is the opinion of the Solid Waste Division that this type of failure mechanism will generally not result in a catastrophic type of failure. Therefore, some flexibility will be given for the design of the stability of landfill cover systems."

Therefore, for pseudostatic slope stability (veneer), an acceptable factor of safety of 1.0 ($FS_{pseudo\text{-}veneer} \geq 1.0$) which is correlated to a tolerable displacement of 1 meter (approximately 3 feet) will be employed. The tolerable displacement is subject to adjustment based on site-specific features and consequences of specific failure modes.

5.1.3.2.2 Post-Earthquake Stability

In addition to permanent displacements that occur during shaking, further movement can occur immediately after shaking if shear strengths are significantly reduced due to liquefaction triggering.

Assigning appropriate post-earthquake strengths first requires a liquefaction triggering assessment for each material in the slope stability model. The results of the liquefaction triggering assessment will inform the derivation of post-earthquake strengths. The post-earthquake slope stability analysis is a static load case; there is no earthquake load applied.

The TDEC guidance for solid waste landfills includes a liquefaction triggering assessment, but does not stipulate a post-earthquake slope stability analysis. Instead, an effort is made to estimate liquefaction-induced damage at the ground surface.

The EPA guidance for solid waste landfills and the TVA guidance for embankment dams include a liquefaction triggering assessment followed by a post-earthquake slope stability analysis. In the EPA and TVA guidance, performance is considered acceptable if the factor of safety ($FS_{post\text{-}EQ}$) is 1.1 or greater. However, TVA guidance also allows an acceptable $FS_{post\text{-}EQ}$ of 1.0 "…for embankments with well-defined subsurface and site condition information."

The CCR Rule requires a liquefaction triggering assessment followed by a post-earthquake slope stability analysis. The acceptance criterion is $FS_{post\text{-}EQ}$ of 1.2. Commentary within the Rule notes that a minimum factor of safety higher than 1.0 was selected because “liquefaction potential analysis and post-liquefaction residual strength analysis involves a larger degree of uncertainties…in assumptions and analysis…”.

Therefore, for post-earthquake slope stability (global), an acceptable factor of safety of 1.1 ($FS_{post\text{-}EQ} \geq 1.1$) will be employed. This applies when an ordinary amount/type of site information is available, and generally corresponds to a Phase 1 assessment as defined herein. If the site characterization is “well-defined” an acceptable factor of safety of 1.0 ($FS_{post\text{-}EQ} \geq 1.0$) will be employed. This generally corresponds to a Phase 2 assessment as defined herein.

If a Phase 3 assessment is necessary, including a nonlinear deformation analysis, the acceptance criteria is a representative displacement of 3 feet. The tolerable displacement is subject to adjustment based on site-specific features and consequences of specific failure modes.

5.2 CROSS SECTION DEVELOPMENT

Each analysis cross section will be selected to represent the critical cross section for slope stability failure. Cross sections previously evaluated will be reviewed and evaluated for use in the proposed analyses. If the previously used cross sections are not considered representative for the new analyses, new cross sections will be developed using available site-specific data (including data collected per the Exploratory Drilling SAP). The basis for analysis cross sections will be documented in the EAR.

5.3 MATERIAL PROPERTIES

Measurements of material properties are obtained from site-specific field and/or laboratory testing where available (including data collected per the Exploratory Drilling SAP). If parameters are not available, they will be derived for each material based on the available data, specific characteristics of the material, geologic setting, application of the parameter in the analysis, and professional judgment. If needed, standard engineering references such as Navy (NAVFAC), US Army Corps of Engineers (USACE), and US Bureau of Reclamation (USBR) publications will be used to develop material parameters. Material properties to be developed include but are not limited to the following parameters for use in the analyses:

- Unit Weights,
- Drained Shear Strengths,
- Undrained Shear Strengths,
- Seismic Shear Strengths,

- Post-Earthquake (Liquefied Strengths), and
- Hydraulic Conductivity.

Prior to the post-earthquake analysis, the materials will be evaluated for liquefaction potential using an industry standard, simplified stress-based approach (e.g., Boulanger and Idriss 2014). The liquefaction assessment may include site-specific ground response analyses. If a material is anticipated to liquefy, residual strengths will be estimated using available laboratory data, field data and/or published correlations.

Appropriate material properties will be applied, consistent with each load case (Table 2). A discussion of utilized parameters and their derivations will be included in the EAR.

5.4 LOADING

5.4.1 Pool Levels and Pore Water Pressures

For static, long-term and seismic load cases, the pool within an impoundment (where applicable) is the normal operating pool. The pool in the adjacent body of water (e.g., river or reservoir) is the normal operating pool (Summer or Winter Pool, whichever is more conservative) for the reservoir.

The slope stability analyses require pore water pressures for computing effective consolidation stresses, as defined for the load conditions. Pore water pressures can be estimated with finite element analyses (i.e., seepage models) or by assigning a piezometric line to the cross section. Either approach will be based, in part, on available site-specific piezometer data. The methodology utilized in the analyses will be documented in the EAR.

Consideration of both estimated pore water pressures and adjacent reservoir pool levels (where applicable) will generally encompass the phreatic conditions that will be experienced by the unit.

5.4.2 Seismic Loading

The design earthquake is an event with a 2 percent probability of exceedance in 50 years (i.e., return period of 2,475 years). This return period is similar to that of an event with a 10 percent probability of exceedance in 250 years (return period of 2,373 years). TVA seismic hazard models or appropriate United States Geological Survey (USGS) seismic hazard mapping may be used to derive the appropriate seismic loading. Derivation of the seismic loads will be documented in the EAR.

5.5 SOFTWARE EMPLOYED IN ANALYSES

Slope stability will be evaluated using conventional, limit equilibrium methods as implemented in the GeoStudio SLOPE/W software or equivalent. With SLOPE/W, the distribution of pore water pressures within the earth mass may be mapped directly from the results of a SEEP/W analysis or piezometric line(s) can be input.

If ground response analyses become warranted, software such as Strata, QUAD4, or other appropriate code may be utilized.

If nonlinear deformation analyses become warranted, software such as FLAC, OpenSees, or other appropriate code may be utilized.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The Quality Assurance Project Plan (QAPP) describes quality assurance (QA)/ quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to stability analyses.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to confirm that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Project Manager considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

The accuracy of the stability analysis processes must be maintained throughout the Investigation.

Office personnel will be responsible for performing checks to confirm that the SAP has been followed. This consists of the completion of applicable forms and documentation of activities.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that data are appropriately maintained and accessible to data end users. The Investigation will be performed in accordance with the QAPP. Analyses will be subjected to data validation in accordance with the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 3. Preliminary Schedule for Stability SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Stability SAP Submittal		Completed
Conduct Stability Analyses	180 Days	Following EIP Approval
Documentation	60 Days	Following Analyses

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- None.

9.0 REFERENCES

Boulanger, R.W. and Idriss, I.M. 2014. "CPT and SPT based liquefaction triggering procedures." Report No. UCD/CGM-14/01, Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, University of California, Davis, CA.

Hynes-Griffin, M. E., and Franklin, A. G. 1984. "Rationalizing the seismic coefficient method." Miscellaneous Paper GL-84-13, July. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi, 37 pages.

Richardson, G. N., Kavazanjian, E., and Matasovi, N. 1995. "RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities." Report No. EPA/600/R-95/051. Prepared for United States Environmental Protection Agency. April.

Tennessee Division of Solid Waste Management (unknown date). "Earthquake Evaluation Guidance Document."

Tennessee Valley Authority (TVA). 2016. "Design and evaluation of new and existing river system dams." SRME-SPP-27.001, Rev. 0000, January 5 (effective date). Chattanooga, Tennessee.

United States Army Corps of Engineers (USACE). 2003. "Slope stability." EM 1110-2-1902, October, Washington D.C.

United States Environmental Protection Agency (USEPA). 2015. "Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities." Federal Register, Vol. 80, No. 74, April 17.

ATTACHMENT A
FIGURES

CCR Unit and Condition	Static Cases		Seismic Cases		
	Long-Term, Global	Long-Term, Veneer[2]	Pseudostatic[1], Global	Pseudostatic[1], Veneer[2]	Post-EQ[3], Global
Active Ash Pond 2 (Existing Condition)	A, B, C, C1, E, F, H, K, L, M, Station 12+00	N/A	B, C, E, H, K	N/A	B, C, E, H, K

[1] Pseudostatic, correlated to a tolerable displacement.

[2] Veneer stability is the slope stability of the final cover.

[3] Post-earthquake (Post-EQ) analysis includes a preceding liquefaction triggering assessment.

Blue cells are completed analyses. Yellow cells are proposed analyses. N/A = Not Applicable.

Figure No.
1

Title

Completed Stability Analyses Active Ash Pond 2

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-05
Technical Review by ZW on 2018-01-05

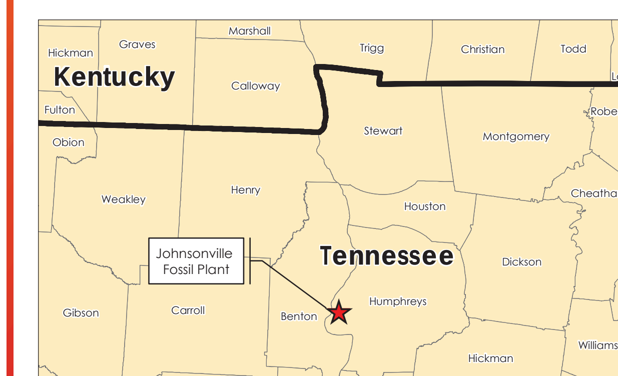
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Cross Section
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec TVA

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CCR Unit and Condition	Static Cases: Long-Term, Global	Static Cases: Long-Term, Veneer[2]	Seismic Cases: Pseudostatic[1], Global	Seismic Cases: Pseudostatic[1], Veneer[2]	Seismic Cases: Post-EQ[3], Global
Ash Disposal Area 1 (Closed Condition)	ADA1	Typ.[4]	ADA1	Typ.[4]	ADA1
DuPont Road Dredge Cell (Closed Condition)	A, B	Typ.[4]	B	Typ.[4]	B

[1] Pseudostatic, correlated to a tolerable displacement.
[2] Veneer stability is the slope stability of the final cover.
[3] Post-earthquake (Post-EQ) analysis includes a preceding liquefaction triggering assessment.
[4] Typical design section for unit will be analyzed as part of EAR.
Blue cells are completed analyses. Yellow cells are proposed analyses. N/A = Not Applicable.

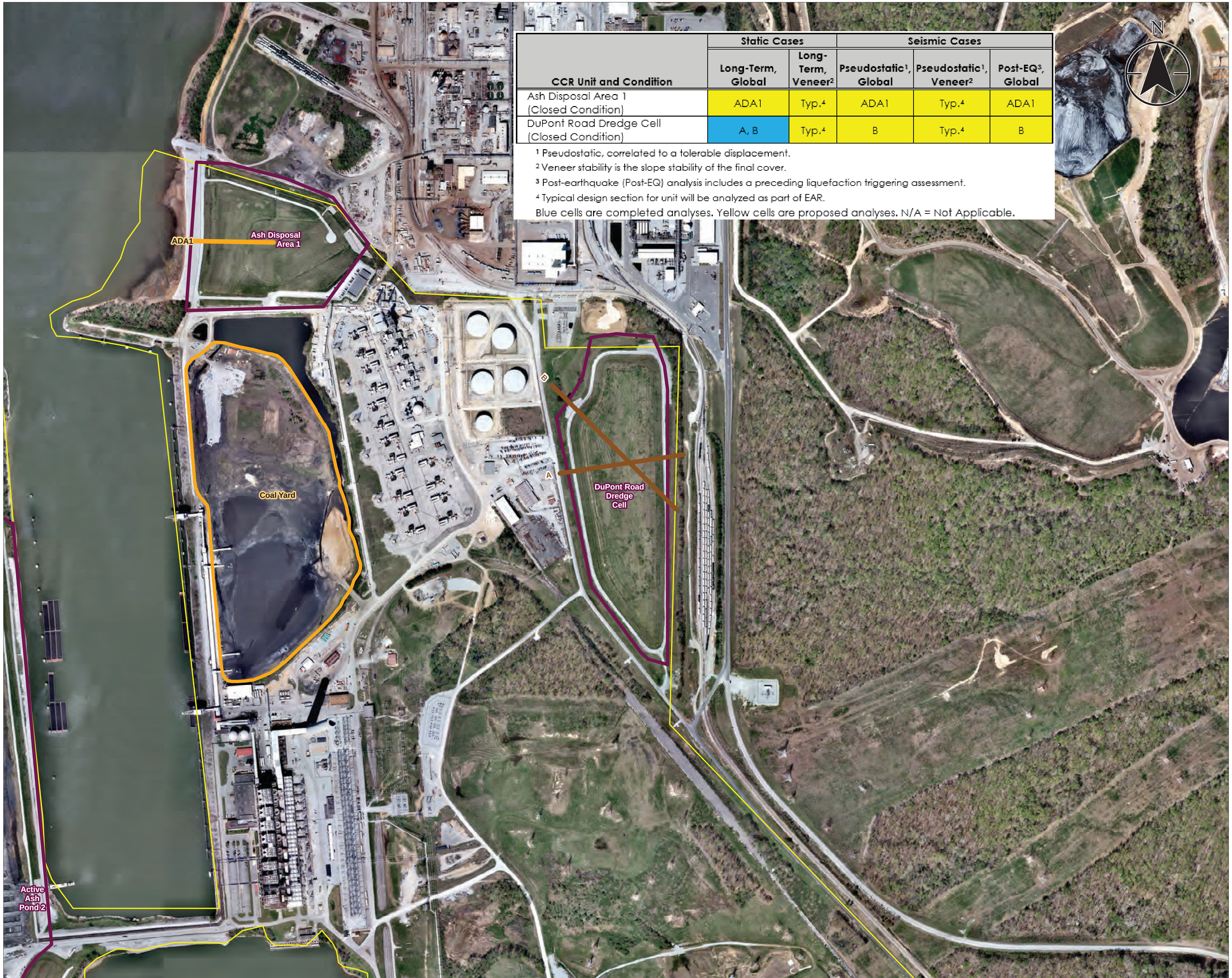


Figure No.
2

Title
Completed & Proposed Stability Analyses Ash Disposal Area 1, Coal Yard, & DuPont Road Dredge Cell

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-05
Technical Review by ZW on 2018-01-05

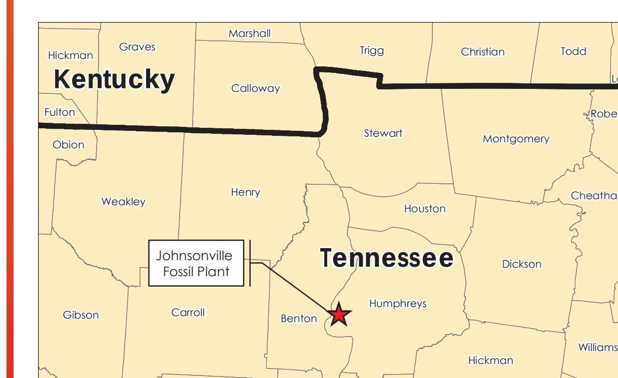
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Cross Section
- Proposed Cross Section
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



CCR Unit and Condition	Static Cases: Long-Term, Global	Static Cases: Long-Term, Veneer[2]	Seismic Cases: Pseudostatic[1], Global	Seismic Cases: Pseudostatic[1], Veneer[2]	Seismic Cases: Post-EQ[3], Global
South Rail Loop Area 4 (Closed Condition)	RL1, RL2, RL3	RL2, RL3	RL1, RL2, RL3	RL2, RL3	RL1, RL2, RL3

[1] Pseudostatic, correlated to a tolerable displacement.
[2] Veneer stability is the slope stability of the final cover.
[3] Post-earthquake (Post-EQ) analysis includes a preceding liquefaction triggering assessment.
Blue cells are completed analyses. Yellow cells are proposed analyses. N/A = Not Applicable.

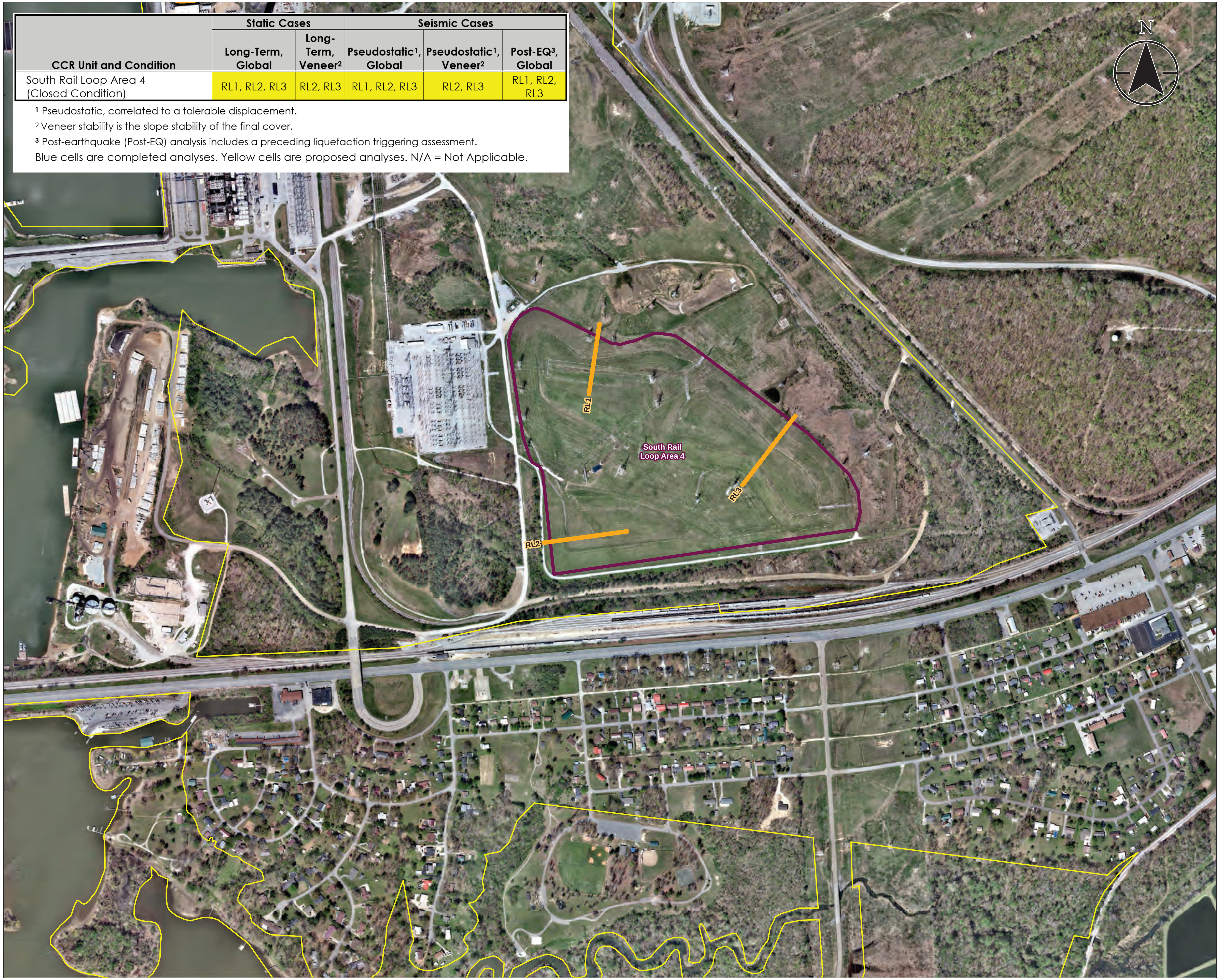


Figure No.
3

Title

Proposed Stability Analyses South Rail Loop Area 4

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296
Prepared by LMB on 2017-12-18
Technical Review by ZW on 2017-12-18

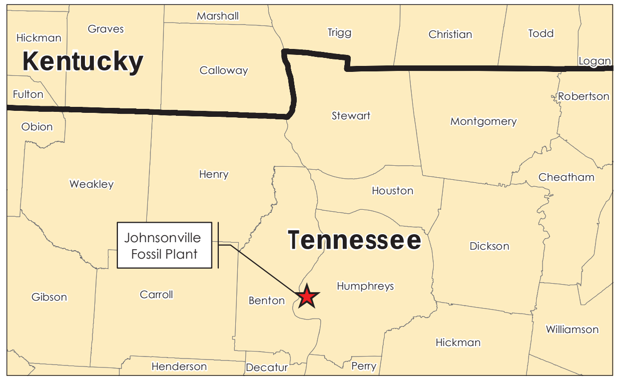
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Proposed Cross Section
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec

TVA

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APPENDIX R
BENTHIC INVERTEBRATE SAP

Benthic
Sampling and Analysis Plan
Johnsonville Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Johnsonville Fossil Plant
New Johnsonville, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 10, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	July 24, 2017
1	Addresses October 19, 2017 TDEC Review Comments and Issued for TDEC Review	January 12, 2018
2	Addresses March 9, 2018 TDEC Review Comments and Issued for TDEC Review	May 11, 2018
3	Addresses June 11, 2018 TDEC Review Comments and Issued for TDEC Review	July 20, 2018
4	Addresses comments and revisions from other EIPs and issued for TDEC review.	December 10, 2018

Benthic
Sampling and Analysis Plan
Johnsonville Fossil Plant

TITLE AND REVIEW PAGE

Title of Plan: Benthic
Sampling and Analysis Plan
Johnsonville Fossil Plant
Tennessee Valley Authority
New Johnsonville, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 10, 2018 Revision 4, Final

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager	12/6/18 Date
TVA Investigation Field Lead	12/7/18 Date
Health, Safety, and Environmental (HSE) Manager	12/05/2018 Date
Investigation Project Manager	12/4/2018 Date
Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.12.03 11:53:22 -05'00' QA Oversight Manager	Date 12.4.18
Tod Noltemeyer Laboratory Project Manager	Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

Stantec

Table of Contents

LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order), to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Johnsonville Fossil Plant (JOF) on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management at JOF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC submitted a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 24, 2017, TVA submitted JOF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

TVA has developed this Benthic Sampling and Analysis Plan (SAP) to collect samples to evaluate sediment chemistry, benthic macroinvertebrate community composition, and benthic macroinvertebrate bioaccumulation in surface streams on or adjacent to the Plant. The plan provides procedures and methods necessary to conduct investigation activities as well as sampling locations.

2.0 OBJECTIVES

The objectives of this study are to characterize sediment chemistry, benthic macroinvertebrate (invertebrate) community composition, and benthic invertebrate bioaccumulation in surface streams on or adjacent to the Plant to determine if CCR material has migrated into those surface streams.

The initial approach is to collect sediment samples from identified transects in surface streams on or adjacent to the Plant. Samples will be analyzed for CCR parameters listed in 40 CFR Part 257, Appendices III and IV along with additional parameters required by the state groundwater monitoring program (copper, nickel, silver, vanadium, and zinc). These constituents, along with strontium, will be hereafter referred to as "CCR parameters." Additionally, samples will be analyzed for percent ash to determine the presence or absence of CCR.

This Benthic SAP will provide the procedures necessary to collect sediment samples from the proposed sediment sampling transects discussed in Section 4.0. The sediment sampling transects will coincide with surface stream sampling locations provided in the Surface Stream SAP. Mayfly sampling locations will cover the same geographic areas as fish tissue sampling areas.

A phased approach to surface stream and sediment sampling has been proposed in the EIP. For Phase 1, all sediment samples will be analyzed by Polarized Light Microscopy (PLM) for percentage of ash and all sediment samples collected from 0 to 6 inches deep will be analyzed for the CCR parameters. All deeper sediment samples collected for the potential analysis of CCR parameters during Phase 1 will be held pending the results of the Phase 1 analyses. Should the percentage of ash in a Phase 1 sample exceed 20%, Phase 2 will consist of analysis of the held sediment sample(s) from the deeper strata collected from the location at which percentage of ash exceeded 20% for the CCR parameters. Depending on the location of the exceedance and collective results of the Phase 1 data, Phase 2 may include sediment sampling at additional locations in surface streams on or adjacent to the Plant. If Phase 2 is not required, no additional sediment samples will be taken or analyzed. Refer to Section 4.0 for additional Plant-specific details.

Quantitative benthic invertebrate samples will also be collected during Phase 1. The benthic invertebrate sediment samples will be collected along transects at the locations discussed in Section 4.0.

The benthic invertebrate samples will be submitted for processing during which the specimens will be identified and enumerated to the lowest practical taxonomic level. The results of the quantitative sampling will be used to assess benthic community diversity.

The benthic invertebrate evaluation will also include collecting composite samples of mayfly nymphs and adults (*Hexagenia)* from random locations within the areas discussed in Section 4.0. Select mayfly nymph samples will have their digestive systems depurated prior to analysis. Composite adult mayfly samples will be opportunistically collected by direct removal from vegetation or other structures along the shoreline or by use of sweep nets. Mayfly sampling locations will cover the same geographic areas as fish tissue sampling areas. The mayfly nymphs (collected for both depuration and non-depuration) and adult mayflies will be submitted for laboratory analysis of metals included in the CCR parameters list (excluding radium). The mayfly analytical results will be used in conjunction with sediment and fish tissue data to evaluate contaminant bioaccumulation.

The field activities associated with Phase 1 will include the following tasks:

- Verify proposed sampling locations using the global positioning system (GPS)
- Collect sediment samples from proposed sampling locations
- Collect benthic invertebrate samples from proposed sampling locations
- Collect adult mayfly, non-depurated mayfly nymph, and depurated mayfly nymph composite samples from proposed sampling locations
- Package and ship sediment samples to laboratory for analysis or for storage pending Phase 1 results
- Package and ship benthic invertebrate samples to laboratory for community evaluation
- Package and ship composite mayfly samples to laboratory for analysis

Should additional samples be needed as part of Phase 2 implementation, a new sampling map will be developed. Data collected during this investigation will be reported to TDEC in the Environmental Assessment Report (EAR).

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLING LOCATIONS

4.1 SEDIMENT SAMPLING LOCATIONS

Sixteen sediment sample transects are planned for the Phase 1 investigation, with individual samples being collected perpendicular to flow from the right descending bank, the center of the channel, and the left descending bank at each transect. Right descending bank and left descending bank will be determined with a downstream-facing orientation. Background transects upstream of the Plant on the Tennessee River are proposed to provide baseline sediment data for CCR parameter concentrations. Phase 1 sediment sampling transects adjacent to the Plant, the Tennessee River, the Boat Harbor, and the Intake Channel were selected to capture areas where CCR could potentially have been released from the impoundment into the surface streams. Additional transects are proposed in the Tennessee River downstream of the ash ponds and in coves east and west of the Tennessee River. See Table 1 below for a summary of transect locations and Figure 1 (Attachment A) for proposed sediment sampling transects.

Water samples will also be taken at coincident sediment sampling locations as described in the Surface Stream Sampling and Analysis Plan. The number and/or location of the proposed sediment samples described above may have to be modified based on conditions encountered in the field.

Table 1. Proposed Sediment Sample Location

Transect Location ID	Description
SED-TR01	Tennessee River Upstream of Plant (Background)
SEC-TR02	Tennessee River Upstream of Plant (Background)
SED-TR03	Tennessee River Upstream of Plant (Background)
SED-TR04	Tennessee River on West Side of Ash Pond 2
SED-TR05	Tennessee River on West Side of Ash Pond 2
SED-TR06	Tennessee River at Northern End of Ash Pond 2 and Southern End of Ash Pond 1
SED-TR07	Tennessee River at Northern End of Ash Pond 1
SED-TR08	Tennessee River Downstream from Ash Ponds
SED-IC01	Intake Channel Adjacent to Ash Pond 2
SED-IC02	Intake Channel Adjacent to Ash Pond 2
SED-BH01	Boat Harbor Adjacent to Ash Pond 2
SED-BH02	Boat Harbor Adjacent to Ash Pond 2
SED-BH03	Boat Harbor North of Ash Pond 2
SED-CV01	Cove on East Side of Tennessee River Upstream from Plant
SED-CV02	Cove on West Side of Tennessee River
SED-CV03	Cove on West Side of Tennessee River

4.2 BENTHIC INVERTEBRATE SAMPLING LOCATIONS

Quantitative benthic invertebrate sampling will also be conducted during Phase 1. The benthic invertebrate sediment samples will be collected along transects at the locations depicted on Figures 2 and 3. See Table 2 below for a summary of transect locations.

Benthic invertebrate sediment samples will be collected from five locations along each proposed transect. If it is not possible to collect samples due to conditions encountered in the field (e.g., large sediment grain size), locations may be adjusted based on the judgement of the field team.

Table 2. Proposed Benthic Invertebrate Transect Sample Locations

Transect ID	Description
MAC-TR01	Tennessee River Upstream of Plant (Background)
MAC-TR02	Tennessee River Upstream of Plant (Background)
MAC-TR03	Tennessee River on West Side of Ash Pond 2 at NPDES Outfall
MAC-TR04	Tennessee River on West Side of Ash Pond 2
MAC-TR05	Tennessee River at Northern End of Ash Pond 2 and Southern End of Ash Pond 1
MAC-TR06	Tennessee River at Northern End of Ash Pond 1
MAC-TR07	Tennessee River Downstream from Ash Ponds
MAC-TR08	Tennessee River Downstream from Plant
MAC-TR09	Tennessee River Upstream from Plant
MAC-TR10	Tennessee River Upstream from Plant
MAC-TR11	Tennessee River Downstream from Plant
MAC-CV01	Cove on East Side of Tennessee River Upstream from Plant
MAC-CV02	Cove on West Side of Tennessee River

Transect ID	Description
MAC-CV03	Cove on West Side of Tennessee River
MAC-IC01	Intake Channel Adjacent to Ash Pond 2
MAC-IC02	Intake Channel Adjacent to Ash Pond 2
MAC-IC03	Intake Channel Adjacent to Ash Pond 2
MAC-BH01	Boat Harbor Adjacent to Ash Pond 2
MAC-BH02	Boat Harbor Adjacent to Ash Pond 2
MAC-BH03	Boat Harbor Downstream from Ash Pond 2

4.3 MAYFLY SAMPLING LOCATIONS

Mayfly sampling will also be conducted during Phase 1. Both nymph and adult mayflies (*Hexagenia*) will be collected. Composite mayfly nymph samples will be collected from submerged sediments at multiple random locations within the areas depicted on Figure 4. See Table 3 below for a summary of these locations. Adult mayflies will be opportunistically collected by direct removal from vegetation or other structures along the shoreline or by use of sweep nets. The timing of the sampling will need to be coordinated with local adult mayfly emergence.

Efforts will be made to collect mayfly adults/nymphs within the designated areas, however other species may need to be evaluated and/or other locations added if an insufficient number of mayfly adults/nymphs are encountered within the designated areas at the time the proposed sampling is conducted.

Table 3. Proposed Mayfly Sample Locations

Location ID	Description
TRU	Tennessee River Upstream from Plant
TRA	Tennessee River Adjacent to Plant
TRD	Tennessee River Downstream from Plant
IC	Intake Channel
BH	Boat Harbor

4.4 CORRESPONDING SAMPLING LOCATIONS

Several of the sediment, benthic invertebrate, and mayfly sample locations coincide with sample locations of other environmental SAPs. Table 4 summarizes the corresponding samples for the Surface Stream, Benthic, and Fish Tissue SAPs.

Table 4. JOF Environmental Corresponding Sample Locations Matrix

Surface Stream Sample Location	Sediment Sample Location	Benthic Sample Location	Mayfly Sample Location	Fish Tissue Sample Location
		MAC-TR01		
STR-TR01	SED-TR01			
STR-TR02	SED-TR02	MAC-TR02		
STR-TR03	SED-TR03			
STR-TR04	SED-TR04	MAC-TR03	TRA	TRA
STR-TR05	SED-TR05	MAC-TR04		
STR-TR06	SED-TR06	MAC-TR05		
STR-TR07	SED-TR07	MAC-TR06		
STR-TR08	SED-TR08	MAC-TR07		
		MAC-TR08		
		MAC-TR09		
		MAC-TR10	TRU	TRU
		MAC-TR11	TRD	TRD
STR-CV01	SED-CV01	MAC-CV01		
STR-CV02	SED-CV02	MAC-CV02		
STR-CV03	SED-CV03	MAC-CV03		
		MAC-IC01		
		MAC-IC02		
STR-IC01	SED-IC01	MAC-IC03	IC	IC
STR-IC02	SED-IC02			
STR-BH01	SED-BH01	MAC-BH01	BH	BH
STR-BH02	SED-BH02	MAC-BH02		
STR-BH03	SED-BH03	MAC-BH03		

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to collect samples, document field activities, and assist in providing scientifically defensible results.

Sample collection will adhere to TVA Technical Instruction (TI) documents. A project field book and/or field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*. Collection of sediment samples will be conducted according to TVA TI ENV-TI-08.80.50, *Soil and Sediment Sampling*.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will:

- Review applicable reference documents, including (but not limited to), TVA TIs (Section 5.2) and Standard Operating Procedures (SOPs), Quality Assurance Project Plan (QAPP; Appendix C), SAPs, and HASP.
- Complete required health and safety paperwork, field readiness checklist, and confirm Field Sampling Personnel have completed required training
- Coordinate activities with the Laboratory Coordinator, including ordering sample containers and preservatives (if required), obtaining coolers and analyte-free deionized (DI) water, and notifying the Laboratory Coordinator of sampling and sample arrival dates
- Coordinate activities with subcontractors
- Obtain required field equipment, including health and safety equipment and sediment sampling devices
- Complete sample paperwork to the extent possible, including chain-of-custody (COC) forms and sample labels
- Obtain ice prior to sample collection for sample preservation
- Complete utility locates and obtain excavation permit for VibeCore™ sample locations. An excavation permit is required prior to initiating any digging or boring at the Plant. A key component to the completion of the excavation permit is consensus on the sampling locations with pertinent TVA staff. Prior to initiating subsurface activities, subsurface utility clearance will be sought via the Plant engineering department and/or the TN 811 service. For locations within the Plant, engineering will provide primary utility clearance assurance

in addition to TN 811 being notified. At sampling locations where, underground obstructions or utilities are expected nearby, TVA or 3rd party underground locators will be engaged to clear sampling locations. For off-Plant sampling locations, utility avoidance assurance will be supplemented by the TN 811 service and the TVA or 3rd party underground locators.)

- Environmental Review as required by the National Environmental Policy Act (NEPA), must be completed to document and mitigate potential impact from the work described herein. The level of review required for this work is anticipated to be a categorical exclusion, which would be documented by TVA with a categorical exclusion checklist (CEC). A CEC has a number of signatories from TVA. It is understood that the environmental review is to be completed before implementation of the field work. Additionally, Plant staff will not issue an excavation permit ahead of the completed environmental review.)

5.2 SAMPLING METHODS AND PROTOCOL

Sampling and collection methods will be conducted in accordance with applicable TVA Technical Instructions, including:

- TI-05.80.02 *Sample Labeling and Custody*
- TI-05.80.03 *Field Record Keeping*
- TI-05.80.04 *Field Sampling Quality Control*
- TI-05.80.05 *Field Sampling Equipment Cleaning and Decontamination*
- TI-05.80.06 *Handling and Shipping of Samples*
- TI-08.80.50, *Soil and Sediment Sampling*

5.2.1 Sampling Method

Samples should be located based on project work control documents using a survey grade GPS unit. Sample locations will be documented in the field logbook in accordance with TVA TI ENV-TI-05.80.03, *Field Record Keeping*. Three-point anchoring may be required to stabilize the vessel during sampling.

5.2.1.1 Sediment Sampling

Sediment sampling will be conducted at the transect locations discussed in Section 4.0, with individual samples being collected perpendicular to flow from the right descending bank, the center of the channel, and the left descending bank at each transect. Sediment samples at each location will be collected in accordance with TVA TI ENV-TI-08.80.50, *Soil and Sediment Sampling* using a VibeCore™ vibration-driven sediment sampler. Refer to the TVA Gallatin *Standard Operating Procedure for Sediment Sampling* document (TVA-GAF-SOP-02) for additional information and guidelines regarding the use of VibeCore™ samplers. Sediment samples collected for analysis of PLM and the CCR parameters are to be collected from downstream to upstream in surface streams on or adjacent to the Plant to prevent the disturbance of bottom sediments from impacting further downstream sample locations.

If the sediment and surface stream sampling are conducted concurrently/during the same event, the surface stream sample will be collected before the associated sediment sample. This will minimize the possibility of water sample contamination from disturbance of sediments.

At each location, the VibeCore™ sampler with a properly decontaminated acrylic core tube will be advanced the full six-foot length of the core tube or until refusal. Upon retrieval, the core will be photographed against a prepared board containing a graduated scale and location information. The core will be inspected, and distinct horizons will be identified based on color, texture, etc. The core length and depth of horizon changes will be recorded in the field notes (logbooks and/or field forms). A sediment sample will be collected from the upper six inches of the collected sediment core at each location after thoroughly homogenizing the material. For each distinct horizon identified below six inches, the sediment will be portioned and homogenized to create a representative sample. Field Sampling Personnel wearing powder-free nitrile gloves will homogenize the samples using decontaminated high-density polyethylene (HDPE) containers and new disposable HDPE scoops. Field Sampling Personnel will first remove twigs, roots, leaves, rocks, and miscellaneous debris from the sample, then mix the sediment until the physical appearance is consistent over the entire sample. Once homogenized, an appropriate volume of sediment will be transferred into certified clean laboratory-supplied pre-labeled containers required for each analysis using the disposable HDPE scoops. Samples will not be collected for deeper sediment-free native soil samples if recovered. In the event sediment sample collection using the VibeCore™ sampler is not practical due to site conditions, attempts to collect sediment samples from the upper six inches using a Wildco™ Ponar Dredge or similar self-closing mechanical benthic sampling device may be conducted.

5.2.1.2 Benthic Community Sampling

Quantitative benthic invertebrate community sampling will be conducted using a Wildco™ Ponar Dredge or similar self-closing mechanical benthic sampling device in accordance with TVA Kingston *Standard Operating Procedure for Reservoir Benthic Macroinvertebrate Sampling* document (TVA-KIF-SOP-35). Adult and nymph mayfly samples will also be collected in accordance with TVA Kingston *Standard Operating Procedure for Mayfly Sampling* (TVA-KIF-SOP-29).

Self-closing mechanical benthic sampling devices use a spring-loaded system that releases when the sampler impacts the bottom and the lowering cable or line becomes slack, causing the scoops to close.

A transect will be established perpendicular to the direction of flow at the quantitative benthic invertebrate sampling locations discussed in Section 4.0. Five grab samples will be collected along each transect from the upper approximate six inches of sediment at each location. Approximate water depth and proportions of substrate types recovered will be recorded for each sample. Three attempts will be made to collect an adequate sample volume based on the judgement of the Field Sampling Personnel at each location. In the event an insufficient volume of sediment is recovered after three attempts, the failed attempts will be documented and no sample for quantitative benthic invertebrate analysis will be collected at that location. Benthic invertebrate sediment samples will be washed on a 500-micrometer screen using river water to remove finer material.

The remaining substrate will be photographed then transferred into individual sample containers along with the benthic organisms. The contents of each sample container will then be fixed with a 10% buffered formalin solution.

5.2.1.3 Mayfly Sampling

Adult and nymph mayfly samples will be collected in accordance with TVA Kingston *Standard Operating Procedure for Mayfly Sampling* (TVA-KIF-SOP-29). Mayfly nymphs will be collected from multiple random submerged locations within each area discussed in Section 4.0. The contents of the benthic sampling device from each mayfly nymph sampling location will be emptied onto a decontaminated stainless-steel sieve fitted with 2 millimeter or less stainless steel, Nitex, or Teflon mesh/netting then rinsed with river water to remove fine sediment particles and expose the nymphs. The nymphs will then be removed from the sieve using decontaminated stainless steel, plastic, or Teflon-coated forceps and placed into a decontaminated or dedicated plastic container filled with surface water from the Plant to allow preliminary removal of substrate adhering to the organisms. Nymphs that appear damaged (i.e. severed head/abdomen) will be discarded. Undamaged nymphs collected from each area will be randomly sorted into composite samples, with a minimum of 50 to 75 nymphs from each area required for both depuration and non-depuration. Nymphs collected for analysis without depuration of their gut contents will then be transferred into individual sample containers and held at temperatures less than 6 degrees Celsius (^{0}C) pending transport to the laboratory. Nymphs collected for depuration prior to laboratory analysis must be kept alive and handling stress to the nymphs must be minimized. Nymphs collected for depuration will be transferred into individual sample containers filled with water from the sampling location and placed in a cooler containing ice pending transport to the off-site laboratory or on-site processing location. To help regulate the temperature of the water in the sample containers containing the nymphs collected for depuration, the sample containers will be prevented from making direct contact with the ice in the coolers using packing material.

Adult mayflies will be opportunistically collected by direct removal from vegetation or other structures along the shoreline or by use of sweep nets. A minimum of 50 to 75 adult mayflies will be collected from each area discussed in Section 4.0. The adult mayflies from each area will be transferred to composite sample containers and held at temperatures less than 6 ^{0}C pending transport to the laboratory.

Issues that could affect the quality of samples will be recorded in the log book along with the action(s) taken to resolve the issue. These could include observations such as insufficient sediment recovery, partial sediment recovery, or defective materials or equipment. The sediment, quantitative benthic invertebrate and mayfly sampling methods described above may have to be modified based on conditions encountered in the field.

5.2.2 Field Equipment Description, Testing/Inspection, Calibration and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Field Team Leader, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by the Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP.

5.2.3 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVA TIs.

5.2.3.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.3.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks.

5.2.3.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COC forms will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality control (QC) check of samples in each cooler compared to sample IDs on the corresponding COC form. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.2.3.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.4 Collection of Samples

Once each sample container is filled, the rim and threads will be cleaned by wiping with a clean paper towel, capped, and a signed and dated custody seal will be applied. Each sample container will be checked to confirm that it is sealed, labeled legibly, and externally clean. Each sample container will be individually wrapped with bubble wrap, secured using tape or rubber bands, and placed in a re-sealable plastic bag.

Sediment samples collected will be submitted for analysis of percentage of ash. Sediment samples collected from 0 to 6 inches deep will also be submitted for analysis of the CCR parameters. All deeper sediment samples collected for analysis of the CCR parameters will be held pending the results of the Phase 1 analyses.

Benthic invertebrate samples will be submitted for quantitative taxonomic analysis of community structure. Mayfly samples will be submitted for analysis of metals included in the CCR parameters list (excluding radium). Mayfly nymph samples must be processed in the off-site laboratory or on-site processing location within 24 hours of sample collection, and mayfly nymphs collected for depuration must be kept alive and handling stress to the nymphs must be minimized. Refer to TVA-KIF-SOP-29 for further details.

Samples will be separated as described above and shipped to the following:

- Sediment samples collected for percentage of ash analysis will be submitted to the RJ Lee Group in Monroeville, Pennsylvania.

- Sediment samples collected for analysis of the CCR parameters (including samples being held pending the results of the Phase 1 analyses) will be submitted to TestAmerica in Pittsburgh, Pennsylvania.

- Benthic invertebrate samples collected for quantitative analysis will be submitted to Pennington and Associates, Inc. in Cookeville, Tennessee.

- Mayfly samples collected for analysis of metals included in the CCR parameters list (excluding radium) will be submitted to Pace Analytical in Minneapolis, Minnesota.

- Mayfly samples designated for depuration prior to laboratory analysis will be submitted to Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee or will be processed at an on-site location. Upon completion of the depuration process at ORNL or on-site the samples will be submitted to Pace Analytical in Minneapolis, Minnesota.

Coolers will be prepared for shipment in accordance with TVA TI ENV-TI-05.80.06 *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright position.

Small uniformly sized containers (such as 4-ounce or 8-ounce soil jars) will be stacked in an upright configuration and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory. Samples will be held at temperatures less than 6 °C during shipment. The cooler will be filled with packing material to secure the containers during transport.

The original COC form will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC form will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC form and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC form. If multiple coolers are required to ship samples contained on a single COC form, then the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e. strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC form. If there are discrepancies the Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Project Manager.

5.2.5 Sample Analyses

All sediment samples will be submitted for analysis of percentage ash using PLM. The top six inches of each sediment sample will also be submitted for analysis of the CCR parameters. The CCR parameters are summarized in Table 5 through 7. The quantitative benthic invertebrate samples will be submitted for processing during which the specimens will be identified and enumerated to the lowest practical taxonomic level. The total number of each taxa will be tallied and used to generate benthic invertebrate community metrics needed to quantify aspects of community structure. The mayfly samples will be submitted for analysis of metals included in the CCR parameters list (excluding radium). Select mayfly nymph samples will have their digestive systems depurated before analysis.

Table 8 provides the analytical laboratory methods, preservation requirements, sample containers and holding times for the PLM analysis, CCR parameters, benthic invertebrates, and mayflies. Additional sampling and laboratory-specific information is covered in more detail in the QAPP.

Table 5. 40 CFR Part 257 Appendix III Constituents

Appendix III Constituents
Boron
Calcium
Chloride *
Fluoride *
pH *
Sulfate *

*Not included in mayfly tissues analyses

Table 6. 40 CFR Part 257 Appendix IV Constituents

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride *
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 Combined *

*Not included in mayfly tissues analyses

Table 7. TN Rule 0400-11-01-.04, Appendix 1 Inorganic Constituents

TDEC Appendix 1 Constituents*
Copper
Nickel
Silver
Vanadium
Zinc
Strontium **

* Constituents not listed in CCR Appendices III and IV

** Constituent not included in TDEC regulations but included in sampling program

Table 8. Analytical Methods, Preservation, Container(s) and Holding Times

Constituent	Analytical Method	Preservative(s)	Container(s)	Holding Time
Percent ash	PLM	NA	4 oz. glass jar	NA
Metals	SW-846 6020A	Cool to < 6° C	4 oz. glass jar	180 days
Mercury	SW-846 7471B	Cool to < 6° C	4 oz. glass jar	28 days
Radium 226	SW-846 901.1	Cool to < 6° C	One 16 oz. widemouth glass jar for both Ra 226 and 228 samples	180 days
Radium 228	SW-846 901.1	Cool to < 6° C	See Ra 226 above	180 days
Chloride	SW-846 9056A Modified	Cool to < 6° C	4 oz. glass jar	28 days
Fluoride	SW-846 9056A Modified	Cool to < 6° C	4 oz. glass jar	28 days
Sulfate	SW-846 9056A Modified	Cool to < 6° C	4 oz. glass jar	28 days
pH	SW-846 9045D	Cool to < 6° C	4 oz. glass jar	NA*
Benthic Invertebrates	NA	10% buffered formalin solution	16 oz./32 oz. glass jars	NA
Non-depurated Mayfly Nymphs	SW-846 6020A	Cool to < 6° C	4 oz. glass jar	24 hours**
Depurated Mayfly Nymphs	SW-846 6020A	Surface water, cool to < 6° C	32 oz. glass jar	24 hours**
Adult Mayflies	SW-846 6020A	Cool to < 6° C	32 oz. glass jar	24 hours**

* Holding time for sediment pH samples is 15 minutes following creation of sediment paste. Sediment samples submitted for laboratory analysis of pH will have paste prepared in the laboratory so that analysis can be completed within the holding time.

**Additional laboratory preparation required upon receipt.

5.2.6 Equipment Decontamination Procedures

Decontamination procedures will be conducted in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*. The following procedures will be used to maintain the overall objective of minimizing the potential for cross-contaminating samples and media during sampling activities. Sampling equipment will be cleaned before transport to the field. When appropriate or practical, disposable sampling equipment will be utilized in the field.

However, non-dedicated and non-disposable equipment used for sampling is to be decontaminated prior to and after each use. Equipment that comes into direct contact with sediment samples for laboratory analyses will undergo decontamination between each use that will include the following steps:

- Wash with non-phosphate detergent (e.g., LiquiNox™) and analyte-free deionized (DI) water solution
- Rinse multiple times with analyte-free DI water
- Air drying

Equipment decontamination is not critical when sampling benthic invertebrates and mayflies. The Ponar Dredge and associated equipment will be rinsed with river water to confirm that all debris is removed from each between sampling locations.

Equipment will be placed in a clean trash bag or other separate container during transport to prevent cross-contamination. Equipment that is not fully decontaminated prior to leaving the Plant will be properly disposed or wrapped and stored to prevent contamination of other equipment until it can be properly decontaminated. Decontamination activities will be documented in the field book or on a field data sheet. Additional information regarding equipment decontamination procedures is located in the QAPP.

5.2.7 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Sediment and debris
- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*, the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/QC requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to benthic sampling and analysis.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to confirm that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation project Manager considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Three types of field QA/QC samples will be collected during sampling activities: field duplicate samples, MS/MSD samples, and equipment blanks. QA/QC samples will be collected in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control*. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below. A complete description of the QA requirements is provided in the QAPP.

Field Duplicate Samples – One duplicate sediment sample will be collected for every twenty sediment samples or once per sampling event. Duplicates samples will be prepared as blind duplicates and will be collected by splitting the homogenized sample volume into two sets of identical, laboratory-prepared sample bottles. One duplicate composite sample of mayflies per type (i.e. adult, depurated nymph, and non-depurated nymph) will be collected per sampling event. Duplicate samples will be prepared as blind duplicates and will be collected by dividing a composite sample into approximate equal numbers of whole individuals collected from one area.

For each duplicate sample collected of each type, one set of samples will be given the sample identifier indicative of the sample location, and the second set of sample bottles will be simply labeled as DUP1, DUP2, etc. followed by the collection date, as further defined below in Section 6.2.1. Sample identifier information will not be used to identify the duplicated samples. Actual sample identifiers for duplicate samples will be noted in the field logbook. The duplicate sample will be analyzed for the same parameters as the primary sample.

MS/MSD Samples – Matrix spike samples will be collected to assess the effects of matrix on the accuracy and precision of the analyses. One MS/MSD sediment sample will be collected for every twenty sediment samples collected. MS/MSD samples will be collected by splitting the homogenized sample volume into three sets of identical, laboratory-prepared sample bottles. Samples designated in the field to be processed as the MS/MSD, for which extra sample volume will be collected, must be identified as such (i.e., "MS/MSD") in the comments field on the COC records and sample labels. The sample locations will be noted in the log book. The MS/MSD sample will be analyzed for the same analytes as the primary sample, with exception of parameters that are not amenable to MS/MSD (e.g., pH, radium-226, radium-228).

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected during each day of the sediment sampling activities. The sediment sampling equipment blank will be collected at a sediment sampling location by pouring laboratory-provided DI water into or over the decontaminated sampling equipment, then into the appropriate sample containers. The locations of collecting the equipment blanks will be noted in the log book.

Field quality control samples are not germane to quantitative benthic invertebrate sampling. Quality control will be assessed by the laboratory by recounting and re-keying a subset of samples and comparing the results to the primary analysis.

6.2.1 Sample Labels and Identification System

Sample IDs will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*. Each sample container will have a sample label affixed and secured with clear package tape as necessary to prevent label removal. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Phase 2 retained samples will be documented on a separate COC form from Phase 1 samples. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

PLM data will not be subjected to data validation due to the specialized training and equipment required to accurately visually quantitate ash. PLM data will be subjected to verification including a review of QC analyses and a reasonability assessment based on photomicrographs included in the data package.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP. The overall project schedule may be adjusted to reflect seasonal restrictions to when SAPs can be implemented. Approval of the final EIP will dictate the actual start and completion dates on the project timeline.

Table 9. Preliminary Schedule for Phase 1 Benthic SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Benthic SAP Submittal		Completed
Prepare for Field Activities	30 Days	Following EIP Approval
Conduct Field Activities	210 Days*	Following Field Preparation
Laboratory Analysis	90 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

* Mayfly nymph anticipated sampling in May/June, mayfly adult anticipated sampling in June/July (after adult mayflies begin emerging), sediment anticipated sampling in August, and benthic invertebrate community anticipated sampling in October/November.

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- The number and/or location of the proposed samples described in this SAP may have to be modified based on conditions encountered in the field. Any deviations from this SAP will be documented in the EAR.
- The sediment, quantitative benthic invertebrate, and mayfly sampling methods described in this SAP may have to be modified based on conditions encountered in the field. Any deviations from this SAP will be documented in the EAR.
- The anticipated schedule in Section 7.0 assumes that approval to proceed is provided such that sampling can be scheduled and conducted during the appropriate time of the year. If approval to proceed is received too late in the year, sampling will not proceed until the following year.

9.0 REFERENCES

Tennessee Valley Authority (TVA). 2013. "TVA Kingston Standard Operating Procedures – TVA-KIF-SOP-35 Standard Operating Procedure for Reservoir Benthic Macroinvertebrate Sampling, Rev 1." August.

Tennessee Valley Authority (TVA). 2015. "TVA Kingston Standard Operating Procedures – TVA-KIF-SOP-29 Standard Operating Procedure for Mayfly Sampling, Rev 2." March.

Tennessee Valley Authority (TVA). 2016. "TVA Gallatin Standard Operating Procedures – TVA-GAF-SOP-02 Standard Operating Procedure for Sediment Sampling, Rev 0." July.

Tennessee Valley Authority (TVA). 2017a. "Sample Labeling and Custody." Technical Instruction ENV-TI-05.80.02, Revision 0001. March 31.

Tennessee Valley Authority (TVA). 2017b. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017c. "Field Sampling Quality Control." Technical Instruction ENV-TI-05.80.04, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017d. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017e. "Handling and Shipping of Samples." Technical Instruction ENV-TI-05.80.06, Revision 0000. March 31.

Tennessee Valley Authority TVA. 2017f. "*Soil and Sediment Sampling*." Technical Instruction ENV-TI-05.80.50, Revision 0000. September 29.

ATTACHMENT A
FIGURES

Figure No.
1

Title
Sediment Sampling Locations

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

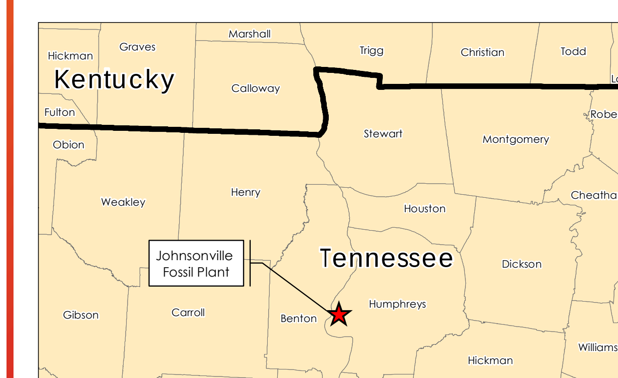
175567296
Prepared by LMB on 2018-01-09
Technical Review by ZW on 2018-01-09

0 800 1,600 2,400 3,200 Feet
1:9,600 (At original document size of 22x34)

Legend

- Sediment Sampling Transect
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemaps



Stantec
TVA

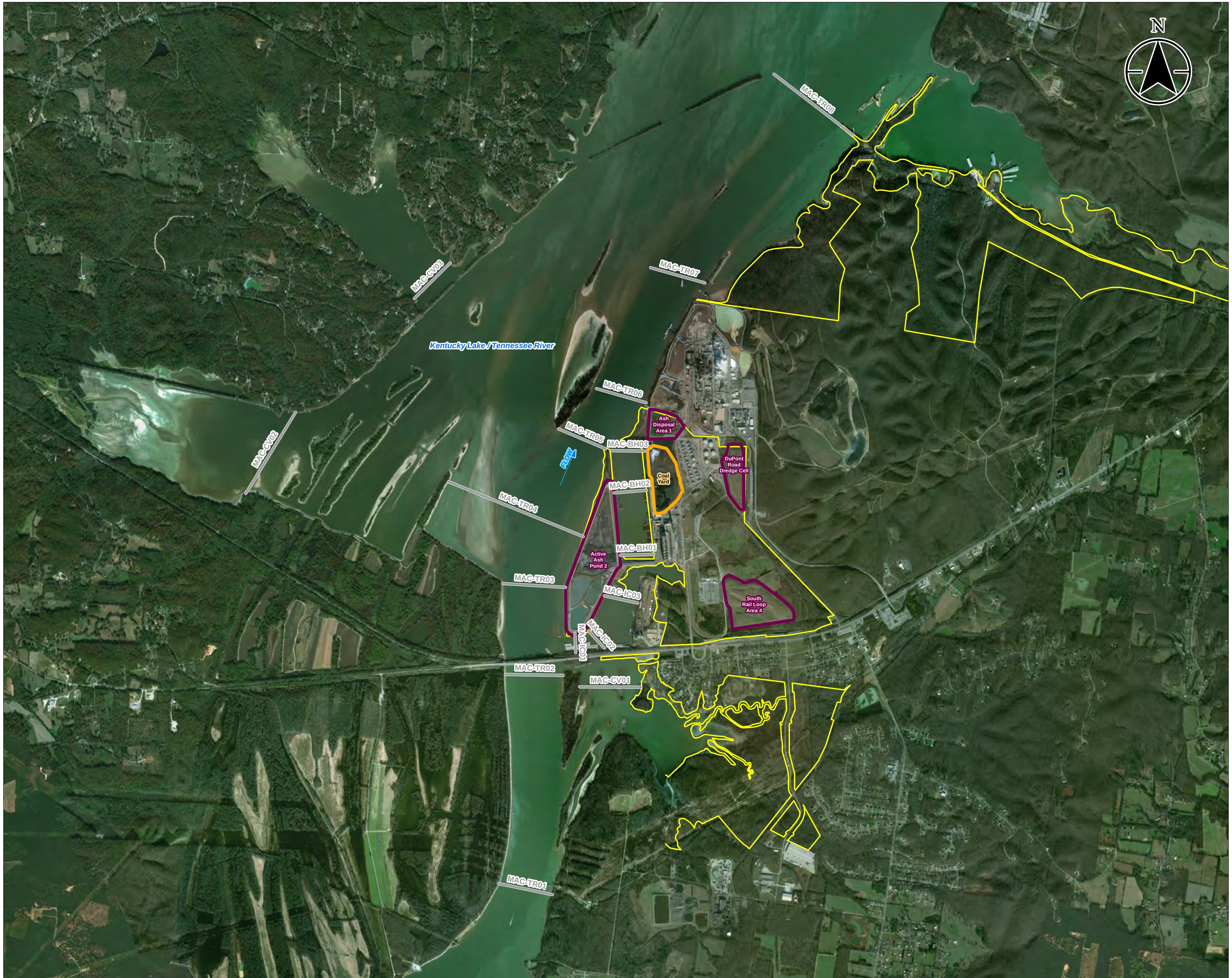


Figure No.
2

Title

Benthic Macroinvertebrates Sampling

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location

New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-09
Technical Review by ZW on 2018-01-09

0 1,500 3,000 4,500 6,000 Feet

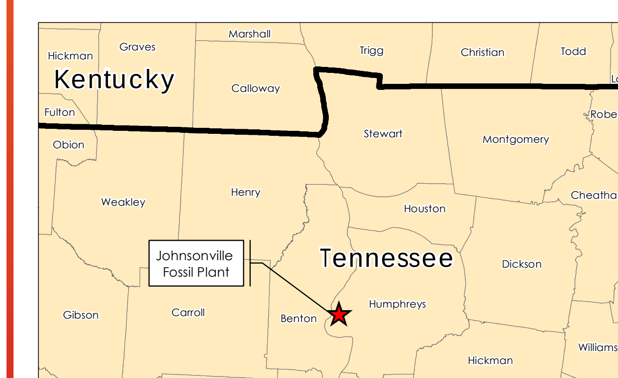
1:18,000 (At original document size of 22x34)

Legend

- Transect
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemaps



Stantec TVA

U:\TVA-EIP\175567296\gis\mxds\JOF_Benthic_Transects.mxd Revised: 2018-01-09 By: mbough

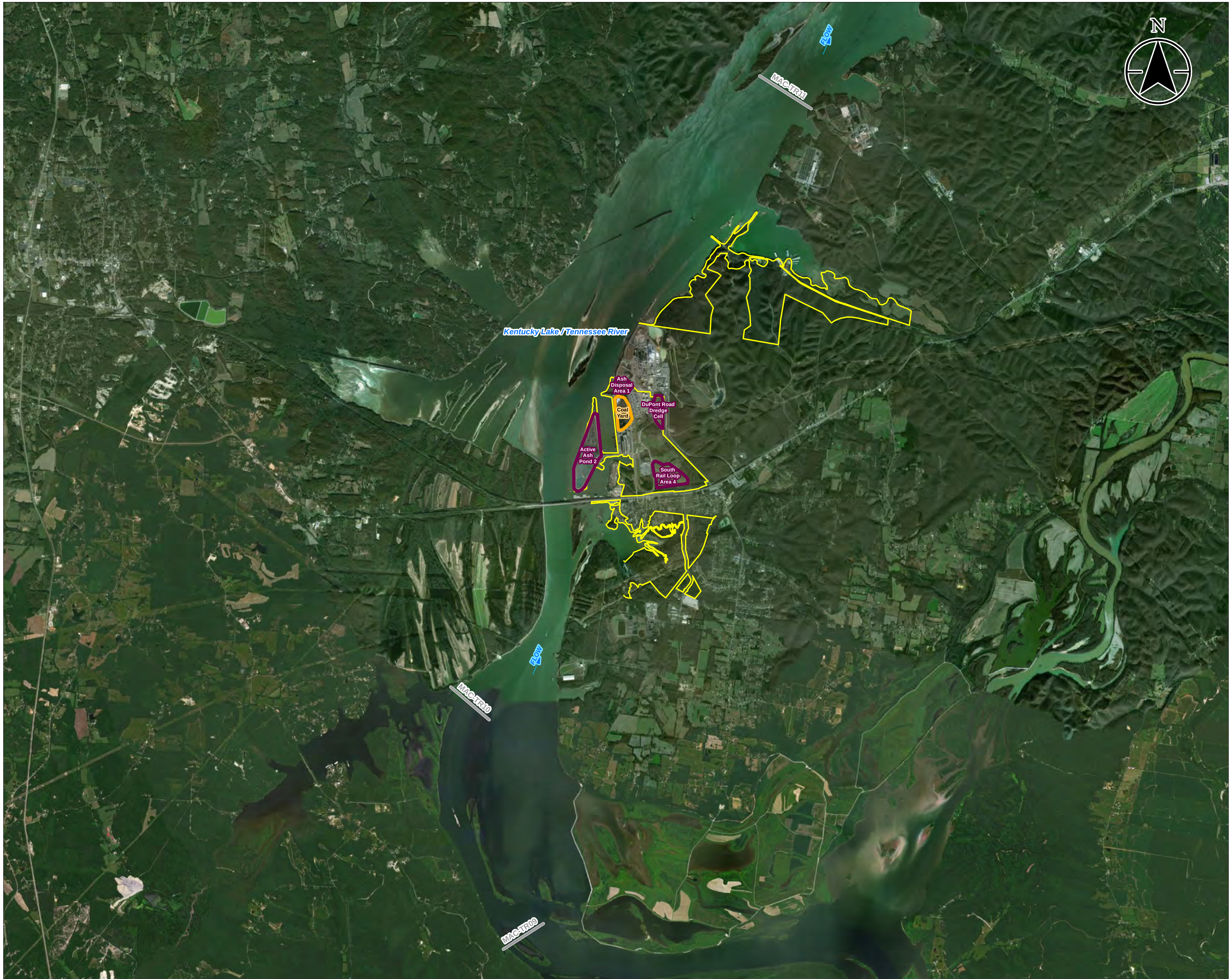


Figure No.
3

Title
Off-Site Benthic Macroinvertebrates Sampling

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

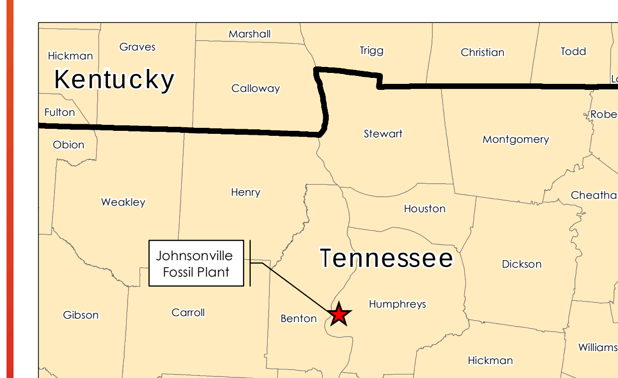
175567296
Prepared by LMB on 2018-01-09
Technical Review by ZW on 2018-01-09

0 3,000 6,000 9,000 12,000 Feet
1:36,000 (At original document size of 22x34)

Legend

- Transects
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemaps



Stantec TVA

Figure No.
4

Title
Mayfly Sampling
Adult Mayflies, Purated Mayfly Nymphs, & Non-Purated Mayfly Nymphs

Client/Project

Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

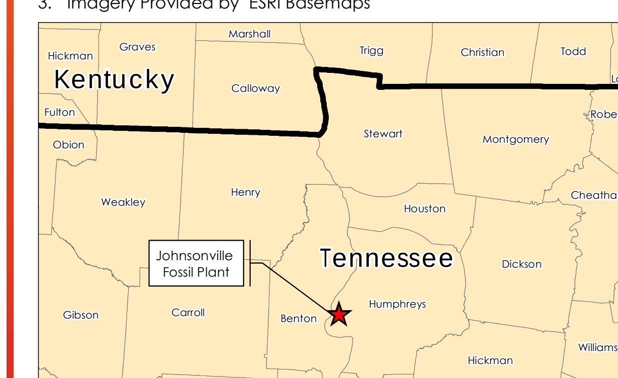
175567296
Prepared by LMB on 2018-01-10
Technical Review by ZW on 2018-01-10

0 3,000 6,000 9,000 12,000 Feet
1:36,000 (At original document size of 22x34)

Legend

- Mayfly Sample Location
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes
1. *** Adult Mayflies, Purated Mayfly Numphs, and Non-Purated Mayfly Nymphs; sampled at each location, samples at each location will have a unique ID sample Biota Matrix Code (MFA, MFP, MFN respectively).
2. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
3. Imagery Provided by ESRI Basemaps



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ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Benthic Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment
Boat
Boat Motor
Paddles
Anchor
Marine Engine Oil
Boat Gas Tank
PFDs
Marine VHF Radio
Wildco™ Ponar Dredge
Prepared board containing a graduated six-foot scale
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
10% buffered formalin solution
Integrated Spout Wash Bottle
500 micrometer screen
Decontaminated HDPE containers and new lab-certified HDPE scoops
Stainless steel sieve fitted with 2 millimeter or less stainless steel, Nitex, or Teflon mesh/netting
Stainless steel, plastic, or Teflon-coated forceps
Sweep nets
***These items are detailed in associated planning documents to avoid redundancy.**

APPENDIX S
SEEP SAP

Seep
Sampling and Analysis Plan
Johnsonville Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Johnsonville Fossil Plant
New Johnsonville, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 10, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	July 24, 2017
1	Addresses October 19, 2017 TDEC Review Comments and Issued for TDEC Review	January 12, 2018
2	Addresses March 9, 2018 TDEC Review Comments and Issued for TDEC Review	May 11, 2018
3	Addresses June 11, 2018 TDEC Review Comments and Issued for TDEC Review	July 20, 2018
4	Addresses comments and revisions from other EIPs and issued for TDEC review.	December 10, 2018

SEEP
SAMPLING AND ANALYSIS PLAN
JOHNSONVILLE FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Seep
Sampling and Analysis Plan
Johnsonville Fossil Plant
Tennessee Valley Authority
New Johnsonville, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 10, 2018 Revision 4, Final

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager — 12/6/18 Date

TVA Investigation Field Lead — 12/6/18 Date

Health, Safety, and Environmental (HSE) Manager — 12/05/2018 Date

Investigation Project Manager — 12/7/2018 Date

Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.12.03 11:53:45 -05'00'
QA Oversight Manager — Date

Laboratory Project Manager — 12-4-18 Date

Charles L. Head
TDEC Senior Advisor — Date

Robert Wilkinson
TDEC CCR Technical Manager — Date

Stantec

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LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order), to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Johnsonville Fossil Plant (JOF) on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management at JOF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC submitted a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 24, 2017, TVA submitted JOF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

TVA has developed this Seep Sampling and Analysis Plan (SAP) to provide procedures and methods necessary to evaluate whether dissolved CCR material is present in surface streams on or adjacent to the JOF Plant (Plant). This Seep SAP presents a phased approach and plan to sample water from seeps along surface impoundments and landfills at the Plant.

2.0 OBJECTIVES

The objectives of this Seep SAP are to identify and characterize active seeps at the Plant for CCR constituents and identify information that may explain and/or assess the potential movement of groundwater/pore water with dissolved CCR constituents into surface water streams on or adjacent to the Plant, through seepage.

This Seep SAP will provide the procedures necessary to identify and conduct the sampling and analysis of water from active seeps, along with soil samples from the same active seep area.

Proposed sampling locations are discussed in Section 4.0. Field activities will include the following tasks:

- Conduct a seep investigation to identify active seeps, if any, that could potentially discharge to adjacent surface water bodies
- Document the location of identified active seeps using a sub-meter global positioning system (GPS) device
- Use the GPS data to identify seeps on the seep sampling location map
- Collect surface water samples from active seeps
- Collect soil samples from active seeps
- Package and deliver samples to the laboratory for analyses of CCR Parameters

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLING LOCATIONS

Figures 1-4 (Attachment A) illustrates the locations of historic seeps at the Plant. Sampling locations will be based on the identification of active seeps at the impoundments and landfills, with locations verified in the field using GPS. Water and soil samples will be taken at each active seep location. A list of the identified active seep(s) will be included in Table 1, Proposed Seep Sampling Locations, and the completed table will be included in the Environmental Assessment Report (EAR).

Table 1. Proposed Seep Sampling Locations

Sample Location ID	Description
e.g., SeS01	(To be determined)
e.g., SeS02	(To be determined)
e.g., SeW01	(To be determined)
e.g., SeW02	(To be determined)

SeS – Seep Soil; SeW – Seep Water

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to prepare for field activities, collect samples, and assist in providing scientifically defensible results.

Seep water sample collection will adhere to TVA Environmental Technical Instruction (TI) documents. The seep water sampling will be conducted in accordance with TVA TI EMA-TI-05.80.40, *Surface Water Sampling*, which references other TIs that are applicable to various aspects of surface water sampling.

A project field book and field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be planned in accordance with TVA TI ENV-TI-05.80.01 *Planning Sampling Events* and documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

Both soil and water samples (provided flow is available), will be collected at each active seep location. Soil samples will be collected provided the seep occurs from soils and not rock. Soil samples will be collected as a five-point composite from within the saturated soil area and will be conducted according to TVA TI ENV-TI-05.80.50, *Soil and Sediment Sampling*. If required for access to seeps, any removal of aggregate and riprap filters at repaired seep locations will be coordinated through TVA prior to sampling. Seep surface water samples will be collected provided flow is adequate to obtain sufficient sample volume. Due to anticipated high turbidity conditions of seep surface water samples, both field-filtered samples and unfiltered surface water samples will be taken from active seeps. The purpose of field filtering is to obtain a sample that is representative of dissolved constituents in the seepage fluid; unfiltered seep surface water samples will be taken for comparative purposes.

Seep soil and seep water samples will be analyzed for the CCR Parameters listed in Section 5.3.5.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will:

- Designate a Safety Officer
- Review applicable reference documents, including (but not limited to), TVA TIs (Section 5.5) and Standard Operating Procedures (SOPs), Quality Assurance Project Plan (QAPP; Appendix C), SAPs, and HASP.
- Complete required health and safety paperwork, field readiness checklist, and confirm field team members have completed required training

- Coordinate activities with the Laboratory Coordinator, including ordering sample bottles with contained preservatives (as required), obtaining coolers and analyte-free deionized water, if needed, and notifying the laboratory of sampling and sample arrival dates

- Obtain required calibrated field instruments, including health and safety equipment

- Perform environmental review prior to sampling – as required by the National Environmental Policy Act (NEPA), an environmental review must be completed to document and mitigate any potential impact of the work described herein. The level of review required for this work is anticipated to be a categorical exclusion, which would be documented by TVA with a categorical exclusion checklist (CEC). A CEC has a number of signatories from TVA.

- Complete sample paperwork to the extent possible, including chain-of-custody forms and sample labels in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping.*

- Obtain decontamination materials, including scrub brushes, soap, solvents, buckets, and deionized (DI) water, as indicated in TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*.

- Obtain ice prior to sample collection for sample preservation

5.2 SEEP INVESTIGATION

As outlined in the EIP, a one-time seep investigation will be conducted to identify active seeps that do not flow through a permitted National Pollutant Discharge Elimination System (NPDES) outfall, are not permitted as an NPDES outfall, and have the potential to discharge into the adjacent surface streams. Known locations of historic seeps, inspection reports, and any other related information will be utilized in the identification of active seeps. If active seeps in this area are discovered, their locations will be staked in the field and shown on a Seep Sampling Location(s) map.

In order to evaluate seeps not visible due to structural mitigation activities (e.g., rip rap), the following investigative protocol will be used:

1. Field testing shall be conducted at the point where water from a seep(s) most likely enters a stream. TVA shall use a boat to monitor the stream channel and surface water at the water's edge.

2. Field testing will be conducted for pH, temperature, dissolved oxygen, and conductivity using a multiparameter Sonde.

3. If field testing indicates a significant difference between stream channel samples and samples adjacent to the stream bank, then TVA shall determine if there is a flow from the seep.

4. If the seep is covered with rock or other material, the material shall be removed to determine if there is flow from the seep. [Note: additional work order will be required to remove rip rap.]

5. If there is flow from the seep, then the seep shall be sampled and analyzed for the CCR parameters.

Should active seeps be discovered during the investigation, a seep sampling location map will be finalized, and seep sampling will be implemented in accordance with Section 5.3.

5.3 SAMPLING METHODS AND PROTOCOL

Samples will be analyzed for CCR constituents listed in 40 CFR Part 257, Appendices III and IV. However, five inorganic constituents listed in Appendix 1 of TN Rule 0400-11-01-.04 (i.e., TDEC regulations), and not included in the federal CCR Appendices III and IV, have been added to the list of CCR constituents for analyses to maintain continuity with other TDEC environmental programs. Those additional constituents include the following metals: copper, nickel, silver, vanadium, and zinc. The combined federal CCR Appendices III and IV constituents, and TDEC Appendix 1 inorganic constituents, will hereafter be referred to collectively as "CCR Parameters."

Seep soil and surface water samples will be collected once and then submitted to the laboratory for the chemical analysis of the CCR Parameters. Various means and methods for collecting seepage water will be used based on the location and flow of the seep. Sampling and collection methods will be conducted in accordance with applicable TVA TIs, including:

- ENV-TI-05.80.01, *Planning Sampling Events*
- ENV-TI-05.80.02, *Sample Labeling and Custody*
- ENV-TI-05.80.03, *Field Record Keeping*
- ENV-TI-05.80.04, *Field Sampling Quality Control*
- ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*
- ENV-TI-05.80.06, *Handling and Shipping of Samples*
- EMV-TI-05.80.40, *Surface Water Sampling*
- ENV-TI-05.80.46, *Field Measurement Using a Multiparameter Sonde*
- ENV-TI-05.80.50, *Soil and Sediment Sampling*

5.3.1 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Field Team Leader, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use.

Additional information regarding field equipment inspection and testing is included in the QAPP (Appendix C).

5.3.2 Field Documentation

Field documentation will be maintained in accordance with TVA TI *ENV-05.80.03, Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.3.2.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.3.2.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks.

5.3.2.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COC forms will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality control (QC) check of samples in each cooler compared to sample IDs on the corresponding COC form. The Investigation Project Manager will staff the project with a field sample manager during sample collection activities. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.3.2.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.3.3 Collection of Samples

5.3.3.1 Seep Soil Sample Collection

Seep soil samples will be collected from surface soils as a five-point composite from within the saturated soil area in accordance with TVA TI ENV-TI-05.80.50, *Soil and Sediment Sampling*. Five surface soils will be collected from discolored areas in the seep areas using a dedicated or decontaminated trowel (or similar tool) or disposal sampling scoop and placed in a re-sealable dedicated plastic bag or decontaminated glass or plastic bowl for compositing. The collected sample will be homogenized until the physical appearance is consistent over the entire sample. After homogenization, a sample will be collected from the mixed soil and placed in the appropriate laboratory-supplied sampling container. Seep soil samples will be submitted to the laboratory for the chemical analysis of the CCR Parameters. Any free water issues will be addressed by the laboratory.

5.3.3.2 Seep Water Sample Collection

Seep water samples will be collected from active seep locations at impoundments and landfills provided flow is adequate to obtain sufficient sample volume, as defined and required by the laboratory. A seep water sample will be collected by directly filling a properly decontaminated sampling device or clean, non-preserved laboratory container from the seep area, and transferring the seep surface water to an appropriate laboratory-supplied and preserved, sampling container for analysis of CCR Parameters listed in Section 5.3.5. Due to the expected high turbidity of seep surface water samples, a second sample of water from each location will be field filtered using a peristaltic pump and a new, certified clean 0.45-micron filter and placed in an appropriate laboratory-supplied and preserved, sampling container for analysis of dissolved constituents. The purpose of field filtering is to obtain a sample that is representative of the dissolved constituents in the seepage itself. In instances where a non-preserved laboratory supplied bottle is used as the transfer container, the transfer container will only be used at that seep location, properly disposed, and will not be used for sampling at other seeps, unless properly decontaminated. A handheld calibrated pH meter will be used to collect pH data at each seep water sample location.

At locations where the surface water stream is not deep enough to directly fill the sampling device or transfer bottle, but a small area of "pooling" is occurring, a peristaltic pump with new, certified clean tubing or a pipette with a bulb may be viable collection options, if recharge is adequate. Collection options are dependent upon field conditions and every effort will be made to collect viable water samples from the seep locations. Filtered and unfiltered seep surface water samples will be submitted to the laboratory for the chemical analysis of CCR Parameters listed in Section 5.3.5.

5.3.4 Preservation and Handling

Sample containers will be labeled in accordance with TVA TI ENV-05.80.02, *Sample Labeling and Custody.* Once each sample container is filled, the rim and threads will be cleaned by wiping with a clean paper towel and capped, and a signed and dated custody seal will be applied. Each sample container will be checked to confirm that it is sealed, labeled legibly, and externally clean. Sample containers will be packaged in a manner to prevent breakage during shipment.

Coolers will be prepared for shipment in accordance with TVA TI ENV-TI-05.80.06, *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright position. Small uniformly sized containers will be stacked in an upright configuration and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory. Loose ice will be placed around and among the sample containers to cool the samples to less than 6 degrees Celsius (°C) during shipment. The cooler will be filled with additional packing material to secure the containers.

The original COC form will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC form will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC form and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC form. If multiple coolers are required to ship samples contained on a single COC form, then the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e., strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC form. If there are discrepancies the Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Project Manager.

5.3.5 Sample Analyses

Samples will be submitted to the TVA-approved laboratory for analysis per the QAPP. Both soil and water samples will be analyzed for the CCR Parameters, while filtered and unfiltered water samples will also be evaluated for dissolved and total constituents, respectively. Tables 2, 3, and 4 summarize the listed constituents. Analytical methods, preservation, containers(s) and holding times are presented in Table 5. Additional sampling and laboratory-specific information is covered in more detail in the QAPP.

Table 2. 40 CFR Part 257, Appendix III Constituents

Appendix III Constituents
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids (TDS)

* Add TSS for aqueous unfiltered sampling

Table 3. 40 CFR Part 257, Appendix IV Constituents

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 Combined

Table 4. TN Rule 0400-11-01-.04, Appendix 1 Inorganic Constituents

TDEC Appendix 1 Constituents*
Copper
Nickel
Silver
Vanadium
Zinc

* Constituents not listed in CCR Appendices III and IV

Table 5. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Metals, dissolved	SW-846 6020A	HNO3 to pH < 2; & Cool to <6°C	250-mL HDPE	180 days
Metals, total	Liquid & Solid - SW-846 6020A	HNO3 to pH < 2 & Cool to <6°C; Cool to <6°C	250-mL HDPE; 4-oz glass (soil)	180 days
Mercury, dissolved	SW-846 7470A	HNO3 to pH < 2 & Cool to <6°C	250-mL HDPE	28 days
Mercury, total	Liquid - SW-846 7470A; Solid - SW-846 7471B	HNO3 to pH < 2 & Cool to <6°C; Cool to <6°C	250-mL HDPE; 4-oz glass (soil)	28 days
Radium 226	Liquid - SW-846 903.0; Solid - SW-846 901.1	HNO3 to pH < 2 & Cool to <6°C; Cool to <6°C	1 L glass or Plastic; One 16-oz widemouth glass jar (soil) for both Ra 226 and 228 samples	180 days
Radium 228	Liquid - SW-846 904.0; Solid - SW-846 901.1	HNO3 to pH < 2 & Cool to <6°C; Cool to <6°C	2 L glass or plastic; See Ra 226 above for soil.	180 days
Chloride	Liquid - SW-846 9056A; Solid - SW-846 9056A Modified	Cool to <6°C; Cool to <6°C	250-mL HDPE; 4-oz glass (soil)	28 days

Table 5. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Fluoride	Liquid - SW-846 9056A; Solid - SW-846 9056A Modified	Cool to <6°C; Cool to <6°C	250-mL HDPE; 4-oz glass (soil)	28 days
Sulfate	Liquid - SW-846 9056A; Solid - SW-846 9056A Modified	Cool to <6°C; Cool to <6°C	125-mL HDPE; 4-oz glass (soil)	28 days
Total Dissolved Solids (TDS)	SM2540C	Cool to <6°C	250-mL HDPE	7 days
Total Suspended Solids (TSS)	SM2540C	Cool to <6°C	1 L HDPE	7 days
pH	Liquid - SW-846 9040C (field measurement); Solid - SW-846 9045D	NA	NA (liquids); 4-oz glass (soil)	NA*

*The pH of water samples will be measured in the field. Holding time for soil pH samples is 15 minutes following creation of soil paste. Soil samples will be tested in the field using field pH test kits, 10% of the sample locations will have confirmation samples submitted for laboratory analysis of pH and will have paste prepared in the laboratory so that analysis can be completed within the holding time.

5.3.6 Equipment Decontamination Procedures

Documented decontamination will be performed for sampling equipment and instruments in contact with water or subsurface materials in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination.

Following decontamination, fluids will be placed into a drum for storage, transportation, and ultimately disposal in accordance with Section 5.3.7. Decontamination activities will be performed away from surface water bodies and areas of potential impacts. Decontamination of non-disposable sampling equipment or instruments can be performed using water and Liquinox® or other appropriate non-phosphatic detergent in 5-gallon buckets.

Decontamination of sampling equipment and instruments (e.g., water level meters, etc.) will be performed prior to use and between sampling locations. Decontamination activities will be documented in the logbook field notes. Additional information regarding equipment decontamination procedures is in the QAPP.

5.3.7 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*, the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to pore water sampling and analysis.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to confirm that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Project Manager considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Five types of field QA/QC samples will be collected during sampling activities: field duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, equipment blanks, field blanks, and filter blanks. QA/QC samples will be collected in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control*. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below. A complete description of the QA requirements is provided in the QAPP.

Field Duplicate Samples – One duplicate sample will be collected for every 20 samples or once per sampling event. Duplicates samples will be prepared as blind duplicates and will be collected in two sets of identical, laboratory-prepared sample bottles. The primary and duplicate samples will be labeled according to procedure in Section 6.2.1. Sample identifier information will not be used to identify the duplicated samples. Actual sample identifiers for duplicate samples will be noted in the field logbook. The duplicate sample will be analyzed for the same parameters as the primary sample.

MS/MSD Samples – A sufficient volume of sample will be collected for use as the MS/MSD. MS/MSD samples will be collected to allow matrix spike samples to be run to assess the effects of matrix on the accuracy and precision of the analyses. One MS/MSD sample will be analyzed for every 20 samples collected or once per sampling event. MS/MSD samples will be collected by filling bottles alternately by thirds in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control* into three sets of identical, laboratory-prepared sample bottles.

Additional sample volume intended for use as the MS/MSD must be identified in the comments field on the COC records and sample labels. The location of sample collection will be noted in the log book. The MS/MSD sample will be analyzed for the same analytes as the primary sample, with exception of parameters that are not amenable to MS/MSD. For parameters such as Total Suspended Solids and radium that are not amenable to the MS/MSD procedure, additional sample volume will be collected for laboratory duplicate analysis per the QAPP.

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected for each sampling event. The equipment blank will be collected at a sampling location by pouring laboratory-provided deionized water into or over the decontaminated sampling equipment, then into the appropriate sample containers. The time and location of collecting the equipment blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the equipment blank is prepared. If the tubing used to collect the filter blank is not certified clean tubing, then a tubing blank will be collected at a frequency of blank per lot.

Field Blanks: One field blank sample will be prepared per day using laboratory-supplied deionized water. The sample will be analyzed for the same analytes, with the exception of pH.

Filter Blanks – One filter blank will be collected during each day of the sampling activities when dissolved parameters are collected for analysis. The filter blank will be collected at a sampling location by passing laboratory-supplied deionized water through in-line filters used in the collection of dissolved metals, (or other analytes), then into the appropriate sample containers. The time and location of collecting the filter blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the filter blank is prepared. In addition, one filter blank will be collected per lot of filters used. The filter lot check is to be performed one per lot of filters used and scheduled in a manner to allow for laboratory to report data prior to investigative sample collection.

6.2.1 Sample Labels and Identification System

Sample IDs will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*. Each sample container will have a sample label affixed and secured with clear package tape as necessary to prevent label removal. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP.

Table 6. Preliminary Schedule for Seep SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Seep SAP Submittal		Completed
Prepare for Field Activities	25 Days	Following NTP
Conduct Field Activities – Seep Investigation	20 Days	Following Field Preparation
Conduct Field Activities – Implement Seep SAP (if required)	20 Days	Following Seep Investigation
Laboratory Analysis (if required)	50 Days	Following Field Activities
Data Validation (if required)	30 Days	Following Lab Analysis

8.0 ASSUMPTION AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Approved sampling methods and protocols may have to be substituted in the EIP based on changing field conditions.
- Plant-specific safety requirements are anticipated to include TVA specified training and attendance at a safety briefing. Only Field Team members will be required to meet the above requirements.
- A dedicated Safety Officer will be present for this work.

9.0 REFERENCES

Tennessee Valley Authority (TVA). 2017a. "Planning Sampling Events." Technical Instruction ENV-TI-05.80.01, Revision 0000 March 31.

Tennessee Valley Authority (TVA). 2017b. "Sample Labeling and Custody." Technical Instruction ENV-TI-05.80.02, Revision 0001 March 31.

Tennessee Valley Authority (TVA). 2017c. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017d. "Field Sampling Quality Control." Technical Instruction ENV-TI-05.80.04, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017e. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017f. "Handling and Shipping of Samples." Technical Instruction ENV-TI-05.80.06, Revision 0000 March 31.

Tennessee Valley Authority (TVA). 2017g. "Surface Water Sampling." Technical Instruction EMA-TI-05.80.40, Revision 0000. May 4.

Tennessee Valley Authority (TVA). 2017h. "Field Measurement Using a Multi-Parameter Sonde." Technical Instruction ENV-TI-05.80.46, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017i. "Soil and Sediment Sampling." Technical Instruction ENV-TI-05.80.50, Revision 0000 September 29.

ATTACHMENT A
FIGURES

Figure No.
1

Title
Historic Seeps Ash Disposal Area 1

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

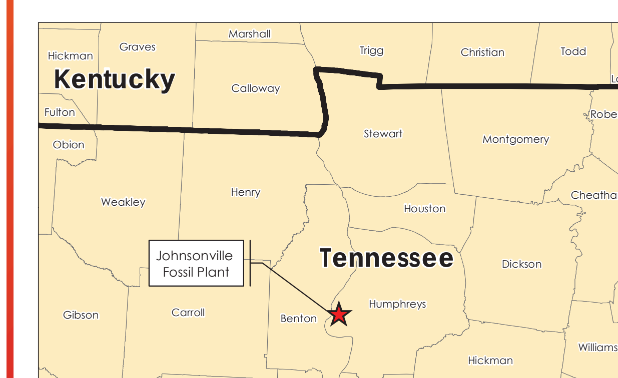
175567296
Prepared by LMB on 2018-01-09
Technical Review by ZW on 2018-01-09

0 100 200 300 400 Feet
1:1,200 (At original document size of 22x34)

Legend

- Approximate Historic Seep Location
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TVA (2017)



Stantec
TVA

Figure No.
2

Title
Historic Seeps
DuPont Road Dredge Cell

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-09
Technical Review by ZW on 2018-01-09

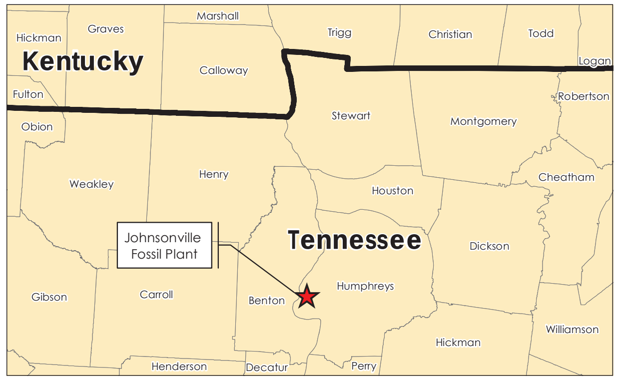
0 150 300 450 600 Feet
1:1,800 (At original document size of 22x34)

Legend

- Approximate Historic Seep Location
- Approximate Historic Seep Location
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TVA (2017)



Stantec
TVA

Figure No.
3

Title
Historic Seeps Active Ash Pond 2

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-09
Technical Review by ZW on 2018-01-09

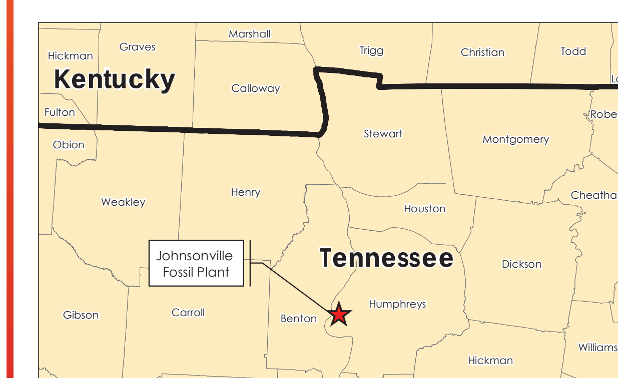
0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Approximate Historic Seep Location
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TerraServer (2016) and TVA (2017)



Stantec
TVA

U:\TVA-EIP\175567296\gis\mxds\JOF_Seeps_AshPond2.mxd Revised: 2018-01-09 By: mbough

Figure No.
4

Title
Historic Seeps
South Rail Loop Area 4

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-09
Technical Review by ZW on 2018-01-09

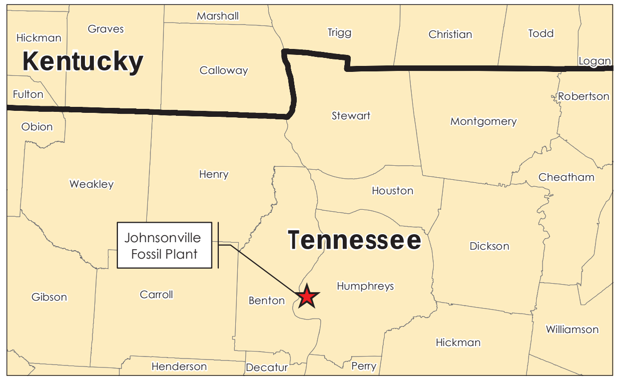
0 150 300 450 600
Feet
1:1,800 (At original document size of 22x34)

Legend

- Approximate Historic Seep Location
- Approximate Historic Seep Location
- CCR Unit Boundary (Approximate)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by TVA (2017)



Stantec
TVA

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ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Seep Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Boat and paddles
Anchor
Two outboard gas tanks
Rope
Waders, muck boots, knee boots, etc.
pH and conductivity meters
Thermometer
***These items are detailed in associated planning documents to avoid redundancy.**
[1]Drilling rig equipment will be selected based on site conditions, selected by the Drilling Contractor, and approved by TVA.

APPENDIX T
SEEPAGE HISTORY SUMMARY

JOF Seepage History Summary

TVA has conducted annual dike inspections at JOF since 1967. These inspections focused on stability issues pertaining to seeps. NPDES Permit No. TN0005444 was issued by TDEC to the TVA Johnsonville Fossil Plant on February 9, 2011. The permit expired on November 29, 2013, but because TVA submitted an application for renewal, the permit is administratively continued in accordance with 40 CFR 122.6. Under the NPDES permit, TVA visually inspects the dikes and toe areas at least quarterly for seepage and submits an annual report to the TDEC Nashville Environmental Field Office documenting the findings of the inspections and remedial activities implemented.

Two projects were completed in 2015 to reduce seepage in Ash Disposal Area 1, including final grading and cap installation and installation of the North Drainage Culvert. The cap installation project reduced seepage by reducing the volume of infiltration into the unit. The North Drainage Culvert project reduced seepage by diverting stormwater away from the unit. TVA completed a third project in 2015 that involved the installation of a graded filter and rock buttress to address seepage with respect to structural stability.

Remedial activities at the DuPont Road Dredge Cell included construction of a 300-foot long dike in the south end of the disposal area in 1996 to mitigate seepage flow through the dike. In October 2005, TVA produced a study entitled *Hydrologic Evaluation of Tree Plantation Control of Ashfill Seepage* that concluded transpiration from planting of additional vegetation (trees) on the landfill surface could reduce the seepage. In accordance with the results of the study, the trees were planted on the cell in early 2006. TVA also installed a series of piezometers to monitor groundwater elevations in the cell and document desired progress toward lowering ground water levels to eliminate the seepage. During the period of late 2008 to the summer of 2009, after three growing seasons, TVA evaluated the effectiveness of the tree planting. Site inspections indicated the seepage from the cell was still occurring; therefore, TVA, in cooperation with TDEC representatives, decided to pursue a solution to mitigate seepage from the cell (Stantec 2012). TVA completed a geotechnical study in 2010 to evaluate the source of seepage. The results of the 2010 study indicated seepage was the result of stormwater flow through the more permeable ash above the crest of the Phase 1 dike. TVA completed the construction of cap improvements including a geosynthetic cap system in 2012 to reduce infiltration into the cell, lower phreatic levels, and significantly reduce seepage. Seepage has not been observed at the DuPont Road Dredge Cell since construction of the cap improvements was completed in 2012.

At Active Ash Pond 2, TVA completed the Northeast Dike Stability Improvements Project (JOF-100126-WP-6) in August 2010 to address seepage with respect to structural stability. This project involved construction of a drainage blanket and the placement of compacted clay fill to regrade the slope. All water has been diverted and drained from the north end of Active Ash Pond 2, thus removing the operating pool level. This effort was followed by the Southeast Dike Stability Improvements Project (JOF-100702-WP-7) in August 2011. Seepage has not been observed at Active Ash Pond 2 since construction of these projects was completed, with the exception of the seasonal wet area at the Seep No. 6 location.

TVA constructed a wetland treatment system at South Rail Loop Area 4 in 1999 to collect and treat red water seepage. Effluent from the wetland was subject to NPDES permit conditions since it discharged to NPDES outfall F5. In 2015-2016, drainage improvements were constructed as part of maintenance activities.

Maps depicting historic seepage areas are shown on Figures 1-4. A summary of the seep history for JOF is provided in Table 1.

Table 1. Seepage History Summary

Figure No.	Seep No.	CCR Unit	Description
1	1A	Ash Disposal Area 1	Seepage has historically been observed at Ash Disposal Area 1 along the river bank during red water inspections and routine facility inspections from 1977 through 2015. Two projects were completed in 2015 to mitigate the seepage, including final grading and cap installation, and the installation of the North Drainage Culvert. The installation of a graded filter and rock buttress was completed for structural stability.
1	1B	Ash Disposal Area 1	Seepage has historically been observed at Ash Disposal Area 1 along the river bank during red water inspections and routine facility inspections from 1977 through 2015. Two projects were completed in 2015 to mitigate the seepage, including final grading and cap installation, and the installation of the North Drainage Culvert. The installation of a graded filter and rock buttress was completed for structural stability.
1	1C	Ash Disposal Area 1	Seepage has historically been observed at Ash Disposal Area 1 along the river bank during red water inspections and routine facility inspections from 1977 through 2015. Two projects were completed in 2015 to mitigate the seepage, including final grading and cap installation, and the installation of the North Drainage Culvert. The installation of a graded filter and rock buttress was completed for structural stability.
1	1D	Ash Disposal Area 1	Seepage has historically been observed at Ash Disposal Area 1 during red water inspections and routine facility inspections from 1977 through 2015. Two projects were completed in 2015 to mitigate the seepage, including final grading and cap installation, and the installation of the North Drainage Culvert. The installation of a graded filter and rock buttress was completed for structural stability. Seepage has not been observed at Ash Disposal Area 1 since construction of these projects was completed in 2015.

Figure No.	Seep No.	CCR Unit	Description
2	5A	DuPont Road Dredge Cell	At the DuPont Road Dredge Cell, seepage was observed on the southeast dike during 1994-1995. A 300-foot long dike was constructed in the south end of the disposal area to mitigate seepage [TVA (1996)]. Seepage was observed in 2004-2006. TDEC approved the use of a tree cap system to address the seepage issue in 2006 [TVA (2006)]. Several seeps developed in 2007 following closure. In 2010, a LLDPE liner and clay cover was constructed to reduce stormwater infiltration and prevent seepage. Seepage has not been observed at the DuPont Road Dredge Cell since completion of this construction project in 2010.
2	5B	DuPont Road Dredge Cell	At the DuPont Road Dredge Cell, seepage was observed on the southeast dike during 1994-1995. A 300-foot long dike was constructed in the south end of the disposal area to mitigate seepage [TVA (1996)]. Seepage was observed in 2004-2006. TDEC approved the use of a tree cap system to address the seepage issue in 2006 [TVA (2006)]. Several seeps developed in 2007 following closure. In 2010, a LLDPE liner and clay cover was constructed to reduce water infiltration and prevent seepage. Seepage has not been observed at the DuPont Road Dredge Cell since completion of this construction project in 2010.
3	General	Active Ash Pond 2	Seepage areas have been observed along the northeast and southeast dikes of Active Ash Pond 2 between 1976 and 2008, as noted in seep inspection reports. All seeps were mitigated between 2009 to present by the diversion of water from the north end of Active Ash Pond 2, and by lowering operating pool levels.
3	1	Active Ash Pond 2	TVA completed construction of the Northeast Dike Stability Improvements project (JOF-100126-WP-6) in August 2010 to address seepage with respect to structural stability [Stantec (2011)]. The area was covered by a drainage blanket, and then compacted clay fill was placed to regrade the slope[TVA (2012)] Seepage has not been observed in this area since construction of this project was completed.

Figure No.	Seep No.	CCR Unit	Description
3	2	Active Ash Pond 2	The area has been mitigated by the Northeast Dike Stability Improvements project (JOF-100126-WP-6) in August 2010 [Stantec (2011)]. The area was covered by a drainage blanket, and then compacted clay fill was placed to regrade the slope [TVA (2012)]. Seepage has not been observed in this area since construction of this project was completed.
3	3	Active Ash Pond 2	The area has been mitigated by the Northeast Dike Stability Improvements project (JOF-100126-WP-6) in August 2010 [Stantec (2011)]. The area was covered by a drainage blanket, and then compacted clay fill was placed to regrade the slope [TVA (2012)]. Seepage has not been observed in this area since construction of this project was completed.
3	4	Active Ash Pond 2	The area has been mitigated by the Northeast Dike Stability Improvements project (JOF-100126-WP-6) in August 2010 [Stantec (2011)]. The area was covered by a drainage blanket, and then compacted clay fill was placed to regrade the slope [TVA (2012)]. An intermittent non-flowing wet area has been observed based on seasonal changes.
3	5	Active Ash Pond 2	This area was mitigated with respect to structural stability by installing a drainage blanket and the area was further developed into a construction road during the Existing Spillway Closure Project Work Plan 4 (JOF-100407-WP-4) in September 2010 [TVA (2012)]. Seepage has not been observed in this area since construction of this project was completed.
3	6	Active Ash Pond 2	A drainage blanket was installed in the area during the Existing Spillway Closure Project Work Plan 4 (JOF-100407-WP-4), however, seepage was observed in intermediate and quarterly inspections [TVA (2012)]. Seepage has not been observed in this area since the completion of construction.

Figure No.	Seep No.	CCR Unit	Description
3	7	Active Ash Pond 2	This area was mitigated with respect to structural stability as part of the Southeast Dike Stability Improvements project (JOF-100702-WP-7) in August 2011 in [Stantec (2011)]. [TVA (2012)] Seepage has not been observed in this area since construction of this project was completed.
3	8	Active Ash Pond 2	This area was mitigated with respect to structural stability as part of the Southeast Dike Stability Improvements project (JOF-100702-WP-7) in August 2011 in [Stantec (2011)]. [TVA (2012)] Seepage has not been observed in this area since construction of this project was completed.
3	9	Active Ash Pond 2	This area was mitigated with respect to structural stability as part of the Southeast Dike Stability Improvements project (JOF-100702-WP-7) in August 2011 in [Stantec (2011)]. [TVA (2012)] Seepage has not been observed in this area since construction of this project was completed.
3	10	Active Ash Pond 2	The Metal Cleaning Waste Pond was closed in October 2012. The pond was drained and capped. Seepage has been observed at this location during intermediate and quarterly inspections [TVA (2012)]. A graded filter was installed to mitigate the seep with respect to structural stability on April 26, 2016. Seepage has not been observed in this area since construction of this project was completed.
3	11	Active Ash Pond 2	The Metal Cleaning Waste Pond was closed in October 2012. The pond was drained and capped. [TVA (2012)] Seepage has not been observed in this area since construction of this project was completed.
3	12	Active Ash Pond 2	The Metal Cleaning Waste Pond was closed in October 2012. The pond was drained and capped. Seepage has been observed at this location during intermediate and quarterly inspections [TVA (2012)]. A graded filter was installed to mitigate the seep with respect to structural stability on April 26, 2016. Seepage has not been observed in this area since construction of this project was completed.

Figure No.	Seep No.	CCR Unit	Description
3	13	Active Ash Pond 2	The Metal Cleaning Waste Pond was closed in October 2012. The pond was drained and capped. This seep was mitigated during the project [TVA (2012)]. Seepage has not been observed in this area since construction of this project was completed.
4	4A	South Rail Loop Area 4	Intermittent non-flowing seeps have been noted at the South Rail Loop Area 4 from 1983 to present. In 1999, a wetland treatment area was constructed as a red water mitigation feature with effluent waters from the wetland subject to NPDES permit conditions at outfall F5. In 2015-2016, drainage improvements were constructed as part of maintenance activities.
4	4B	South Rail Loop Area 4	Intermittent non-flowing seeps have been noted at the South Rail Loop Area 4 from 1983 to present. In 1999, a wetland treatment area was constructed as a red water mitigation feature with effluent waters from the wetland subject to NPDES permit conditions at outfall F5. In 2015-2016, drainage improvements were constructed as part of maintenance activities.
4	4C	South Rail Loop Area 4	Intermittent non-flowing seeps have been noted at the South Rail Loop Area 4 from 1983 to present. In 1999, a wetland treatment area was constructed as a red water mitigation feature with effluent waters from the wetland subject to NPDES permit conditions at outfall F5. In 2015-2016, drainage improvements were constructed as part of maintenance activities.

References

Stantec Consulting Services Inc. (Stantec). 2011. "2011 Annual Inspection of CCP Facilities and Ponds, Johnsonville Fossil Plant." September 2011.

Stantec Consulting Services Inc. (Stantec). 2012. "Construction Certification Report – DuPont Dredge Cell Cap Improvements and Closure, Work Plan 8 (JOF-100716-WP-8." Prepared for Tennessee Valley Authority. April 25.

Tennessee Valley Authority (TVA). 1996. "Johnsonville Fossil Plant – Annual Report on Dike Stability and Seep Inspections." June 1996

Tennessee Valley Authority (TVA). 1999. "Johnsonville Fossil Plant – Annual Report on Dike Stability and Seep Inspections." June 1999

Tennessee Valley Authority (TVA). 2006. "Johnsonville Fossil Plant – Annual Report on Dike Stability and Seep Inspections." June 2006

Tennessee Valley Authority (TVA). 2012. "TVA Seepage Log" – Johnsonville Fossil Plant." Excel spreadsheet, created May 24.

APPENDIX U
SURFACE STREAM SAP

Surface Stream Sampling and Analysis Plan Johnsonville Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Johnsonville Fossil Plant
New Johnsonville, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 10, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	July 24, 2017
1	Addresses October 19, 2017 TDEC Review Comments and Issued for TDEC Review	January 12, 2018
2	Addresses March 9, 2018 TDEC Review Comments and Issued for TDEC Review	May 11, 2018
3	Addresses June 11, 2018 TDEC Review Comments and Issued for TDEC Review	July 20, 2018
4	Addresses comments and revisions from other EIPs and issued for TDEC review.	December 10, 2018

SURFACE STREAM
SAMPLING AND ANALYSIS PLAN
JOHNSONVILLE FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Surface Stream
Sampling and Analysis Plan
Johnsonville Fossil Plant
Tennessee Valley Authority
New Johnsonville, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 10, 2018 Revision 4, Final

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager — Date 12/6/18

TVA Investigation Field Lead — Date 12-7-18

Health, Safety, and Environmental (HSE) Manager — Date 12/05/2018

Investigation Project Manager — Date 12/7/2018

Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.12.03 11:54:04 -05'00'
QA Oversight Manager — Date

Laboratory Project Manager — Date 12.4.18

Charles L. Head
TDEC Senior Advisor — Date

Robert Wilkinson
TDEC CCR Technical Manager — Date

Stantec

TITLE AND REVIEW PAGE

Title of Plan: Surface Stream
Sampling and Analysis Plan
Johnsonville Fossil Plant
Tennessee Valley Authority
New Johnsonville, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: ______________________________ Revision ___

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

______________________________ __________
TVA Investigation Project Manager Date

______________________________ __________
TVA Investigation Field Lead Date

______________________________ __________
Health, Safety, and Environmental (HSE) Manager Date

______________________________ __________
Investigation Project Manager Date

______________________________ __________
QA Oversight Manager Date

______________________________ __________
Laboratory Project Manager Date

______________________________ __________
Charles L. Head Date
TDEC Senior Advisor

______________________________ __________
Robert Wilkinson Date
TDEC CCR Technical Manager

Table of Contents

LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order), to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Johnsonville Fossil Plant (JOF) on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management at JOF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC submitted a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 24, 2017, TVA submitted JOF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

TDEC's comments included a request for greater clarification on TVA's phased approach for evaluating whether dissolved CCR material has migrated to surface streams on or adjacent to the JOF Plant (Plant). TDEC also requested the submittal of a Surface Stream Sampling and Analysis Plan (SAP) and a map of surface stream sampling locations.

2.0 OBJECTIVES

The objective of this Surface Stream SAP is to characterize surface stream water quality on or adjacent to the Plant for CCR constituents and identify information that may explain the potential transport of CCR constituents into those surface streams.

This Surface Stream SAP will provide the procedures necessary to conduct investigation activities associated with the sampling and analysis of water bodies bordering and in the vicinity of the Plant. Surface stream sampling is anticipated to be conducted concurrently with sediment sampling, as described in the Benthic SAP. Most sample locations will require both sediment and water sampling, but some locations will require one or the other. At locations that require both surface water and sediment sampling, the surface water sample will be collected first. To account for seasonal variations, two surface stream sampling events are proposed.

Surface stream samples will be collected from designated transects in the subject streams and analyzed for total and dissolved CCR constituents, as listed in Appendices III and IV of the CCR Rule, as well as TN Rule 0400-11-01-.04 Appendix 1. Five inorganic constituents listed in Appendix 1 of TN Rule 0400-11-01-.04 (i.e., TDEC regulations), and not included in the federal CCR Appendices III and IV, have been added to the list of CCR constituents for analyses to maintain continuity with other TDEC environmental programs. Those additional constituents include the following metals: copper, nickel, silver, vanadium, and zinc. The combined federal CCR Appendices III and IV constituents, and TDEC Appendix 1 inorganic constituents, will hereafter be referred to collectively as "CCR Parameters."

Proposed surface stream sampling transects to be evaluated are discussed in Section 4.0. Field activities will include the following tasks:

- Verify proposed sampling locations using the global positioning system (GPS)
- Collect water quality parameters and surface water samples from proposed sampling transects
- Package and deliver surface stream samples to laboratory

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLING LOCATIONS

A phased approach to surface stream sampling will be utilized. Phase 1 surface stream sampling locations in the Tennessee River, Intake Channel, and Boat Harbor (Attachment A; Figure 1) were selected to evaluate whether ash processing at the plant has had or is having adverse effects on water quality.

Sixteen surface stream sample locations are planned for the investigation (see Figure 1). Table 1 provides a summary of the proposed sampling locations. Eleven sampling locations are proposed in the Tennessee River and associated Kentucky Lake coves to evaluate water quality upstream of the CCR Units, near the JOF Impoundment permitted discharge location, and downstream of the CCR Units. Two sampling locations are proposed in the Intake Channel, and three sample locations will be from the Boat Harbor. The number and/or location of the proposed surface stream samples may be modified based on conditions encountered in the field. Samples will be analyzed for total and dissolved CCR Parameters and selected cations to calculate Total Hardness. Sampling and laboratory specific information is covered in more detail in the Quality Assurance Project Plan (QAPP; Appendix C).

Phase 2 of surface stream sampling will be conducted if there is an exceedance of 20% ash content (based on PLM analysis) in one or more of the sediment samples collected in accordance with the Benthic SAP. Phase 2 will consist of collecting additional surface stream samples from the location(s) where greater than 20% ash occurs. Several surface stream sample transects at the location(s) with greater than 20% ash content may be necessary to delineate the extent of potential contamination. Should this second phase be implemented, a new sampling location map will be developed. Phase 2 sampling procedures will remain the same as those described in this SAP. Only the sampling locations will differ.

Table 1. Proposed Surface Stream Sample Locations

Sample Location ID	Description
STR-TR01	Tennessee River Upstream of JOF (Background)
STR-TR02	Tennessee River Upstream of JOF - Background
STR-TR03	Tennessee River Upstream of JOF (Background)
STR-TR04	Tennessee River on West Side of Ash Pond 2
STR-TR05	Tennessee River on West Side of Ash Pond 2
STR-TR06	Tennessee River at Northern End of Ash Pond 2 and Southern End of Ash Pond 1
STR-TR07	Tennessee River at Northern End of Ash Pond 1
STR-TR08	Tennessee River Downstream from Ash Ponds
STR-IC01	Intake Channel Adjacent to Ash Pond 2
STR-IC02	Intake Channel Adjacent to Ash Pond 2
STR-BH01	Boat Harbor Adjacent to Ash Pond 2
STR-BH02	Boat Harbor Adjacent to Ash Pond 2
STR-BH03	Boat Harbor North of Ash Pond 2
STR-CV01	Cove on East Side of Kentucky Lake Upstream from JOF
STR-CV02	Cove on West Side of Kentucky Lake
STR-CV03	Cove on West Side of Kentucky Lake

Several of the surface stream sample locations coincide with sample locations of other environmental SAPs. Table 2 summarizes the corresponding sample locations for the surface stream, benthic, and fish tissue SAPs.

Table 2. JOF Environmental Corresponding Sample Locations Matrix

Surface Stream Sample Location	Corresponding Sediment Sample Location	Corresponding Benthic Sampling Location	Corresponding Mayfly Sampling Location	Corresponding Fish Tissue Sampling Location
		MAC-TR01		
STR-TR01	SED-TR01			
STR-TR02	SED-TR02	MAC-TR02		
STR-TR03	SED-TR03			
STR-TR04	SED-TR04	MAC-TR03	TRA	TRA
STR-TR05	SED-TR05	MAC-TR04		
STR-TR06	SED-TR06	MAC-TR05		
STR-TR07	SED-TR07	MAC-TR06		
STR-TR08	SED-TR08	MAC-TR07		
		MAC-TR08		
		MAC-TR09		
		MAC-TR10	TRU	TRU
		MAC-TR11	TRD	TRD
STR-CV01	SED-CV01	MAC-CV01		
STR-CV02	SED-CV02	MAC-CV02		
STR-CV03	SED-CV03	MAC-CV03		
		MAC-IC01		
		MAC-IC02		
STR-IC01	SED-IC01	MAC-IC03	IC	IC
STR-IC02	SED-IC02			
STR-BH01	SED-BH01	MAC-BH01	BH	BH
STR-BH02	SED-BH02	MAC-BH02		
STR-BH03	SED-BH03	MAC-BH03		

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to collect samples, document field activities, and assist in providing scientifically defensible results.

Surface stream sample collection will adhere to TVA Environmental Technical Instruction (TI) documents. The surface stream sampling will be conducted in accordance with TVA TI EMA-TI-05.80.40 *Surface Water Sampling*, which references other TIs that are applicable to various aspects of surface stream sampling. A project field book and field forms will be maintained by the Field Team Leader to record field measurements, analyses, and observations. Field activities will be documented according to TVA TI ENV-TI-05.80.03, *Field Record Keeping*.

5.1 PREPARATION FOR FIELD ACTIVITIES

Preparation for field activities will be conducted in accordance with TVA TI ENV-TI-05.80.01, *Planning Sampling Events.* As part of field mobilization activities, the field sampling team will:

- Designate a Safety Officer
- Review applicable reference documents, including (but not limited to), TVA TIs (Section 5.5) and Standard Operating Procedures (SOPs), QAPP (Appendix C), SAPs, and HASP.
- Complete required health and safety paperwork, field readiness checklists, and confirm field team members have completed required training
- Coordinate activities with the Laboratory Coordinator, including ordering sample bottles containing preservatives (if required), obtaining coolers and analyte-free, deionized water (DI), if needed, and notifying the Laboratory Coordinator of sampling and sample arrival dates
- Obtain required field instruments, including health and safety equipment, Hydrolab® DS5X (or similar) multiparameter Sonde, handheld sonic water depth meter (if needed), and sampling equipment and accessories (i.e. peristaltic pump or Kemmerer depth sampler, as per EMA-TI-05.80.40 *Surface Water Sampling*).
- Complete sample paperwork to the extent possible, including chain-of-custody forms and sample labels in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*

- Determine current flow conditions of subject streams to assess whether conditions are appropriate to conduct sampling. Sampling will need to occur during flows as described in Section 5.2.4

- Coordinate arrangements for obtaining a boat or vessel for accessing sample locations.

- Obtain ice prior to sample collection for sample preservation

- Obtain decontamination materials, including scrub brushes, soap, solvents, buckets, and deionized (DI) water, as indicated in TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*.

5.2 SAMPLING METHODS AND PROTOCOL

Sampling and collection methods will be conducted in accordance with applicable TVA TIs, including:

- ENV-TI-05.80.01, *Planning Sample Events*

- ENV-TI-05.80.02, *Sample Labeling and Custody*

- ENV-TI-05.80.03, *Field Record Keeping*

- ENV-TI-05.80.04, *Field Sampling Quality Control*

- ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*

- ENV-TI-05.80.06, *Handling and Shipping of Samples*

- EMA-TI-05.80.40, *Surface Water Sampling*

- ENV-TI-05.80.46, *Field Measurement Using A Multi-Parameter Sonde*

5.2.1 Field Analyses

A Hydrolab® DS5X (or similar) multiparameter sonde will be used to record a depth profile of conventional water quality parameters at each sample transect location in accordance with ENV-TI-05.80.46 Field Measurement Using A Multi-Parameter Sonde. If water depth is less than two meters, water quality parameters will be monitored at the surface and mid-depth of the water column. For depths greater than two meters, water quality parameters will be monitored within 1 meter of the stream bottom and in increments of one meter to the surface. If a thermocline, as determined by the procedure outlined in Section 5.2.4, is observed, the depth interval will be adjusted to better define the thermocline. The instrument will undergo documented calibration daily. Instrument use and calibration will follow TVA TI ENV-TI-05.80.46, *Field Measurement Using A Multi-Parameter Sonde*. Conventional field parameters to be measured include:

- Temperature (degrees Celsius; °C)
- Dissolved Oxygen (milligrams per Liter; mg/L)
- Specific Conductivity (microSiemens per centimeter [µS/cm], in accordance with ENV-TI-05.80.42)
- Oxidation Reduction Potential (milliVolts; mV)
- pH (Standard Units)
- Turbidity (Nephelometric turbidity units; NTU)

Water depth will be measured at each water sample location. Data will be recorded as described in TVA TI ENV-TI-05.80.03, *Field Record Keeping.* The surface water samples will be collected according to the procedures outlined in *ENV-TI-05.80.40*, *Surface Water Sampling* and this SAP.

5.2.2 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Field Team Leader, and approved by TVA, prior to mobilization. Field equipment will be inspected by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP.

5.2.3 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.2.3.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.3.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks.

5.2.3.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COCs will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality control (QC) check of samples in each cooler compared to sample IDs on the corresponding COC. The Investigation Project Manager will staff the project with a field sample manager during sample collection activities. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.2.3.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.4 Collection of Samples

A Hydrolab® DS5X (or similar) will be used to collect water quality parameters along sample location transects. If thermal stratification is identified based on the Hydrolab® data, four water column samples will be collected at the stream thalweg (deepest point), right bank, and left bank along the sample transect for a total of 12 samples. If no thermal stratification is identified, surface, mid-depth, and epibenthic samples will be collected at the thalweg, right bank, and left bank locations for the transect for a total of nine samples. The thalweg will be identified by passing the boat along the transect with depth finding equipment or measuring the water depth on intervals for smaller channels. Sampling procedures may be adjusted as described below to accommodate shallow and narrow sample locations. Water depth and velocity will be measured with respective meters and recorded.

Collection of surface stream samples will follow TVA TI EMA-TI-05.80.40 *Surface Water Sampling.* Sample collection will follow the procedures detailed below. Note that sampling methods may have to be substituted in some locations based on changing field conditions (obstructions, water depth, etc.). To account for seasonal variations, two sampling events are proposed (one during summer pool, and one during winter pool). Flow during sampling events should be in greater than the 25th percentile and less than the 75th percentile, based on analysis of the mean daily flows of the nearest United States Geological Survey (USGS) gage.

- The following sampling procedures will be followed: Upon arrival at a sample location where both sediment and surface water are being collected, the surface stream sample will be collected before the associated sediment sample if the sediment and surface stream sampling is conducted concurrently/during the same event. This will minimize the possibility of water sample contamination by disturbance of sediments.

- Surface stream samples are to be collected from downstream to upstream locations to prevent the disturbance of bottom sediments from impacting further downstream sample locations.

- A sub-meter GPS unit will be used to navigate to sample locations. The depth of water will be determined, and water quality parameters will be measured in-situ with the Hydrolab® DS5X (or similar) multiparameter Sonde.

- A peristaltic pump sampler or Kemmerer depth sampler (or approved other sampler will be used to obtain samples, with new pump tubing to be used at each sampling site.

- Presence of thermal stratification will be evaluated along sample transects at each site. This will determine sampling procedure, as outlined below.

- The following method will be used to determine whether each sampling location is thermally stratified or mixed (unstratified).

    1. Position and anchor the boat at the proper GPS coordinates.

    2. Use the boat's depth finder to determine the river depth at that location.

    3. Lower the calibrated Hydrolab® (or similar unit) to the bottom of the river, minimizing disturbance of bottom sediments.

    4. Collect field parameter readings for temperature at one-meter depth intervals. Readings will be collected over the entire column of water on whole meter increments, beginning a minimum of 0.5 m above the bottom.

    5. Allow the Hydrolab® approximately 30 seconds to equilibrate at each depth increment, or until otherwise observed stable with Hydroplus GPS software.

Observe the parameter readings for 5-7 seconds to confirm stable readings before recording values. If readings are unstable, allow them to stabilize before recording the value.

6. Record the temperature measured from each depth location.

7. Evaluate the recorded data for evidence of stratification (specifically temperature).

   A temperature change of greater than 1° C per meter indicates that there is a thermocline and that the location is stratified. A thermocline is defined as "a layer of water between the warmer, surface zone (epilimnion) and the colder, deep water zone (hypolimnion)". The thermocline will exhibit a more rapid decrease in temperature with depth when compared to the epilimnion and hypolimnion

   Note: temperature changes with depth will also be observed in the epilimnion and hypolimnion, but not as rapid as in the thermocline. Thermal stratification may not be present at all sampling locations.

8. If a thermocline is present, bound the upper and lower reaches of the epilimnion and hypolimnion (in depth below the surface) for reference during sample collection, as described below.

- Where applicable, surface water samples will be collected prior to collection of sediment samples. A peristaltic pump sampler or Kemmerer depth sampler (or approved other sampler) will be used to obtain samples. Pump tubing will be replaced upon completion of sampling at each site and prior to sampling at subsequent locations. Surface stream samples will be collected away from and upstream of the boat and motor to reduce potential for contamination.

- Along each transect, samples will be collected vertically through the water column at thalweg, right bank, and left bank stations. "Left bank" and "right bank" will be determined with a downstream-facing orientation.

- Sampling at each site will be conducted as follows:

  If thermally stratified, four samples will be collected at each of the three transect stations (thalweg, left bank, and right bank) at various depths: epibenthic (near bottom) sample within 0.5 m of the streambed, mid-hypolimnion sample midway between bottom of thermocline and streambed, mid-epilimnion sample midway between top of the thermocline and water surface, and near-surface sample collected at 0.5 m depth. This sampling approach will yield a maximum of 12 total samples per transect, assuming stratification is homogenous throughout the transect.

If not thermally stratified, three samples will be collected at each of the three transect stations at various depths: near-surface, mid-depth, and epibenthic. This sampling approach will yield nine total samples per transect.

For waterbodies that may not have adequate depth to collect multiple samples from the water column, the field sampling team may adjust the number of samples to accommodate. Similarly, if the width of the waterbody along a sampling transect is not sufficient to support the collection of multiple samples along the transect, the field sampling team may adjust the procedure accordingly. These determinations will be documented in the field logbook.

Specific sample collection procedures are included in EMA-TI-05.80.40 Surface Water Sampling. Samples will be collected for both total and dissolved inorganic analysis. The field team will filter dissolved fractions immediately following sample collection using a new, certified clean high-capacity inline 0.45-micron filter and following the quality assurance procedures for filter blanks. Each filter will be treated as single-use and will be replaced before collection at each sample location (Table 1).

- When filling sample bottles, care will be taken to minimize sample aeration (i.e., water will be directed down the inner walls of the sample bottle) and avoid overfilling and diluting preservatives. Each sample bottle will be capped before filling the next bottle.

- The sampling team will take care not to contaminate the samples. Nitrile gloves will be worn when collecting samples. A new pair of gloves will be used at each sample location.

5.2.5 Preservation and Handling

Samples will be collected in a transfer bottle that will then be poured into laboratory-provided sample containers.

Sample containers will be labeled in accordance with TVA TI ENV-05.80.02, *Sample Labeling and Custody.* Once each sample container is filled, the rim and threads will be cleaned by wiping with a clean paper towel and capped, and a signed and dated custody seal will be applied. Each sample container will be checked to confirm that it is sealed, labeled legibly, and externally clean. Sample containers will be packaged in a manner to prevent breakage during shipment.

Coolers will be prepared for shipment in accordance with TVA TI ENV-05.80.06, *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright single layer. Small uniformly sized containers will be stacked in an upright configuration and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible. A temperature blank will be placed inside each cooler to measure sample temperature upon arrival at the laboratory. Loose ice will be placed around and among the sample containers so that the samples remain at less than 6 degrees Celsius (°C) during shipment. The cooler will be filled with additional packing material to minimize the potential for container breakage during shipment.

The original COC will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC. If multiple coolers are required to ship samples contained on a single COC, then the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e., strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC. If there are discrepancies the Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Project Manager.

5.2.6 Sample Analyses

Surface stream samples will be submitted to the TVA-approved laboratory for analysis. Surface stream samples will be analyzed by a lab for concentrations of the CCR Parameters summarized in Tables 3, 4, and 5. Additional cations in Table 6 will be analyzed to calculate Total Hardness.

Table 3. 40 CFR Part 257 Appendix III Constituents

Appendix III Constituents
Boron
Calcium
Chloride
Fluoride
pH
Sulfate
Total Dissolved Solids (TDS)
Total Suspended Solids (TSS)

Table 4. 40 CFR Part 257 Appendix IV Constituents

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Fluoride
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
Radium 226 and 228 Combined

Table 5. TN Rule 0400-11-01-.04, Appendix 1 Inorganic Constituents

TDEC Appendix 1 Constituents*
Copper
Nickel
Silver
Vanadium
Zinc

*Constituents not listed in CCR Rule Appendices III and IV

Table 6. Additional Cations to be Analyzed

Cations
Magnesium
Manganese
Iron

Surface stream data collected during this investigation will be reported to TDEC in an Environmental Assessment Report (EAR). Analytical methods, preservatives, containers, and holding times are summarized in Table 7.

Table 7. Analytical Methods, Preservation, Container(s) and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
Metals, dissolved	SW-846 6020A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Metals, total	SW-846 6020A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	180 days
Mercury, dissolved	SW-846 7470A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Mercury, total	SW-846 7470A	HNO3 to pH < 2 Cool to <6°C	250-mL HDPE	28 days
Radium 226	SW-846 903.0	HNO3 to pH < 2 Cool to <6°C	1 L glass or Plastic	180 days
Radium 228	SW-846 904.0	HNO3 to pH < 2 Cool to <6°C	2 L glass or plastic	180 days
Chloride	SW-846 9056A	Cool to <6°C	250-mL HDPE	28 days
Fluoride	SW-846 9056A	Cool to <6°C	250-mL HDPE	28 days
Sulfate	SW-846 9056A	Cool to <6°C	125-mL HDPE	28 days
Total Dissolved Solids (TDS)	SM2540C	Cool to <6°C	250-mL HDPE	7 days
Total Suspended Solids (TSS)	SM2540C	Cool to <6°C	1 L HDPE	7 days

5.2.7 Equipment Decontamination Procedures

The following procedures will be used to maintain the overall objective of minimizing the potential for cross-contaminating samples and media during sampling activities. Sampling equipment will be cleaned before transport to the field. When appropriate or practical, disposable sampling equipment will be utilized in the field. However, non-dedicated and non-disposable equipment used for sampling is to be decontaminated prior to and after each use in accordance with TVA TI ENV-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*.

Equipment that comes into direct contact with surface stream samples for laboratory analyses will undergo decontamination between each use that will include the following steps:

- Wash with non-phosphate detergent (i.e., LiquiNox™) and deionized (DI) water solution
- Rinse multiple times with analyte-free, DI water
- Air drying

During site data collection, decontamination of water quality meters will be performed upon arriving to each new sampling location using metals grade nitric acid for cleaning. Single-use equipment will be placed in a clean trash bag or other separate container during transport to prevent cross-contamination. Equipment that is not fully decontaminated prior to leaving the Plant will be properly disposed or wrapped and stored to prevent contamination of other equipment until it can be properly decontaminated. Decontamination activities will be documented in the field book or on a field data sheet. Additional information regarding equipment decontamination procedures is located in the QAPP.

5.2.8 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but will not be limited to:

- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*, the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to surface stream sampling and analysis.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to confirm that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Project Manager considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Five types of field QA/QC samples will be collected during sampling activities: field duplicate samples, matrix spike/matrix spike duplicate (MS/MSD) samples, equipment blanks, field blanks, and filter blanks. QA/QC samples will be collected in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control*. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below.

Field Duplicate Samples – One duplicate sample will be collected for every 20 samples or once per sampling event. Duplicates samples will be prepared as blind duplicates and will be collected in two sets of identical, laboratory-prepared sample bottles. The primary and duplicate samples will be labeled according to procedure in Section 6.2.1. Sample identifier information will not be used to identify the duplicated samples. Actual sample identifiers for duplicate samples will be noted in the field logbook. The duplicate sample will be analyzed for the same parameters as the primary sample.

MS/MSD Samples – A sufficient volume of sample will be collected for use as the MS/MSD. MS/MSD samples will be collected to allow matrix spike samples to be run to assess the effects of matrix on the accuracy and precision of the analyses. One MS/MSD sample will be analyzed for every 20 samples collected or once per sampling event. MS/MSD samples will be collected filling bottles alternately by thirds in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control* into three sets of identical, laboratory-prepared sample bottles. Additional sample volume intended for use as the MS/MSD must be identified in the comments field on the COC records and sample labels.

The location of sample collection will be noted in the log book. The MS/MSD sample will be analyzed for the same analytes as the primary sample, with exception of parameters that are not amenable to MS/MSD. For parameters such as Total Suspended Solids and radium that are not amenable to the MS/MSD procedure, additional sample volume will be collected for laboratory duplicate analysis per the QAPP.

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected for each sampling event. The equipment blank will be collected at a sampling location by pouring laboratory-provided deionized water into or over the decontaminated sampling equipment, then into the appropriate sample containers. The time and location of collecting the equipment blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the equipment blank is prepared. If the tubing used to collect the filter blank is not certified clean tubing, then a tubing blank will be collected at a frequency of blank per lot.

Field Blanks: One field blank sample will be prepared per day using laboratory-supplied deionized water.

Filter Blanks – One filter blank will be collected during each day of the sampling activities when dissolved parameters are collected for analysis. The filter blank will be collected at a sampling location by passing laboratory-supplied deionized water through in-line filters used in the collection of dissolved metals, (or other analytes), then into the appropriate sample containers. The time and location of collecting the filter blank will be noted in the log book. The sample will be analyzed for the same analytes as the sample collected from the location where the filter blank is prepared. In addition, one filter blank will be collected per lot of filters used. The filter lot check is to be performed one per lot of filters used and scheduled in a manner to allow for laboratory to report data prior to investigative sample collection.

6.2.1 Sample Labels and Identification System

Sample IDs will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, Sample Labeling and Custody and ENV-TI-05.80.03, Field Record Keeping. Each sample container will have a sample label affixed and secured with clear package tape as necessary to prevent label removal. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP. The overall project schedule may be adjusted to reflect seasonal variability to when SAPs can be implemented for sampling of fish tissue (April through October), fish ovary (April and June) and benthic/mayfly (June through August). Approval of the final EIP will dictate the actual start and completion dates on the project timeline.

Table 8. Preliminary Schedule for Surface Stream SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Surface Stream SAP Submittal		Completed
Prepare for Field Activities	30 Days	Following EIP Approval
Conduct Field Activities	15 Days	Following Field Preparation
Laboratory Analysis	50 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- Sampling methods and field locations may be adjusted based on actual field conditions. Any adjustments will be reported in the EAR.
- The anticipated schedule in Section 7.0 assumes that approval to proceed is provided such that sampling can be scheduled and conducted during the appropriate time of the year. If approval to proceed is received too late in the year, sampling will not proceed until the following year.

9.0 REFERENCES

Tennessee Valley Authority (TVA). 2017. "Surface Water Sampling." Technical Instruction ENV-TI-05.80.40, Revision 0000. May 4.

Tennessee Valley Authority (TVA). 2017. "Planning Sampling Events." Technical Instruction ENV-TI-05.80.01, Revision 0000 March 31.

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Tennessee Valley Authority (TVA). 2017b. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

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Tennessee Valley Authority (TVA). 2017d. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

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ATTACHMENT A
FIGURE

Figure No.
1

Title
Surface Stream Sampling

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-09
Technical Review by RD on 2018-01-09

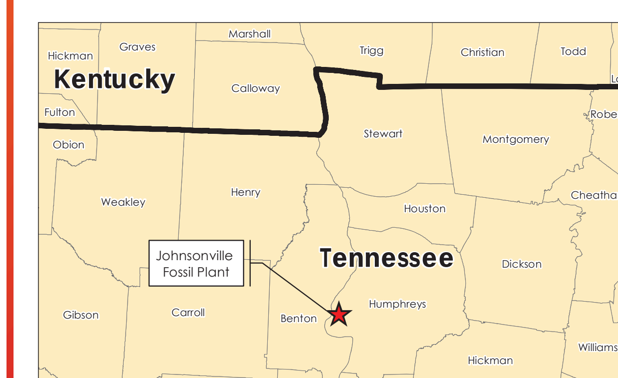
0 800 1,600 2,400 3,200 Feet
1:9,600 (At original document size of 22x34)

Legend

- Stream Sampling Transect
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemaps



Stantec TVA

U:\TVA-EIP\175567296\gis\mxds\JOF_Surface_Stream.mxd Revised: 2018-01-09 By: mbough

ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Surface Stream Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Waders, muck boots, knee boots, etc.
Peristaltic pump
Tubing
Hydrolab DS5X
Sonic depth meter
***These items are detailed in associated planning documents to avoid redundancy.**

APPENDIX V
FISH TISSUE SAP

Fish Tissue Sampling and Analysis Plan Johnsonville Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Johnsonville Fossil Plant
New Johnsonville, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 10, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	July 24, 2017
1	Addresses October 19, 2017 TDEC Review Comments and Issued for TDEC Review	January 12, 2018
2	Addresses March 9, 2018 TDEC Review Comments and Issued for TDEC Review	May 11, 2018
3	Addresses June 11, 2018 TDEC Review Comments and Issued for TDEC Review	July 20, 2018
4	Addresses comments and revisions from other EIPs and issued for TDEC review.	December 10, 2018

FISH TISSUE
SAMPLING AND ANALYSIS PLAN
JOHNSONVILLE FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Fish Tissue
Sampling and Analysis Plan
Johnsonville Fossil Plant
Tennessee Valley Authority
New Johnsonville, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 10, 2018 Revision 4, Final

All parties executing work as part of this Sampling and Analysis Plan sign below acknowledging they have reviewed, understand, and will abide by the requirements set forth herein.

TVA Investigation Project Manager	12/6/18 Date
TVA Investigation Field Lead	12-7-18 Date
Health, Safety, and Environmental (HSE) Manager	12/15/2018 Date
Investigation Project Manager	12/7/2018 Date
Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.12.03 11:54:25 -05'00' QA Oversight Manager	Date
Tod Noltemeyer Laboratory Project Manager	Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

Stantec

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LIST OF TABLES

LIST OF ATTACHMENTS

1.0 BACKGROUND

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (TDEC Order), to the Tennessee Valley Authority (TVA), setting forth a "process for the investigation, assessment, and remediation of unacceptable risks" at TVA's coal ash disposal sites in Tennessee. In accordance with the TDEC Order, TDEC and TVA held an Investigation Conference at the Johnsonville Fossil Plant (JOF) on August 17-18, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management at JOF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On June 14, 2016, TDEC submitted a follow-up letter to TVA which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On July 24, 2017, TVA submitted JOF EIP Revision 0 to TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

In response to TDEC's comments, this Fish Tissue Sampling and Analysis Plan (SAP) has been developed to evaluate whether fish in the immediate vicinity and downstream of JOF have higher concentrations of CCR-related constituents than fish from reference locations not adjacent to or downstream from the JOF Plant (Plant).

2.0 OBJECTIVES

The objective of this Fish Tissue SAP is to set forth the procedures to be followed to capture fish, remove tissue samples, and store and ship samples to a laboratory. Laboratory-generated results from the samples will be used to assess whether fish in the immediate vicinity and downstream of the Plant have higher tissue concentrations of CCR-related constituents than the same species of fish from reference locations not adjacent to or downstream of the Plant.

The fish tissue analytical results will be used in conjunction with sediment and mayfly data to evaluate contaminant bioaccumulation. Methods for collecting and analyzing sediment and mayfly tissues are described in other SAPs. This Fish Tissue SAP:

- Provides guidance on the use of boat-mounted electro-shocker and/or gill nets to capture target fish species
- Describes protocols for obtaining and processing fish tissue samples, and completing quality control activities so that data quality objectives are achieved
- Documents the analytical method/parameter list for sample analysis to be performed by TVA's contracted laboratory
- Describes the data validation and management activities that will be performed on the fish tissue samples and resulting data

3.0 HEALTH AND SAFETY

This work will be conducted under an approved Plant-specific Health and Safety Plan (HASP). This HASP will be in accordance with TVA Safety policies and procedures. Each worker will be responsible for reviewing and following the HASP. Personnel conducting field activities will have completed required training, understand safety procedures, and be qualified to conduct the field work described in this SAP. The HASP will include a job safety analysis (JSA) for each task described in this SAP and provide control methods to protect personnel. Personal protective equipment (PPE) requirements and safety, security, health, and environmental procedures are defined in the HASP. In addition, authorized field personnel will attend TVA required safety training and Plant orientation.

The Field Team Leader will conduct safety briefings each day prior to beginning work and at mid-shift or after lunch breaks and document these meetings to include the names of those in attendance and items discussed. TVA-specific protocols will be followed, including the completion of 2-Minute Rule cards. The JSAs will be updated if conditions change.

4.0 SAMPLING LOCATIONS

Five reaches have been selected for the collection of fish and associated fish tissue as shown in Figure 1 (Attachment A) and Table 1. These five reaches are strategically located based on access, current hydrogeologic knowledge, and the greatest expectation of successfully capturing target fish species. Three sites associated with the CCR units are located in the Tennessee River adjacent to Active Ash Pond 2. The first site, TRA, is located to the west of Active Ash Pond 2 at river mile 99.5 and extends approximately one mile to river mile 100.5. The second site, BH, is located east of Active Ash Pond 2 in what is known as the Boat Harbor Channel and is approximately 0.9 mile in length. The third sampling site, IC, is located east of Active Ash Pond 2 in what is known as the Intake Channel. The sample site is approximately 0.4 mile in length. The BH and IC sample sites were chosen due to their proximity to reported seeps from Active Ash Pond 2. The downstream sample site on the Tennessee River, TRD, extends from river mile 94.5 for approximately 1.5 miles to river mile 97 and is located approximately 2 miles downstream from Active Ash Pond 2. The upstream site, TRU, starts at river mile 102.5 and extends for two miles to river mile 104.5. This site is located approximately 2 miles upstream from the JOF facility and will act as a reference site. The sampling site locations may be modified based on conditions in the field at the time of the sampling activities. Table 1 lists each of the approximate fish collection locations proposed for the fish tissue sampling. Proposed sampling locations are shown on Figure 1.

The fish tissue sample locations coincide with sample locations for surface water, mayfly, benthic, and sediment sampling at the Plant. The corresponding sample locations are outlined in Table 2.

Table 1. Fish Collection Sampling Reaches Used for the Fish Tissue Sampling at JOF, Humphreys County, Tennessee.

Sampling Reach Name	Drainage	Approximate River/Creek Mile	Latitude	Longitude
TRD	Tennessee River	94.5 - 97	36.008342	-87.952097
			36.067617	-87.98025
TRA	Tennessee River	99.5 – 100.5	36.035686	-87.995372
			36.019758	-88.001158
TRU	Tennessee River	102.5 – 104.5	35.9924	-88.004347
			35.967242	-88.0098
BH	Boat Harbor Channel	NA	36.038864	-87.993275
			36.026489	-87.989367
IC	Intake Channel	NA	36.025892	-87.988872
			36.020067	-87.990767

Table 2. Corresponding Sample Locations at JOF, Humphreys County, Tennessee.

<table>
<tr><th>Surface Stream Sample Location</th><th>Corresponding Sediment Sample Location</th><th>Corresponding Benthic Sampling Location</th><th>Corresponding Mayfly Sampling Location</th><th>Corresponding Fish Tissue Sampling Location</th></tr>
<tr><td>N/A</td><td>N/A</td><td>MAC-TR01</td><td>N/A</td><td>N/A</td></tr>
<tr><td>STR-TR01</td><td>SED-TR01</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>STR-TR02</td><td>SED-TR02</td><td>MAC-TR02</td><td>N/A</td><td>N/A</td></tr>
<tr><td>STR-TR03</td><td>SED-TR03</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>STR-TR04</td><td>SED-TR04</td><td>MAC-TR03</td><td>TRA</td><td>TRA</td></tr>
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<tr><td>N/A</td><td>N/A</td><td>MAC-TR10</td><td>TRU</td><td>TRU</td></tr>
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<tr><td>STR-CV01</td><td>SED-CV01</td><td>MAC-CV01</td><td>N/A</td><td>N/A</td></tr>
<tr><td>STR-CV02</td><td>SED-CV02</td><td>MAC-CV02</td><td>N/A</td><td>N/A</td></tr>
<tr><td>STR-CV03</td><td>SED-CV03</td><td>MAC-CV03</td><td>N/A</td><td>N/A</td></tr>
<tr><td>N/A</td><td>N/A</td><td>MAC-IC01</td><td>N/A</td><td>N/A</td></tr>
<tr><td>N/A</td><td>N/A</td><td>MAC-IC02</td><td>N/A</td><td>N/A</td></tr>
<tr><td>N/A</td><td>N/A</td><td>MAC-TR01</td><td>N/A</td><td>N/A</td></tr>
<tr><td>STR-TR01</td><td>SED-TR01</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>STR-TR02</td><td>SED-TR02</td><td>MAC-TR02</td><td>N/A</td><td>N/A</td></tr>
<tr><td>STR-IC01</td><td>SED-IC01</td><td>MAC-IC03</td><td rowspan="2">IC</td><td rowspan="2">IC</td></tr>
<tr><td>STR-IC02</td><td>SED-IC02</td><td>N/A</td></tr>
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<tr><td>STR-BH02</td><td>SED-BH02</td><td>MAC-BH02</td></tr>
<tr><td>STR-BH03</td><td>SED-BH03</td><td>MAC-BH03</td></tr>
</table>

5.0 SAMPLE COLLECTION AND FIELD ACTIVITY PROCEDURES

This section provides details of procedures that will be used to collect fish tissue samples and document field activities.

Fish tissue sample collection will be consistent with applicable TVA Technical Instruction (TI) and Standard Operating Procedure (SOP) documents. Quality Assurance/Quality Control (QA/QC) procedures and data quality objectives are included in Section 6.0 and the Plant-specific Quality Assurance Project Plan (QAPP). Related TVA methods used for sampling and/or any deviations from standard techniques listed in this SAP, the SOPs, or TI's will be documented in the field logbook. A project field logbook and field forms will be maintained by the Field Team Leader to record field data and observations including water quality data, electro-shocking and gill netting efforts, number and species of fish captured, and specific data for fish processed for laboratory testing. Field activities will be documented in accordance with Section 5.2.3.

5.1 PREPARATION FOR FIELD ACTIVITIES

As part of field mobilization activities, the field sampling team will:

- Designate a Safety Officer
- Review applicable reference documents, including (but not limited to), TVA TIs (Section 5.2) and SOPs, QAPP (Appendix C), SAPs, and HASP.
- Complete required health and safety paperwork and confirm field team members have completed required training
- Coordinate activities with the Laboratory Coordinator, including ordering sample bottles, obtaining re-sealable sample bags, coolers, and high-purity deionized (DI) water, if needed, and notifying the Laboratory Coordinator of sampling and sample arrival dates
- Coordinate activities with Tennessee Wildlife Resources Agency (TWRA) as required by the Scientific Collection Permit
- Obtain the required field instruments and perform calibrations each day of sampling
- Obtain field equipment
- Discuss project objectives and potential hazards with project personnel
- Complete sample paperwork to the extent possible prior to deploying into the field, including chain-of-custody forms and sample labels

- Locate Sampling Reaches – Prior to starting sampling efforts each day, locate the sampling reaches using the Global Positioning System (GPS) and collect new coordinates if sampling reaches are modified due to field conditions

- Complete a field reconnaissance of proposed sampling locations to identify access locations

- Monitor weather, water levels, and water temperatures for safe and appropriate field sampling conditions and fish breeding seasons

5.2 SAMPLING METHODS AND PROTOCOL

Fish collection and associated fish tissue sampling will be completed following TVA TI's/SOPs to the extent practicable. Methods used for sampling and any deviations from the TVA TI's/SOPs will be documented in the field logbook. The TVA TI's/SOPs to be used during fish tissue sampling include but are not limited to the following:

- ENV-TI-05.80.02, *Sample Labeling and Custody*

- ENV-TI-05.80.03, *Field Record Keeping*

- ENV-TI-05.80.04, *Field Sampling Quality Control*

- ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*

- ENV-TI-05.80.06, *Handling and Shipping of Samples*

- KIF-SOP-31, *Fish Sampling with Gill Nets*

- KIF-SOP-33, *Fish Sampling Using Boat-Mounted Electroshocker*

The following sections describe fish collection and tissue sampling procedures.

5.2.1 Fish Collection

The fish sampling team will consist of personnel with expertise in fish sampling techniques and experience with the quality control requirements of the sampling protocols listed in Section 6.0. Prior to conducting fish sampling for tissue collection, appropriate Scientific Collection Permits will be obtained from TWRA. In addition, the survey will be coordinated with TWRA's Regional Office in accordance with TWRA's Scientific Collection Permits. Fish sampling will be completed on sampling reaches discussed in Section 4.0. Fish sampling will be conducted using a combination of boat-mounted electro-shocking (electro-fishing) and gill netting. The primary collection method will be electro-shocking; however, in the event that any species proves difficult to collect, gill nets will be used.

Electro-fishing will be performed beginning at the upstream end of each sampling reach and moving with the current to the downstream end of each sampling reach. As fish are shocked and begin to surface, Field Sampling Personnel will use dip nets to retrieve individuals with priority given to females of the target species.

In the event that some fish species (e.g. channel catfish) prove difficult to collect with boat electro-shocking equipment, gill nets will be used. Gill nets consist of a length of netting with a diameter large enough for a fish to pass partially through. There is a float line on top, and a lead line on the bottom, allowing the net to remain suspended in the water column. Gill nets will be set before dusk and retrieved just after sunrise the following morning. Fish visually observed to be decomposing will not be collected for sample analysis.

The fish captured will be observed for abnormalities, such as scoliosis, blind eye, parasites, fungus, or lesions. Fish collected for tissue samples will be weighed and measured. Collected fish will be stored in separate livewells or coolers of wet ice for each sampling reach until the sampling is completed each day.

In order to collect female fish with mature ovaries for tissue sampling, fish of each species will be collected during their respective spawning seasons which may necessitate multiple sampling events. Typically, these events will occur between April and June, corresponding with the spawning of each species targeted. Up to five electro-shocking passes and up to three gill net sampling events of a stream sampling reach will be performed during each sampling event, if necessary, to collect the appropriate number of fish of the desired size and fecundity for analysis.

Fish sampling techniques used and QA/QC procedures will follow TVA KIF-SOP-33, *Fish Sampling Using Boat-Mounted Electroshocker* and KIF-SOP-31, *Fish Sampling with Gill Nets*, to the extent practicable. The methods used for sampling, or the deviations made from them, will be documented in the field logbook.

5.2.2 Field Equipment Description, Testing/Inspection, Calibration, and Maintenance

A list of anticipated equipment for the field activities described herein is provided as Attachment B. A final list of equipment will be prepared by the Field Team Leader, and approved by TVA, prior to mobilization. Field equipment will be inspected, tested, and calibrated (as applicable) prior to initiation of fieldwork by Field Sampling Personnel and, if necessary, repairs will be made prior to equipment use. If equipment is not in the proper working condition, that piece of equipment will be repaired or taken out of service and replaced prior to use. Additional information regarding field equipment inspection and testing is included in the QAPP.

5.2.3 Field Documentation

Field documentation will be maintained in accordance with TVA TI ENV-05.80.03, *Field Record Keeping* and the QAPP. Field documentation associated with investigation activities will primarily be recorded in Plant-specific field forms, logbooks and/or on digital media (e.g., geographic information system (GIS)/GPS documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVAs TIs.

5.2.3.1 Daily Field Activities

Field observations and measurements will be recorded and maintained daily to chronologically document field activities, including sample collection and management. Field observations and measurements will be recorded in bound, waterproof, sequentially paginated field logbooks and/or on digital media and field forms.

Deviations from applicable work plans will be documented in the field logbook during sampling and data collection operations. The TVA Technical Lead and the QA Oversight Manager or designee will approve deviations before they occur.

5.2.3.2 Field Forms

Plant-specific field forms will be used to record field measurements and observations for specific tasks.

5.2.3.3 Chain-of-Custody Forms

For the environmental samples to be collected, chain-of-custody (COC) forms, shipping documents, and sample logs will be prepared and retained. Field Quality Control samples will be documented in both the field notes (logbooks and field forms) and on sample COC records. COC forms will be reviewed daily by the Field Team Leader and Field Oversight Coordinator for completeness and a quality control (QC) check of samples in each cooler compared to sample IDs on the corresponding COC form. Additional information regarding COC forms is included in Section 6.2.2 of this SAP, the QAPP, and TVA TIs.

5.2.3.4 Photographs

In addition to documentation of field activities as previously described, photographs of field activities will also be used to document the field investigation. A photo log will be developed, and each photo in the log will include the location, date taken, and a brief description of the photo content, including direction facing for orientation purposes.

5.2.4 Collection of Samples

For purposes of tissue sampling, fish will be categorized into five distinct groups, representing specific trophic levels within the aquatic ecosystem. Each trophic level group will be represented by one specific species. The representative species for this SAP are consistent with TVA study protocols:

- Top Carnivores – largemouth bass (*Micropterus salmoides*)
- Invertivores – bluegill (*Lepomis macrochirus*)
- Bottom Feeding Invertivore – redear sunfish (*Lepomis microlophus*)
- Bottom Feeding Omnivore – channel catfish (*Ictalurus punctatus*)
- Planktivore (Forage Fish) –shad (*Dorosoma spp.*)

Except for shad, a minimum of six to eight individuals of each species will be collected from each sampling reach to obtain sufficient sample weight for analysis and to measure variability within the sampling reach. The six to eight individuals of each species will be processed into fillet, ovary, or liver tissues (as described below) and combined to form composite tissue samples for each species from each sampling reach. Whole fish composite samples of 10 – 20 shad will be obtained from each sampling reach and combined to form a composite sample from each reach. Female fish are preferred over males, so male fish will only be retained in the event that six to eight females of each species can't be captured in a sampling reach. Composite samples of six to eight individual fish of the same species are consistent with United States Environmental Protection Agency (EPA) guidance on fish tissue monitoring (EPA 2000) and recommendations for fish collection to compare to the fish tissue-based water quality standard for selenium (EPA 2016).

Whole fish will be transported from the field on wet ice to the TVA Chickamauga Power Service Center (PSC) in Chattanooga, Tennessee for processing. Alternatively, if a contractor completes the fish tissue sampling, fish tissues will be processed onsite, with TVA's permission. Fish tissue will be resected within 48 hours of sample collection and frozen. Fish tissue samples will be shipped overnight on dry ice to the analytical laboratory.

For the composite fish samples (all species except shad), the following tissue samples will be collected from each species and combined into four separate resealable bags from each sampling reach as follows:

- Fillets from the right sides of the fish
- Fillets from the left sides of the fish
- Ovaries from the right sides of female fish

- Ovaries from the left sides of female fish
- Livers

One set of fillets and ovaries (left or right side) from each species from each sampling reach will be submitted to the analytical laboratory and composited for analysis. The remaining tissues from each individual fish will be stored individually in resealable bags and frozen to -20°C at TVA's Chickamauga PSC for potential future analysis, as needed.

In the event that insufficient fillet or ovary tissue is obtained from one set of fillets or ovaries (left or right side), the additional set (opposite side) of fillet or ovary tissue will be added to the sample for compositing by the analytical laboratory. Any remaining composite tissue will be frozen and held at the analytical laboratory for potential future analysis, as needed.

Due to smaller weight, fish livers tissue from each species from each sampling reach will be sent to the analytical laboratory for compositing and analysis. Any remaining composite liver tissue will be frozen and held at the analytical laboratory for potential future analysis, as needed.

In the event that any homogenized composite tissue (fillet, liver, or ovary) sample yields unexpected results, the frozen and stored fish tissue samples may be used to validate or contradict previous laboratory analysis. Long-term storage, up to one year if stored at or less than -20°C, and laboratory preparation of stored ovaries will follow protocol established by EPA (2016).

One co-located sample will be collected from each sampling reach and will consist of additional composite fillets, ovaries, and liver tissues of one of the target species, preferably different target species at each stream sampling reach, and submitted to the analytical laboratory for analysis. Duplicate samples are discussed in Section 6.2.

The fish used in a composite sample must meet the following criteria:

- Be of the same species
- Meet legal requirements of harvestable size or weight
- Be of similar size so that the smallest individual in a composite is no less than 75% of the total length of the largest individual, consistent with EPA guidance (EPA 2000 and 2016)
- Individuals of the same species will be collected as close to the same time as possible. This assumes that a sampling team was unable to collect all fish needed to prepare the composite sample on the same day. If fish used in the same composite are collected on different days, individual fish will be kept on ice until all the fish to be included in the composite are available for delivery to the laboratory
- Six to eight individuals per composite (or 10-20 individuals for shad) are proposed for collection. However, individuals must be collected in sufficient numbers and of

adequate size so that collectively, they will provide at least eight grams of material per sample (i.e. eight grams of fillet, eight grams of liver, and eight grams of ovaries) to allow analysis of the CCR Parameters

All fish collection, tissue sampling, processing, and shipment activities will be recorded in the field logbook and on field forms as specified by TVA-ENV-TI-05.80.02, *Sample Labeling and Custody*, and TVA-ENV-TI-05.80.03, *Field Record Keeping.*

5.2.5 Preservation and Handling

Once each composite fish tissue sample container is filled, a water proof sample label will be placed inside, the container will be sealed, the outside will be cleaned by wiping with a clean paper towel, a sample label will be attached to the outside of the container, and a signed and dated custody seal will be applied. Each sample container will be checked to confirm that it is sealed, labeled legibly, and externally clean. Sample containers will be packaged in a manner to prevent breakage during shipment.

Coolers will be prepared for shipment in accordance with TVA TI ENV-05.80.06, *Handling and Shipping of Samples* by taping the cooler drain shut and lining the bottom of the cooler with packing material or bubble wrap. Sample containers will be placed in the cooler in an upright position. Small uniformly sized containers will be stacked in an upright configuration and packing material will be placed between layers. Plastic containers will be placed between glass containers when possible.

Wet ice will be placed around and among the sample containers in the cooler during transportation to the processing laboratory. Dry ice will be placed among the sample containers in the cooler during shipment to the analytical laboratory. The cooler will be filled with additional packing material to secure the containers.

The original COC form will be placed in a re-sealable plastic bag taped to the inside lid of the cooler. A copy of the COC form will be retained with the field notes in the project files. A unique cooler ID number will be written on the COC form and the shipping label placed on the outside of the cooler. The total number of coolers required to ship the samples will be recorded on the COC form. If multiple coolers are required to ship samples contained on a single COC form, then the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers. Two signed and dated custody seals will be placed on alternate sides of the cooler lid. Packaging tape (i.e., strapping tape) will be wrapped around the cooler to secure the sample shipment.

Upon receipt of the samples, the analytical laboratory will open the cooler and will sign "received by laboratory" on each COC form. The laboratory will verify that the custody seals have not been previously broken and that the seal number corresponds with the number on the COC form. The laboratory will note the condition and temperature of the samples upon receipt and will identify discrepancies between the contents of the cooler and COC form. If there are discrepancies the

Laboratory Project Manager will immediately call the Laboratory Coordinator and Field Team Leader to resolve the issue and note the resolution on the laboratory check-in sheet. The analytical laboratory will then forward the back copy of the COC form to the QA Oversight Manager and Investigation Project Manager.

5.2.6 Sample Analyses

Composite fish tissue samples will be submitted for laboratory analysis of the following constituents, hereafter referred to as "CCR Parameters":

- Boron and calcium, 40 CFR Part 257 Appendix III
- 40 CFR Part 257 Appendix IV Constituents, excluding radium and fluoride
- Five inorganic constituents, Appendix 1 of TN Rule 0400-11-.04
- Strontium
- Percent moisture

The constituents listed in Appendix 1 of TN Rule 0400-11-01-.04 (i.e., TDEC regulations) were added to the list of CCR constituents for analyses to maintain continuity with other TDEC environmental programs. The fish tissue analysis will not include dissolved oxygen, chloride, fluoride, pH, sulfate, or total dissolved solids which are on the federal CCR Appendices III and IV constituents lists, because the constituents are not analyzed in animal tissues. The individual constituents of the CCR Parameters to be analyzed for the fish tissue study are listed in Tables 2 through 4.

Once received and custody has been established, the analytical laboratory will homogenize composite tissue samples using a series of dicing and mechanical blending procedures. The samples will be composited and homogenized on a species and sampling reach specific basis, resulting in a separate homogenate composite fillet, ovary, and liver tissue sample for each species at each sampling reach. These homogenized tissue samples will be analyzed for percent moisture and CCR Parameters outlined in Tables 3 through 5 below. Table 6 provides the analytical laboratory methods, sample size, preservation requirements, container size and holding times for the analysis.

Table 3. 40 CFR Part 257 Appendix III Constituents[1]

Appendix III Constituents
Boron
Calcium

Notes [1] Total dissolved solids, chloride, fluoride, pH, and sulfate are included in 40 CFR Part 257 Appendix III Constituents; however, are not included in the CCR Parameters for fish tissue sampling.

Table 4. 40 CFR Part 257 Appendix IV Constituents[1, 2]

Appendix IV Constituents
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium

Notes [1] Radium 226 and 228 Combined are included in 40 CFR Part 257 Appendix IV Constituents; however, are not included in the CCR Parameters for fish tissue sampling.

[2] Analysis of fluoride is not applicable to fish tissue samples.

Table 5. TN Rule 0400-11-01-.04, Appendix 1 Inorganic Constituents

TDEC Appendix 1 Constituents[1, 2]
Copper
Nickel
Silver
Vanadium
Zinc

Notes [1] Strontium will be analyzed as part of the CCR Parameters; however, is not included in the Appendices III or IV or TDEC Appendix I constituents.

Table 6. Specifications for TVA Fish Tissue Sample Collection Analysis

Matrix	Parameters	Analytical Methods	Sample Size [1]	Preservation Requirements (chemical, temperature, light protected)	Containers (number, size, and type)	Maximum Holding Time (preparation/analysis)
Fish Tissue	Constituents in Tables 2 – 4 (except mercury)	SW-846 6020A	5 g	Stored and shipped at 6°C Frozen to < - 10°C at laboratory Archived samples: Frozen to < - 20°C	Re-sealable plastic bags or laboratory supplied bottles	One Year
	Mercury	SW-846 7473	1 g			
	Percent Moisture	ASTM D2974 - 87	2 g			

Notes: [1] Sample size is a minimum.

5.2.7 Equipment Decontamination Procedures

Decontamination will be performed for fish tissue sampling and processing equipment in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination* to prevent cross-contamination. Processing equipment and tools in contact with fish tissues will be decontaminated prior to use, between samples, and between sampling reaches. Nitrile gloves used during preparation of fish tissue sampling, and any swabs, or other decontamination brushes and wash pans used will be disposed of as general trash. All general trash, including fish remains, will be containerized and disposed of in accordance with Section 5.2.8. Decontamination activities will be documented in the field logbook. Additional information regarding equipment decontamination procedures and QA/QC is located in the QAPP.

5.2.8 Waste Management

Investigation derived waste (IDW) generated during implementation of this Sampling and Analysis Plan may include, but is not limited to:

- Fish remains
- Personal Protective Equipment
- Decontamination fluids
- General trash

IDW will be handled in accordance with TVA TI ENV-TI-05.80.05, *Field Sampling Equipment Cleaning and Decontamination*, the Plant-specific waste management plan, and local, state, and federal regulations. Transportation and disposal of IDW will be coordinated with TVA Plant personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP describes quality assurance (QA)/quality control (QC) requirements for the overall Investigation. The following sections provide details regarding QA/QC requirements specific to fish tissue sampling and analysis.

6.1 OBJECTIVES

The Data Quality Objectives (DQOs) process is a tool employed during the project planning stage to confirm that data generated from an investigation are appropriate and of sufficient quality to address the investigation objectives. TVA and the Investigation Project Manager considered key components of the DQO process in developing investigation-specific SAPs to guide the data collection efforts for the Investigation.

Specific quantitative acceptance criteria for analytical precision and accuracy for the matrices included in this investigation are presented in the QAPP.

6.2 QUALITY CONTROL CHECKS

Two types of field QA/QC samples will be collected when collecting fish tissue samples in accordance with TVA TI ENV-TI-05.80.04, *Field Sampling Quality Control*. Criteria for the number and type of QA/QC samples to be collected for each analytical parameter are specified below.

Field Duplicate Samples – One co-located sample will be collected from each sampling reach and will consist of additional fillet, ovaries, and liver tissues of one of the target species, preferably different target species at each stream sampling reach, and submitted to the analytical laboratory for analysis. These samples will be prepared as blind duplicates. The co-located sample will be analyzed for the same parameters as the primary sample.

Equipment Blanks (Rinsate Blanks) – One equipment (rinsate) blank will be collected during each day of the fish tissue processing activities. The equipment blank will be collected by pouring laboratory-provided deionized (DI) water into or over the decontaminated tissue processing equipment, then into the appropriate sample containers. The time and location of collecting the equipment blank will be noted in the field logbook. The sample will be analyzed for the same analytes as the fish tissue samples.

Homogenization blank samples from the analytical laboratory processing equipment will be obtained by running ice through the fish tissue blending apparatus into laboratory grade sample containers for analysis.

6.2.1 Sample Labels and Identification System

Sample IDs will be recorded on all sample container labels, custody records, and field sheets in accordance with TVA TIs ENV-TI-05.80.02, *Sample Labeling and Custody* and ENV-TI-05.80.03, *Field Record Keeping*. Each sample container will have a sample label affixed and secured with clear package tape as necessary to prevent label removal. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in the QAPP.

6.2.2 Chain-of-Custody

The possession and handling of individual samples must be traceable from the time of sample collection until the time the analytical laboratory reports the results of sample analyses to the appropriate parties. Field staff will be responsible for sample security and record keeping in the field.

The COC form documents the sample transfer from the field to the laboratory, identifies the contents of a shipment, provides requested analysis from the laboratory, and tracks custody transfers. Additional information regarding COC procedures is located in the QAPP.

6.3 DATA VALIDATION AND MANAGEMENT

As stated in the EIP, a QAPP has been developed such that environmental data are appropriately maintained and accessible to data end users. The field investigation will be performed in accordance with the QAPP. Laboratory analytical data will be subjected to data validation in accordance with the QAPP. The data validation levels and process will also be described in the QAPP.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of this SAP are summarized below. This schedule is preliminary and subject to change based on approval, field conditions, and weather conditions. For the overall EIP Implementation schedule, including anticipated dates, see the schedule provided in the EIP. The overall project schedule may be adjusted to reflect seasonal restrictions to when SAPs can be implemented for sampling of fish tissue (April through October), fish ovary (April and June) and benthic/mayfly (June through August). Approval of the final EIP will dictate the actual start and completion dates on the project timeline.

Table 7. Preliminary Schedule for Fish Tissue SAP Activities

Project Schedule		
Task	**Duration**	**Notes**
Fish Tissue SAP Submittal		Completed
Prepare for Field Activities	20 Days	Following EIP Approval
Conduct Field Activities	40 Days	Following Field Preparation
Laboratory Analysis	45 Days	Following Field Activities
Data Validation	30 Days	Following Lab Analysis

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, assumptions are as follows:

- The number and/or location of the proposed samples described in this SAP may have to be modified based on conditions encountered in the field. Any deviations from this SAP will be included in the EAR.

- The fish sampling methods and analysis described in this SAP may have to be modified based on conditions encountered in the field, number of target specimen captured, presence of ovaries in female fish, and ability to obtain required sample weight of tissues. Any deviations from this SAP will be discussed in the EAR.

- The anticipated schedule in Section 7.0 assumes that approval to proceed is provided such that sampling can be scheduled and conducted during the appropriate time of the year. If approval to proceed is received too late in the year, sampling will not proceed until the following year.

9.0 REFERENCES

Tennessee Valley Authority (TVA). "Standard Operating Procedure for: Management of Investigation-Derived Waste." Standard Operating Procedure TVA-KIF-SOP-12.

Tennessee Valley Authority (TVA). 2010a. "Standard Operating Procedure for: Fish sampling with Gill Nets." Standard Operating Procedure TVA-KIF-SOP-31. August.

Tennessee Valley Authority (TVA). 2010b. "Standard Operating Procedure for: Fish Sampling Using Boat-mounted Electroshocker." Standard Operating Procedure TVA-KIF-SOP-33. June.

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Tennessee Valley Authority (TVA). 2017b. "Field Record Keeping." Technical Instruction ENV-TI-05.80.03, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017c. "Field Sampling Quality Control." Technical Instruction ENV-TI-05.80.04, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017d. "Field Sampling Equipment Cleaning and Decontamination." Technical Instruction ENV-TI-05.80.05, Revision 0000. March 31.

Tennessee Valley Authority (TVA). 2017e. "Handling and Shipping of Samples." Technical Instruction ENV-TI-05.80.06, Revision 0000 March 31.

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United States Environmental Protection Agency (EPA). 2016. "Aquatic Life Ambient Water Quality Criterion for Selenium (Freshwater)." https://www.epa.gov/sites/production/files/2015-10/documents/draft-aquatic-life-ambient-water-quality-criterion-for-selenium-freshwater-2015-factsheet.pdf. June.

United States Environmental Protection Agency (EPA). 2016. "Technical Support for Fish Tissue Monitoring for Implementation of EPA's 2016 Selenium Criterion (Draft), EPA 820/F-16/007." September.

United States Environmental Protection Agency (EPA) Region 4. 2001. "Environmental Investigations Standard Operating Procedures and Quality Assurance Manual." November.

United States Environmental Protection Agency (EPA) Region 4. 2011. "Data Validation Standard Operating Procedures for Contract Laboratory Program Routine Analytical Services, Revision 2.0." September.

ATTACHMENT A
FIGURE

Figure No.
1

Title
Fish Sampling

Client/Project
Tennessee Valley Authority
Johnsonville Fossil Plant

Project Location
New Johnsonville, Tennessee

175567296
Prepared by LMB on 2018-01-09
Technical Review by ZW on 2018-01-09

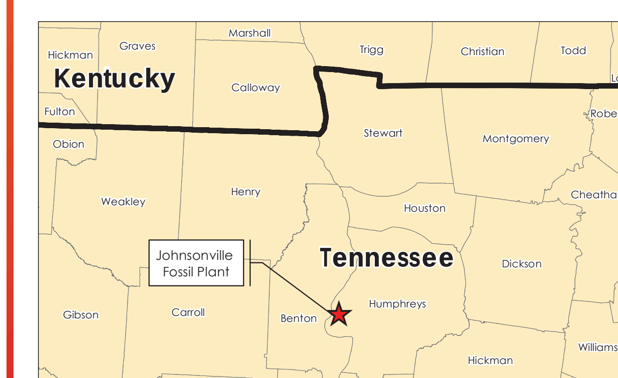
0 3,000 6,000 9,000 12,000 Feet
1:36,000 (At original document size of 22x34)

Legend

- Fish Sample Location
- CCR Unit Boundary (Approximate)
- Coal Yard
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by ESRI Basemaps



Stantec
TVA

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ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Fish Tissue Investigation

Item Description
***Health and Safety Equipment (e.g. PPE, PFD, first aid kit)**
***Field Supplies/Consumables (e.g. data forms, labels, nitrile gloves)**
***Decontamination Equipment (e.g. non-phosphate detergent)**
***Sampling/Shipping Equipment (e.g. cooler, ice, jars, forms)**
Field Equipment
GPS (sub-meter accuracy preferred)
Digital camera
Batteries
Boat and paddles
Depth finder
Anchor
Boat-mounted electro-shocker
Gasoline-powered generator
Control box (including isolation transformer)
"Dead-man" switch
Two outboard gas tanks
Positive and negative electrodes mounted on fiberglass poles
Gill nets (including spare nets)
Rope
Net hooks and net picks
Dragging hook for recovering lost nets
Marker floats (one per net)
Net anchors
Fiberglass fish club
Data logger
Galvanized net tubs
Live tank with water pump and aerator
Fillet knives
Fillet board
Knife sharpening equipment
900 mm measuring board
10 kg platform weighing scale
Scalers and spoons
Dip nets, long and short handled, insulated
Hand pails (approximately 13 liter)
5 gallon buckets
Waders, muck boots, knee boots, etc.
pH and conductivity meters
Thermometer
***These items are detailed in associated planning documents to avoid redundancy.**

APPENDIX W
DATA MANAGEMENT PLAN

Tennessee Valley Authority, 1101 Market Street, BR 4A, Chattanooga, Tennessee 37402-2801

March 8, 2018

Mr. Chuck Head
Assistant Commissioner
Tennessee Department of Environment
and Conservation (TDEC)
Tennessee Tower William R. Snodgrass Building
312 Rosa L Parks Avenue
Nashville, Tennessee 37243-1548

Dear Mr. Head:

TENNESSEE VALLEY AUTHORITY (TVA) – DATA MANAGEMENT PLAN (DMP) – COMMISSIONER'S ORDER NUMBER OGC15-0177

Enclosed is the DMP for the above mentioned order. This DMP Revision 1 responds to comments provided by TDEC in an email dated February 7, 2018.

If you have questions regarding this information, please contact Bryan Wells at (423) 751-7393 or by email at wbwells@tva.gov. You may also contact me at (423) 751-3304 or by email at sstidwell@tva.gov.

Sincerely,

M. Susan Smelley

M. Susan Smelley
Director
Environmental Compliance & Operations

Enclosure

cc (w/o Enclosure):

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Setting the Standards for Innovative Environmental Solutions

TENNESSEE VALLEY AUTHORITY

MULTI-SITE ORDER ENVIRONMENTAL INVESTIGATIONS

DATA MANAGEMENT PLAN

Revision 1

March 2018

Prepared by

ENVIRONMENTAL STANDARDS, INC.
1140 Valley Forge Road
P.O. Box 810
Valley Forge, PA 19482-0810

Prepared for

TENNESSEE VALLEY AUTHORITY
1101 Market Street
Chattanooga, TN 34702-2801

Revision Log MULTI-SITE ORDER ENVIRONMENTAL INVESTIGATIONS DATA MANAGEMENT PLAN (TVA EI DMP)		
Revision and Date	Section Reference	Revision Description
Revision 0, November 2017	n/a	Issued for TDEC Review
Revision 1, March 2018	2.1.2	Updated responsibilities to align with QA Program definitions.
Revision 1, March 2018	2.1.2.1	Updated responsibilities to align with QA Program definitions.

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

On August 6, 2015, the Tennessee Department of Environment and Conservation (TDEC) issued Commissioner's Order No. OGC15-0177 (Multi-Site Order), to the Tennessee Valley Authority (TVA), setting forth a process for the investigation, assessment, and remediation of unacceptable risks at TVA's coal ash disposal sites in Tennessee. In response to the Multi-Site Order, TVA is initiating Environmental Investigations (EIs) at each of the TVA facilities in Tennessee addressed in the Multi-Site Order. The primary goal of this TVA EI Data Management Plan (TVA EI DMP) is to address the logistics and technical challenges of managing analytical data generated by environmental laboratories and Field Sampling Personnel in support of activities intended to address the requirements set forth in the Multi-Site Order. This TVA EI DMP is intended to provide a basis for supporting a full technical data management business cycle from pre-planning of sampling events to reporting and analysis with a particular emphasis on completeness, data usability, and most importantly, defensibility of the analytical data.

Typical environmental Quality Assurance Project Plans (QAPPs), Sampling and Analysis Plans (SAPs), and Data Management Plans (DMPs) predominately focus on analytical chemistry data from the environmental investigations of various media (air/vapors, soil, sediment, surface water, and groundwater) and receptors (ecological and human). Due to the comprehensive nature of the Coal Combustion Residuals (CCR) Rule and the Multi-Site Order, the over-arching disciplines requiring data management are:

- Civil/Mapping;
- Environmental/Surface Water;
- Geotechnical; and
- Hydrogeology.

The work products of these disciplines will produce a wide-range of data and deliverables needing management. In addition, the Multi-Site Order requires a timely distribution of information to TDEC as well as public involvement.

TVA has decided that the best way to support the wide-array of data management needs related to the Multi-Site Order, is to build a SharePoint-based knowledge management portal (KMP) where data and deliverables will be housed and accessible. The KMP will integrate the EarthSoft® EQuIS™ (EQuIS) database for analytical chemistry and field parameter data, geographic information system (GIS) database for geospatial data, and various other databases for historical and current deliverables. The KMP will thus serve as the central access point for the Environmental Investigation Plans (EIPs), the EI data, and other data necessary for the Corrective Action/Risk Assessment (CARA).

To support the TVA Multi-Site Order response objectives, a Quality Assurance (QA) program has been implemented to verify that environmental data generated for use in decision-making is of high quality and is legally defensible. The QA program is documented in the QAPPs developed as part of each site-specific EIP. The sampling design and execution for monitoring activities associated with each EI are described in the site-specific EIP and investigation-specific SAPs.

Environmental data have been and will continue to be used for purposes such as, but not limited to, operational decisions, ecological and human health risk assessments; delineation of the extent of contamination and ash transport; and to demonstrate the achievement of project objectives. Accordingly, it is imperative that the data are subjected to a formal data management process.

On behalf of TVA, Environmental Standards, an independent QA firm, has prepared this TVA EI DMP. The requirements of the TVA EI DMP are applicable to TVA environmental personnel, TVA information technologies personnel, support staff, contractors, and analytical laboratories.

1.1 Historical and Recent Data

Environmental data associated with surface water, groundwater, sediment, biological, CCR, and soil samples have been collected by TVA during previous operational periods. For the purpose of this TVA EI DMP, “historical” data on this project is defined as analytical data collected by TVA or its contractors prior to the institution of this data management plan. Historical analytical data sets intended for use under the TVA Multi-Site Order response will be included in TVA's project database as requested by TVA. Historical data migration efforts will be detailed in one or more separate Data Migration Plans, at such time that the scope of the migration has been developed. TVA will conduct environmental sampling under the EIPs developed in response to the Multi-Site Order, resulting in the generation of a significant amount of environmental analytical and related field data; these data are referred to as “Recent” data in this TVA EI DMP.

1.2 Existing Project Database General Structure

TVA and its designated contractors will use an existing EQuIS database (TVA EI database) to store recent data, as well as any historical data requiring migration. The TVA EI database will be separated into distinct facilities to store data associated with each site-specific EIP. The database will use common valid values, data qualifier definitions, and management processes across all TVA facilities. Reference value files (RVF) containing lists of valid values used in the database will be provided to analytical laboratories, Field Team Leaders, and other appropriate parties, as needed.

1.3 Objectives

The major objectives for the TVA Multi-Site Order Data Management Program are to:

- Maintain data control, consistency, reliability, and reproducibility throughout the life of the EIs;
- Establish the framework for consistent documentation of the quality and validity of field and laboratory data compiled during investigations;
- Describe in detail the data management procedures for EI-related data;
- Include procedures and timelines for sharing data with stakeholders as well as procedures for providing both electronic and hardcopies to specified recipients of each type of data; and
- Enable the use of EI data in a consistent and easily shared format among appropriate parties.

2.0 DATA MANAGEMENT TEAM

This section describes the key roles and responsibilities associated with the Data Management Program and processes for managing data.

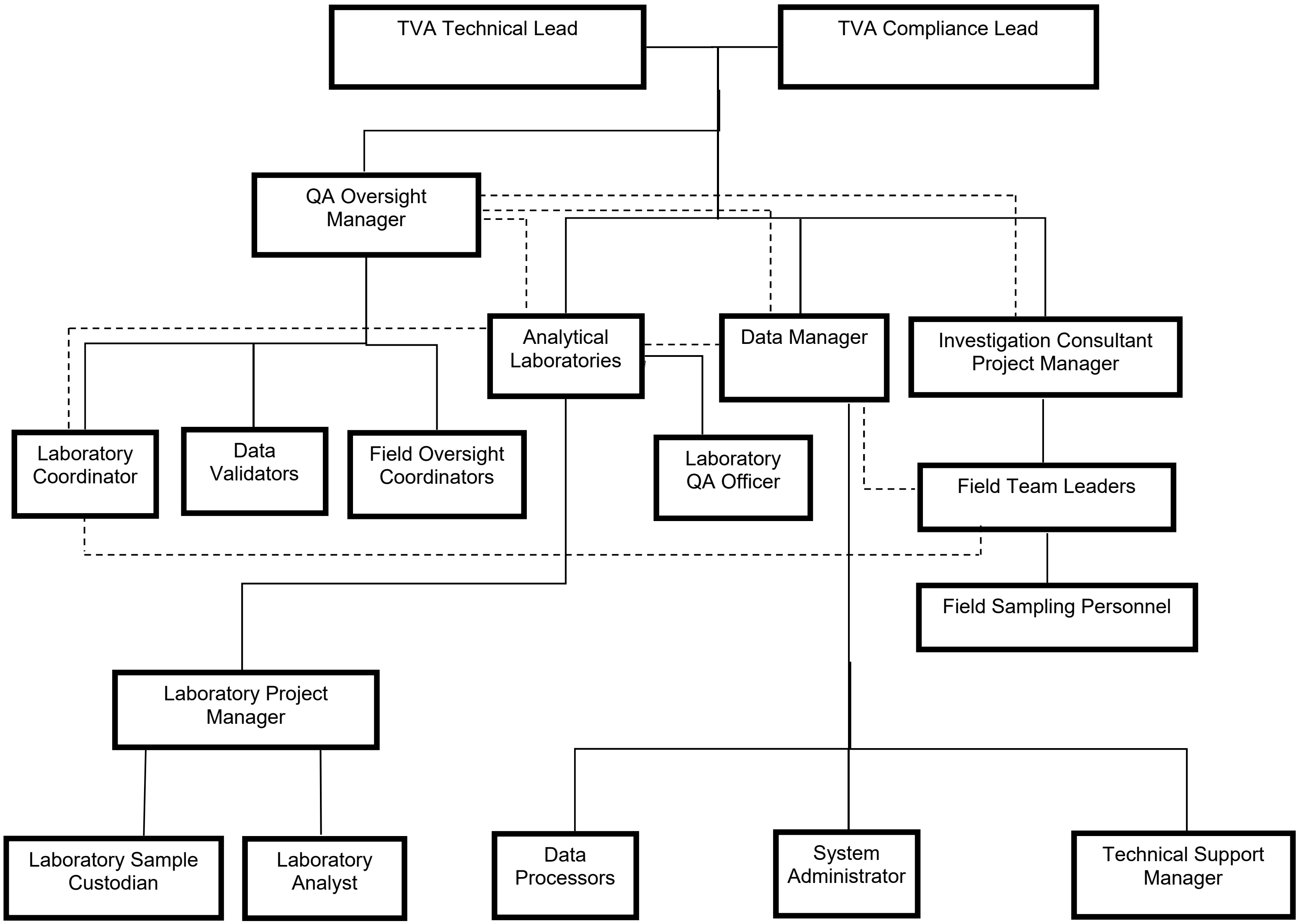
Users of the EQuIS Quality and Data Management System (EQDMS) primarily consist of technical and project staff that are assumed to have a general understanding of the environmental data and the EIs being conducted at each TVA facility. Some users are also required to have an advanced understanding of the EQDMS and relational database architecture.

The data management team consists of the following positions.

- Data Manager
- Data Processors
- Technical Support Manager
- System Administrator
- Data Analysts and Other Data Users
- Field Team Leaders
- Field Sampling Personnel
- Laboratory Coordinator

The organization chart for the TVA EI Data Management Program is presented in Figure 2-1. The Data Management Team is a component of the overall QA Program for each plant-specific EI. The roles and responsibilities for the TVA Technical Lead, TVA Compliance Lead, Investigation Consultant Project Manager and subordinate roles, Analytical Laboratory and subordinate roles, and QA Oversight Manager and subordinate roles are detailed in the QAPP developed for each of the plant-specific EIs. The relationship between the TVA Technical Lead and the TVA Compliance Lead is reflected in Part VII.F of the Multi-Site Order. Descriptions of data management personnel roles and responsibilities, and additional responsibilities of project personnel specific to the data management program, are provided in the sections below.

Figure 2-1. Organization Chart and Lines of Communication for TVA Multi-Site Order EI Data Management



2.1 Data Managers

Data Managers are responsible for managing the project EQuIS database, which includes analytical data from the project laboratories, field data from the investigation consultant, and historical data of known quality that is intended for use under the TVA Multi-Site Order. The Data Manager acts as the single point of contact for TVA for data management and for data-related issues. Data Managers are responsible for ensuring compliance with the plant-specific EI QAPP and the TVA EI DMP. Data Managers make certain that adequate Data Management Team members are available and properly trained, and that adequate software and hardware are available. Data Managers perform periodic audits on components of the data management system including access and security controls, system documentation, and data backup procedures. Data Managers have an intimate knowledge of the data management process, relational database concepts, and the architecture of the EQDMS.

Data Managers are typically the most knowledgeable and active user of the EQDMS and performs or directs the majority of the data updates or changes. A Data Manager or designee receives electronic data deliverables (EDDs) directly from the project laboratories after sample analysis and formats the deliverables such that they can be used during the validation/verification process. Field data is collected and submitted to a Data Manager from the Field Team Leaders utilizing field EDDs and is loaded and managed in the project database. Data Managers work directly with the Investigation Consultant Project Managers and field staff members to perform checks that the data are complete and accurate, as well as with data analysts, and other data users to provide queries, tables, graphs, and data exports. Data Managers are responsible for updating and implementing the TVA EI DMP and other quality documentation pertaining to data management.

2.1.1 Data Processors

Data Processors log in and load data delivered to the system. Data Processors are responsible for first-level activities and report any exceptions encountered in a standard process to the Data Manager for review and action. Data Processors are responsible for deliverable tracking, standard data loading, and providing standard EQDMS reports. Data Processors update or modify data in the database at the direction of the Data Manager in support of QA activities.

2.1.2 Technical Support Manager

The Technical Support Manager is responsible for any programming or database schema change required to support the operation of the EQDMS for this project. The Technical Support Manager is typically involved in the planning and implementation phases of the project and, once the system is operational, acts primarily as a technical advisor to the project team for any contemplated change in functionality. The Technical Support Manager sets user authentication and controls access to the data, maintains data tables necessary for the EQDMS to run, and generally manages EQDMS usage. The Technical Support Manager has a strong background in information systems and relational database hardware, software design and programming, detailed understanding of the EQDMS architecture, and familiarity with the data management business process.

2.1.3 System Administrator

The System Administrator will be responsible for the operation and maintenance of the EQDMS. The System Administrator will back up the data and confirm that the system is available for users. The System Administrator has a strong background in network support, information systems, and hardware and software maintenance.

2.2 Field Team Leaders

The Field Team Leaders are the primary contacts in the field and are responsible for field activities, as listed below.

- Provide coordination and management of field personnel and subcontractors.
- Provide coordination of field sampling and calibration activities.
- Submit analytical requests to the Laboratory Coordinator.
- Verify field-sampling personnel are familiar with field procedures and that these procedures are followed to achieve the data objectives.
- Review field logbooks and field data sheets for completeness, consistency, and accuracy.
- Conduct QA review of field data and coordinate submittal of field data to the Data Manager

Field Team Leaders are responsible for implementing the investigation-specific SAPs that describe data collection requirements and activities to be conducted. Field Team Leaders are responsible for overall coordination between field activities and the data management process. Field Team Leaders understand the data management process and interactions between field and data management staff.

2.2.1 Field Sampling Personnel

Field Sampling Personnel are responsible for the performance of field activities as required by the investigation-specific SAPs and associated field TIs. Field Sampling Personnel document compliance with project requirements by recording field activities and observations in a field logbook at the time of the activity or observation. In addition, Field Sampling Personnel are responsible for collecting samples, submitting them to laboratories, and maintaining COC Records.

2.3 Laboratory Coordinator

The Laboratory Coordinator serves as a liaison between Field Team Leaders and the analytical laboratories. The Laboratory Coordinator’s responsibilities include:

- Review analytical requests to verify consistency with project SAPs.
- Submit analytical requests to the Laboratory Project Manager.
- Schedule sample submission and transportation (as needed).
- Review and approve laboratory bottleware orders.

- Review Chain of Custody (COC) Records submitted to the laboratories and sample receipt documentation provided by the laboratories.
- Serve as the point of contact for questions and issues arising during laboratory analysis.

2.4 Data Analysts and Other Data Users

Data analysts and other data users may be any project team members who require access to analytical data for reporting, interpretation, or decision-making. Data analysts and other data users use the EQDMS to evaluate data that have completed the verification/validation process. Analysts and Users can run standard reports in EQDMS and do not update or modify data in the database.

3.0 DATA MANAGEMENT PROCESS

Optimal control of data is enforced by rigorous pre-planning of sampling activities. The EQDMS provides the functionality to support the creation of COC forms and bottle labels, auto loading of laboratory-generated analytical chemistry data, automated correctness checking, detailed completeness checking, data verification, support for data validation reporting and editing, and technical data reporting and presentation. This functionality exists so that the stages of data management are efficient and performed as accurately as possible. Appendix A presents workflow diagrams illustrating the overall data management process and the detailed data verification/validation process.

3.1 Planning

The data management process starts with preparation of the investigation-specific SAP. This planning phase gives consideration for appropriate levels of documentation specific to the individual data collection process and details any appropriate field measurements and/or other event-related data. Based on the field-planning document, the Data Manager configures the EQDMS for the investigation to support the data collected on the required COC forms. Configuration of the system may involve defining Method Analyte Groups (MAGs) in the database that include the methods used by laboratories to analyze samples and the analytes to be reported by those methods, as well as setting up standard forms and reports to meet the needs of the project team. The EQDMS supports storage of the information on the COC form, including the laboratory, shipping information, sample identifications (IDs), type and quantity of containers, preservatives, analytical tests, sample date, and sampler. At the time of sample collection, the Field Sampling Personnel fill out the remaining information including the sampler's initials, sample collection date, and time, shipping information and sample IDs. Some deviation from this approach may be acceptable if it is fully documented and approved in investigation-specific SAPs.

3.2 Field Measurements and Sample Collection

The process continues with Field Sampling Personnel collecting environmental samples and field measurements, and documenting field activities. Field documents must be recorded and stored electronically in accordance with project requirements. The EQDMS provides the functionality to create the electronic COCs (eCOCs), or COCs may be manually populated by the Field Sampling Personnel, at the discretion of TVA and its designated contractor(s). The COC form, whether generated as an eCOC or hand-written, will serve as the legal document of sample handling and transfer. The COC form is provided to the Data Project Manager to enter technical data into the EQDMS and could possibly include additional sampling event information, coordinate data and field measurements. The details for the specific data to be collected during sampling or other activities are contained in investigation-specific SAPs and related TIs.

3.3 Sample Tracking

Sample tracking begins when the COC is created. Events tracked in the EQDMS include: sample shipment, laboratory sample receipt, data package receipt, EDD receipt, and any rejection or resubmission dates, as needed.

Data Processors update the sample tracking records in EQDMS upon receiving a deliverable. The laboratory receives and evaluates the samples for proper COC procedures and sample handling. The laboratory assigns unique laboratory sample IDs and a Sample Delivery Group (SDG) number. To confirm that samples were received and that the correct analyses will be performed, the laboratory then provides the Data Processors with a sample receipt confirmation (SRC) that specifies the following.

- Sample receipt quantities and condition of containers (such as broken/leaking, temperature, hold time, custody maintained).
- Sample preparation (such as compositing and filtration) and analyses to be conducted.
- Date that analyses will be completed.
- Laboratory sample IDs and SDG number.

A copy of the SRC is provided to Data Processors who update the database with the sample receipt information and continue to track sample/data reporting progress until all data are delivered and review completed.

3.4 Laboratory Analysis and Reporting

The laboratory personnel analyze the samples as specified on the COC Record and according to the published method and project-specific requirements outlined in the associated plant-specific EI QAPP. Once the samples are analyzed, an electronic copy of the laboratory data package and an EDD are produced and forwarded to an electronic mailbox established specifically for the project. A Data Processor monitors the project mailbox for deliverables received and processes the data for testing against project specifications as described in the following sections.

3.5 Data Loading and Review

Data are assigned status values based on progression through the data loading and review process. There are currently three status levels for data that have been reviewed. These status levels are “VERIFIED”, “FINAL-VERIFIED”, and “VALIDATED”. Data are automatically unclassified and assigned no status upon initial load to the database. After an automated chemistry data verification and second-level review, data are manually assigned a state of “VERIFIED” by a Data Processor. If automated verification is the only level of review required, the Data Processor sets the data to a stage of “FINAL-VERIFIED”. Upon completion of data validation inclusive of senior reviews, data are assigned a status of “VALIDATED” by a Data Processor.

3.5.1 Initial Data Loading

EDDs are received in an electronic mailbox established specifically for the project. EDDs are loaded by a Data Processor and data are automatically unclassified. The first test of the EDD is for correctness against the project specifications. Correctness testing is a review of the EDD format against structural rules. Correctness determines if data are delivered using the correct file layout, data types, and adherence to project specific values. The full list of requirements can be found in the EDD specification in Appendix B. When an error is identified during testing for correctness, an e-mail containing a report of the deficiency is created and reviewed by a Data Manager and sent to the laboratory with the request for resubmission. Typical problems found in this review are missing or incorrect valid values, incorrectly formatted data, duplicate rows, and missing Parent/Child sample relationships.

After successfully passing the correctness testing and subsequent loading to the database, data completeness is checked by comparing the planned sampling data associated with the COC form to the actual sample, analytical method and analyte delivered by the laboratory. When an error is identified during testing for completeness, an e-mail containing a report of the deficiency is created and reviewed by the Data Manager and sent to the laboratory requesting resubmission, with a copy to the QA Oversight Manager.

Once data have passed correctness and completeness processing, the data are ready for automated data verification processing.

3.5.2 VERIFIED Status

Automated electronic data verification is only performed on data that has been deemed to be correct and complete. A verification report is produced for review by the Data Validator. Data verification activities are conducted according to the associated plant-specific QAPP. The criteria used to assess accuracy and precision of the data are detailed in the associated plant-specific QAPP. The data are reviewed from a usability perspective using screening software; the qualification assigned by the screening software are subsequently reviewed by a Data Validator. A Data Processor will make any needed edits identified by the Data Validator. All edits are reviewed by the initial Data Validator, as well as peer reviewed by the QA Oversight Manager. After review and approval of the data verification report and related results by the Data Validator, the data are assigned a status of “VERIFIED” by a Data Processor.

3.5.3 FINAL-VERIFIED Status

Data that are not going to be subjected to data validation are set to a status of “FINAL-VERIFIED” by a Data Processor once the verification process as detailed above is complete.

3.5.4 VALIDATED Status

Validation will occur after automated verification has been completed. The decision to perform data validation on any given data set will be determined based upon the data quality objectives for that data set. Data validation is supported by reporting and edit functionalities in the EQDMS. Data tables are provided to the Data Validator, who will manually annotate those tables with validation edits. A Data Processor will make any needed edits; edited data tables are returned to the initial Data Validator for review and approval. Once all edits have been confirmed, final validation tables will be prepared for inclusion in reports. All edits are reviewed by the initial Data Validator, as well as peer reviewed by the QA Oversight Manager. This stage also reveals and resolves any EDD to hardcopy data discrepancies. After review and approval of the final data validation tables by the QA Oversight Manager, the data are assigned a status of “VALIDATED” by a Data Processor.

The associated plant-specific QAPP and/or the investigation-specific SAPs detail the sample program specific goals for the timeline of activities such as validation.

3.6 EQuIS Reports

Reports are available to users through EQuIS Professional or EQuIS Enterprise. Standard EQuIS reports and a summary of their purposes are detailed in Appendix C.

3.7 Management of Historical Data

As indicated in Section 1.2, there have been prior sampling events at TVA facilities that generated historical data. Managing historical data from these investigations is complicated by the fact that the agencies and contractors performing the investigations used different methods for sampling and analysis. In addition, the historical data may not have complete laboratory reports that allow proper verification/validation of the data. To manage historical data in a manner that addresses the variety of types, sources, and formats, as well as concerns regarding data validation, the following procedures will be implemented.

Electronic data received from other consultants may be migrated to EQDMS. The migration steps include matching up the historical fields with the fields in EQDMS, appending the historical data into the previously determined EQDMS fields, and running error checks on the newly appended data. If questions arise, the previous consultants are contacted for data clarifications. The data migration steps, such as field matching and changes made, are documented for future reference.

If only hardcopy files exist for desired results, these files may be used to perform manual entry of data into EQDMS. Any data requiring manual entry are checked by a second person for correctness of the entry.

Depending on the source and reliability of the historical data, data will be marked reportable or non-reportable. Reportable data are data deemed appropriate for quantitative use. Non-reportable data are deemed to be of unknown quality and may be used for qualitative purposes only. Historical data will be reviewed and assessed for potential quantitative or qualitative use following the procedures described in Section 14.0 of the associated plant-specific QAPP. Data are loaded into the database with an unclassified status, and updated to a status of “FINAL-NOT QCd” or another relevant status based upon the data quality and review.

Historical and legacy data that are determined to be intended for quantitative use will be subjected to a formal critical review process. Historical data will minimally be subjected to a reasonability review to identify potentially suspect data, apparent anomalies, or data that are not representative of current site conditions. Additional evaluation and/or validation may be conducted following the reasonability review; the level of review and validation conducted will be dependent on the data type, availability of supporting documentation, and criticality of the dataset for completing project objectives. In the event that historical or legacy data cited in the EIP cannot be substantiated, the data may not be suitable to support certain aspects of the investigation, and new data may be collected to supplement the historical/legacy data. After undergoing the review process described in the plant-specific QAPP, the data are marked appropriately within the EQDMS (*i.e.*, data deemed appropriate for quantitative use are marked as reportable and data deemed of unknown quality and or appropriate for qualitative use only are marked as non-reportable. Non-reportable results remain in EQDMS and can be queried, but are not included in standard reports. Custom reports can be created for non-reportable historical data, but users are cautioned about the undetermined reliability of the data.

3.8 Documenting and Communicating Changes to Reported Data

3.8.1 Communication of Issue

Errors in reported data are typically found by the data user or an individual working as part of the data management team. It is the responsibility of the individual to correctly identify and report an error in data stored in the EQDMS. An individual on the project team (a stakeholder) who identifies a need to change data must send an e-mail to a Data Manager describing the requested data change and providing supporting documentation. Any individual requesting a changed to data in the EQDMS is referred to as the Data Change Requestor in the subsequent sections. The Data Change Request Workflow Diagram presented in Appendix D illustrates the process for managing changes to reported data.

3.8.2 Completion of the Data Change Request Form

A Data Manager is responsible for reviewing the request and initiating a Data Change Request Form. An example Data Change Request Form is presented in Appendix E. Completion of the Data Change Request Form is essential to ensuring that the appropriate procedures and approvals are in place prior to initiating any changes and/or updates to the data reported in the EQDMS. The form contains essential information pertaining to the request itself, the origin of the request, the solution applied, contact information and signatures upon the approval and completion of the task. The Data Change Request Form shall be completed by the Data Manager with information from the Data Change Requestor. Additionally, the Data Change Request Form requires signatures by the QA Oversight Manager, the Data Manager, and the Data Change Requestor.

The Data Manager shall complete the Data Change Request Form prior to the approval and initiation of any changes and/or updates to the data already loaded to the EQDMS. The following sections of the Data Change Request Form shall be completed in full:

- Date: Date of the request as initiated by the Data Change Requestor
- Proposed Completion Date: Tentative date of completion as identified by the Data Requestor

- Name: Data Change Requestor
- Company: Data Change Requestor's company
- Phone/E-mail: Contact information of the Data Change Requestor
- Description of Request: A detailed summary outlining the request along with its origin and purpose
- Required Signatures: the printed name, signature and date signed of the:
    - Data Manager
    - QA Oversight Manager
    - Data Change Requestor

3.8.3 Communication and Approval Process for Data Change Request Form

The following steps are performed when communicating and approving the Data Change Request Form.

- The Data Manager complete the Data Change Request Form in its entirety as detailed above. A brief description of the resolution shall be provided in the section for use by the Data Project Manager.
- The Data Manager shall then request the review and confirmation of the Data Change Request Form by the Data Change Requestor.
- Upon approval of the Data Change Request Form, the Data Requestor will sign and date the form.
- The Data Manager will submit the Data Change Request Form to the QA Oversight Manager for review and signature.
- The Data Manager shall coordinate or perform the data change or update as requested. Upon resolution, the Data Manager shall sign and date the form.
- Once the Data Change Request Form is signed by all necessary parties, the Data Manager shall e-mail the approved Data Change Request Form, along with a report or query to confirm appropriate changes, to all stakeholders.
- Completed Data Change Request Forms will be posted on the KMP.

4.0 EQDMS DATA MANAGEMENT SYSTEM

This section provides an overview of the EQDMS and its components. This section also describes the specification for laboratory data submission and valid values.

4.1 EQDMS Overview

The EQDMS is composed of a commercially available environmental data management software suite, EQuIS, and can be supplemented and expanded using purpose-built QA Modules to work with the EQuIS software. The EQDMS has been configured to support project-specific requirements. The EQuIS software suite, which has been in use and continuously improved since 1994, is used on many environmental projects by industrial clients, consultants, and regulatory agencies at the state and federal levels. Functionality is provided on the internet for casual users and on the desktop for power users.

Software modules used on this project are described below.

4.1.1 EQuIS Enterprise Database

Analytical data, field data, and water level measurements are stored and hosted in a Microsoft® SQL database using the EQuIS Enterprise SQL server data schema. EQuIS connects to and accesses data using industry standard methodology. Security of the data is maintained using SQL server roles and assigning users appropriately.

4.1.2 COC Forms

COC forms for this project may be hand-written or generated utilizing an eCOC generator, if desired. The eCOC generator creates a unique COC ID and enables the Field Sampling Personnel to print COC forms. The eCOC is provided to the Data Project Manager to enter technical data into the EQDMS and could possibly include additional sampling event information, coordinate data and field measurements. The data generated from the eCOC are used to test analytical laboratory data for completeness and support status reports. The details for the specific data to be collected during sampling or other activities are detailed in investigation-specific SAPs, and related TIs.

4.1.3 EQuIS Enterprise Electronic Data Processor

The Enterprise electronic data processor (EDP) functionally enables loading of EDDs, testing against project specifications, and reporting the results of the testing to users. The rules and criteria built into the selected EDP Format are used to verify the correctness of EDDs.

4.1.4 Completeness Processor

The Completeness Processor assesses laboratory data within an SDG for the existence of project-specified data such as target analyte lists. Each SDG should represent a set of samples based on a COC form, each sample represents a set of analytical methods, and each analytical method represents a particular list of target analytes. MAGs are used to define required methods, analytes, fractions, and units. Completeness checks performed on data loaded into the EQDMS include:

- Confirming that all samples, analytical methods, and analytes requested on the COC/MAG are provided by the laboratory
- Confirming that no additional samples, analytical methods, or analytes are provided by the laboratory that were not planned
- Confirming that the following fields match identically between the planned and laboratory data:
    - Sample Names
    - Sample Matrix
    - Analytical Method
    - Fraction
    - Chemical Abstract Service (CAS) Registry Number
    - Result Units

4.1.5 Data Verification Module

The Environmental Standards Data Verification Module assesses loaded, correct, and complete data against project-specific QC limits for field and lab blank contamination, holding times, accuracy, precision, and surrogates. This functionality supports the project goals by automating a significant amount of manual effort in the quantitative assessment of analytical data.

4.1.6 EQuIS Enterprise

Enterprise is a web-based portal for visualization and generating pre-defined reports on demand. This function is ideally suited for casual users with a need to access project data in a simplified way and build simple reports. Users may run reports with defined parameters selected and save those settings for future uses as a “Pick Report.” Pick Reports can be scheduled for automated processing based on pre-defined triggers, the arrival of an EDD, or on a schedule such as a day of the week. Output from this reporting function can be a spreadsheet, a PDF, or a complex formatted deliverable such as an Excel® file that auto-formats based on selections.

4.1.7 EQuIS Professional

EQuIS Professional is a desktop application that is designed for more technical users. It has the capability to perform the same reporting functions as seen in Enterprise, but can additionally design, build, and publish Enterprise reports. This application enhances decision support by enabling links to analysis and visualization functions that can create crosstab tables, graphs, and statistical output. EQuIS Professional can also interface with third-party tools such as gINT®, Rockworks®, EVS®, Visual Modflow®, and Excel.

4.2 Electronic Data Deliverable Specification

The EQDMS can import EDDs in a wide variety of formats. The standard EQuIS EQEDD is used for submittal of all recent data by analytical laboratories. Laboratories are required to submit EDDs in accordance with the EQEDD Format provided in Appendix B.

5.0 SYSTEMS MANAGEMENT AND ADMINISTRATION

This section describes how the EQDMS is managed and administrated. Database Administration includes:

- Adding, altering, and deleting users, roles, and privileges; and
- Providing for routine backup of the database.

5.1 Access and Security

The EQDMS uses application-level and database-level security to limit access to system functionality. Users are required to log onto the system in order to gain entry into the application. The Data Management team has defined privileges based on roles while other users, such as data analysts and other data users have read-only privileges to the project data and read/write privileges to their personal reports. User accounts and privileges are maintained by the Technical Support Manager and approved by a Data Manager.

5.2 Data Backup

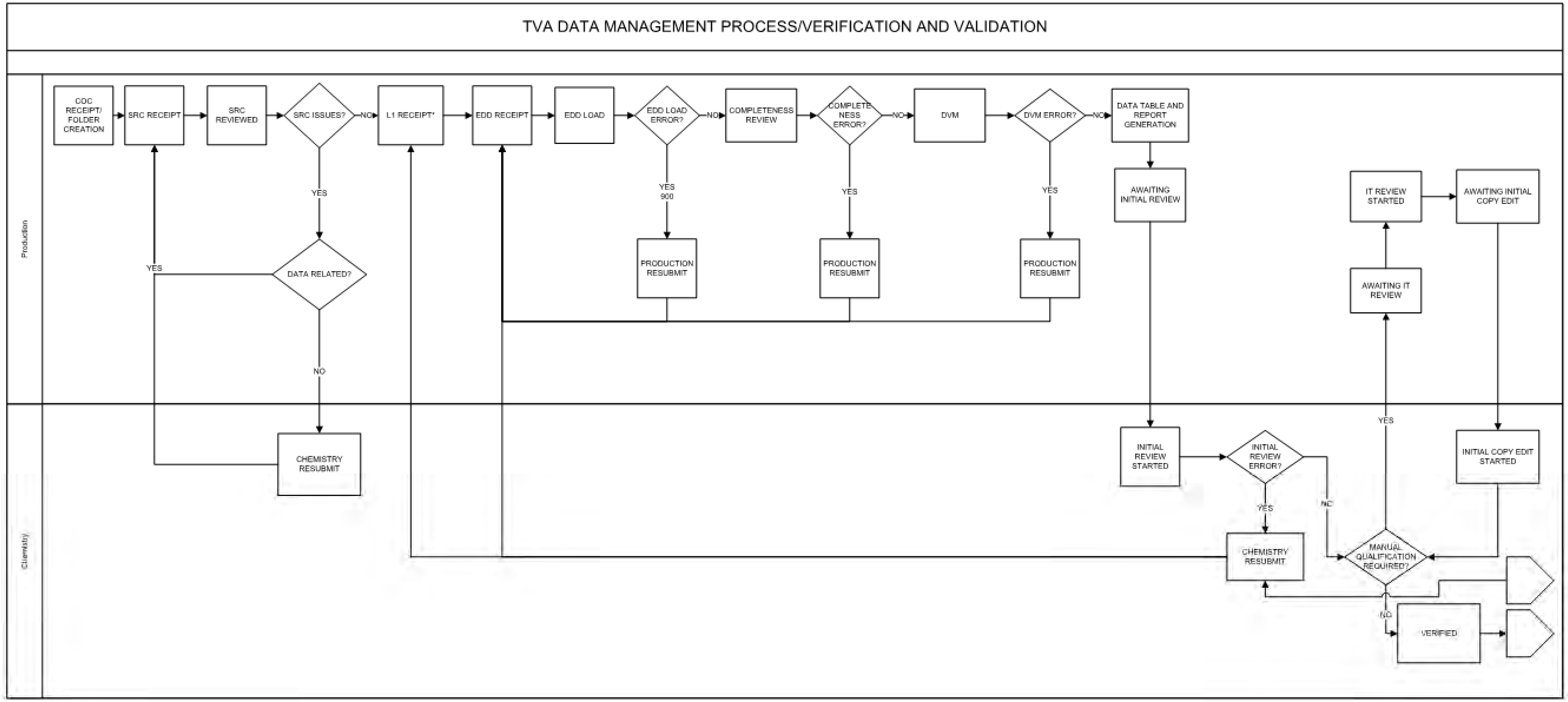
Automated full backups of the EQDMS are performed daily, and automated incremental backups of transactions are performed every 15 minutes to safeguard that any potential data loss is limited. An incremental daily backup is archived every night and retained for 30 days. A full weekly backup is archived and retained for 2 months. Monthly full backups are archived and retained for 40 years. Backups are written to digital tapes and are stored the next business day in an off-site environmentally controlled storage facility.

6.0 REFERENCES

- ENV-TI 05.80.02 Sample Labeling and Custody
- ENV-TI 05.80.03 Field Record Keeping
- ENV-TI 05.80.04 Field Sampling Quality Control
- ENV-TI 05.80.06 Handling and Shipping of Samples

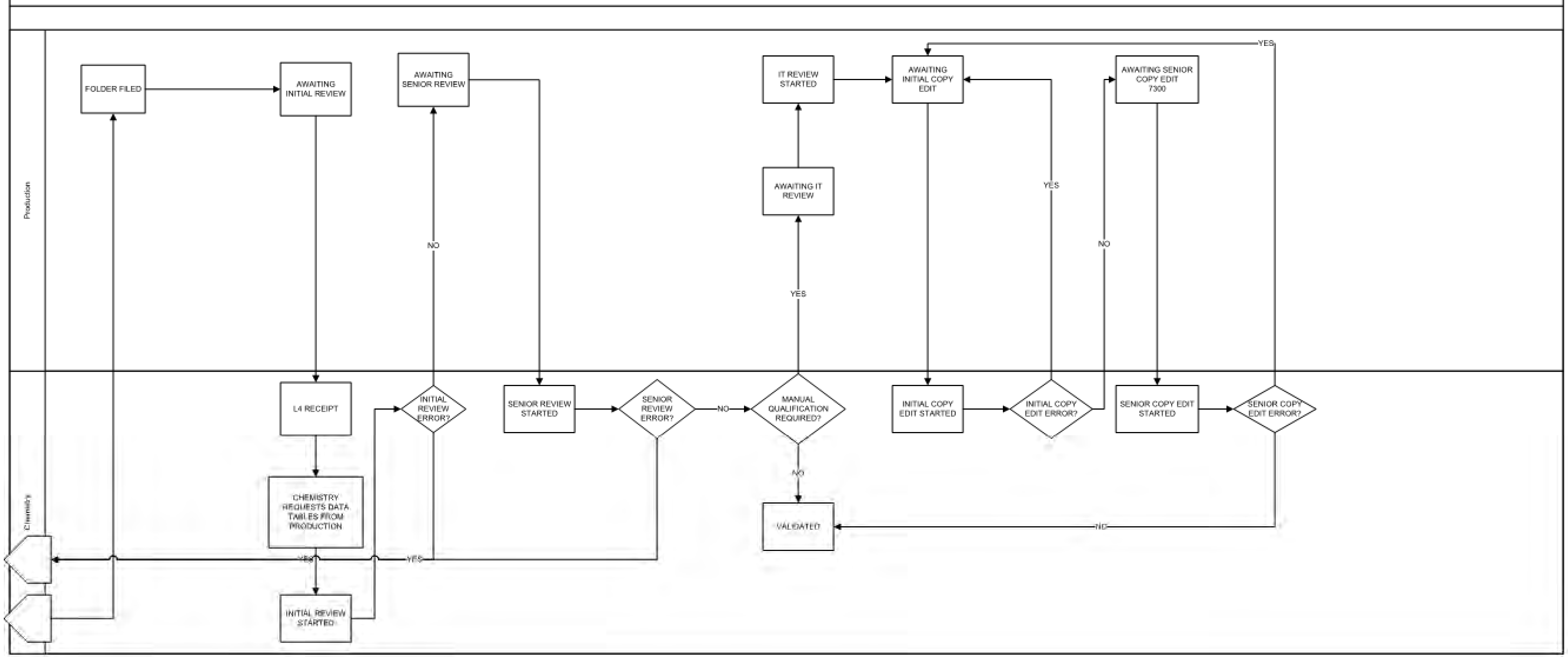
APPENDIX A

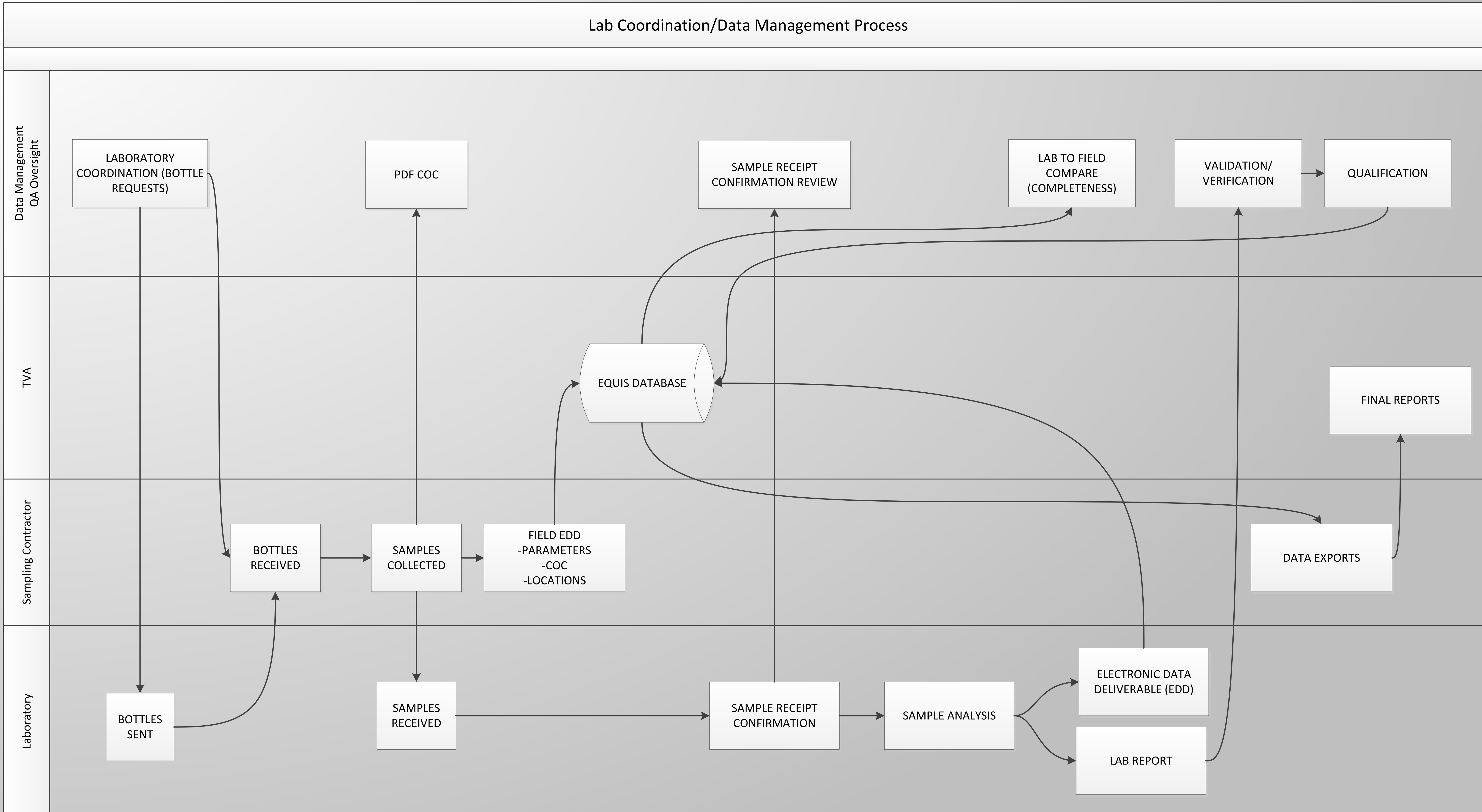
DATA MANAGEMENT WORKFLOW DIAGRAMS



TVA DATA MANAGEMENT PROCESS/VERIFICATION AND VALIDATION
Production
Chemistry
COC RECEIPT/ FOLDER CREATION
SRC RECEIPT
SRC REVIEWED
SRC ISSUES?
NO
YES
DATA RELATED?
YES
NO
CHEMISTRY RESUBMIT
L1 RECEIPT*
EDD RECEIPT
EDD LOAD
EDD LOAD ERROR?
NO
YES 900
PRODUCTION RESUBMIT
COMPLETENESS REVIEW
COMPLETENESS ERROR?
NO
YES
PRODUCTION RESUBMIT
DVM
DVM ERROR?
NO
YES
PRODUCTION RESUBMIT
DATA TABLE AND REPORT GENERATION
AWAITING INITIAL REVIEW
INITIAL REVIEW STARTED
INITIAL REVIEW ERROR?
YES
NO
CHEMISTRY RESUBMIT
MANUAL QUALIFICATION REQUIRED?
YES
NO
VERIFIED
AWAITING IT REVIEW
IT REVIEW STARTED
AWAITING INITIAL COPY EDIT
INITIAL COPY EDIT STARTED

TVA DATA MANAGEMENT PROCESS/VERIFICATION AND VALIDATION (CONT)





Lab Coordination/Data Management Process
Data Management QA Oversight
TVA
Sampling Contractor
Laboratory
LABORATORY COORDINATION (BOTTLE REQUESTS)
PDF COC
SAMPLE RECEIPT CONFIRMATION REVIEW
LAB TO FIELD COMPARE (COMPLETENESS)
VALIDATION/ VERIFICATION
QUALIFICATION
EQUIS DATABASE
FINAL REPORTS
BOTTLES RECEIVED
SAMPLES COLLECTED
FIELD EDD -PARAMETERS -COC -LOCATIONS
DATA EXPORTS
ELECTRONIC DATA DELIVERABLE (EDD)
BOTTLES SENT
SAMPLES RECEIVED
SAMPLE RECEIPT CONFIRMATION
SAMPLE ANALYSIS
LAB REPORT
ENVIRONMENTAL® STANDARDS
30 YEARS
1987 - 2017

APPENDIX B

EQUIS EDD SPECIFICATIONS

EQuIS EQEDD Laboratory EDD Specifications

November 2017

INTRODUCTION

The purpose of this document is to describe the processing of the laboratory data and provides the required specifications of the electronic data deliverable (EDD).

FILE FORMAT

All data from the field must be stored in an ASCII file using a tab-delimited standard format. Maximum length of text fields is indicated in the parentheses. If the information is less than the maximum length, do not pad the record with spaces.

Each record must be terminated with a carriage return/line feed (*i.e.,* standard DOS text file). The file can be produced using any software with the capability to create ASCII files. Date is reported as MM/DD/YYYY (month/day/year) and time as HH:MM (hour: minute). Time uses a 24-hour clock, thus 3:30 p.m. will be reported as 15:30.

Each record in an import file must have one or more fields with values that make the row unique. These fields are indicated in the “PRIMARY KEY?” column. Required fields are indicated in the “REQUIRED?” column.

NULL FORMAT

Some fields in the EDD are optional or only required “when applicable.” When a field is <u>not</u> listed as required, this means that a null or blank may be appropriate. However, the blank value must still be surrounded by tabs. In other words, the number of fields is always the same, whether or not the fields include data.

NAMING CONVENTION

The filename extensions are used to indicate the file type as follows:

Type of Rows	File Name
Lab Sample	LabSample._v1.txt
Test & Results	TestResultsQC_v1.txt
Test Batch	TestBatch_v1.txt

FILE DELIVERY

All EDD deliverables must be sent in a zip file containing the EDD files listed above. The zipped file must be named using the following naming convention:

- *SDG*.FACILITYCODE.EQEDD.zip

ENVIRONMENTAL STANDARDS

EDD SPECIFICATION

LabSample_v1

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
	sys_sample_code	Text(40)	Y	PK		Unique sample identifier.
	sample_name	Text(50)				Additional sample identification information as necessary.
	sample_matrix_code	Text(10)	Y		RVF	Code which distinguishes between different of sample matrix types.
	sample_type_code	Text(20)	Y		RVF	Code which distinguishes between different types of samples.
	sample_source	Text(10)	Y		ENUM	This field identifies where the sample came from, either field or laboratory.
	parent_sample_code	Text(40)				The value of "sys_sample_code" that uniquely identifies the sample that was the source of this sample.
	sample_delivery_group	Text(20)				The sampling event with which the sample is associated.
	sample_date	DateTime	Y			Date and time sample was collected (in MM/DD/YYYY HH:MM format for EDD).
	sys_loc_code	Text(20)				Soil boring or well installation location.
	start_depth	Numeric				Beginning depth (top) of sample in feet below ground surface.

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
	end_depth	Numeric				Ending depth (top) of sample in feet below ground surface.
	depth_unit	Text(15)			RVF	Unit of measurement for the sample begin and end depths.
	chain_of_custody	Text(40)				Chain-of-Custody identifier. A single sample may be assigned to only one Chain-of-Custody.
	sent_to_lab_date	DateTime				Date sample was sent to laboratory (in MM/DD/YYYY format for EDD).
	sample_receipt_date	DateTime				Date that sample was received at laboratory (in MM/DD/YYYY format for EDD).
	sampler	Text(50)				Name or initials of sampler.
	sampling_company_code	Text(40)	Y		RVF	Name or initials of sampling company (not controlled vocabulary).
	sampling_reason	Text(30)				
	sampling_method	Text(40)				Sampling method.
	task_code	Text(40)				Code used to identify the task under which the field sample was retrieved.
	collection_quarter	Text(5)				Format: YYQ# where YY is year and # is 1, 2, 3, or 4 representing the quarter.

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
	composite_yn	Text(1)	Y		ENUM	Is sample a composite sample? 'Y' for yes or 'N' for no.
	composite_desc	Text(255)				Description of composite sample (if composite_yn is 'Yes').
	sample_class	Text(10)				Report as null.
	custom_field_1	Text(255)				Report as null.
	custom_field_2	Text(255)				Report as null.
	custom_field_3	Text(255)				Report as null.
	comment	Text(2000)				Comment.

TestResultsQC_v1

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
	sys_sample_code	Text(40)	Y	PK		Unique sample identifier.
	lab_anl_method_name	Text(20)	Y	PK	RVF	Laboratory analytical method name or description.
	analysis_date	DateTime	Y	PK		Date and time of sample analysis in 'MM/DD/YYYY HH:MM' format.
	total_or_dissolved	Text(10)	Y	PK	RVF	Must be either 'D' for dissolved or filtered [metal] concentration, 'T' for total or undissolved, or "N" for everything else.
	column_number	Text(2)				Values include either '1C' for first-column analyses, '2C' for second-column analyses, or 'NA' for tests for which this distinction is not applicable.
	test_type	Text(10)	Y	PK	RVF	Type of test.
	lab_matrix_code	Text(10)			RVF	Code which distinguishes the type of sample matrix.
	analysis_location	Text(2)	Y		ENUM	Must be either 'FI' for field instrument or probe, 'FL' for mobile field laboratory analysis, or 'LB' for fixed based laboratory analysis.
	basis	Text(10)	Y		ENUM	Must be either 'Wet' for wet-weight basis reporting, 'Dry' for

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
						dry-weight basis reporting, or 'NA' for tests for which this distinction is not applicable.
	container_id	Text(30)				Report as null.
	dilution_factor	Numeric				Effective test dilution factor.
	prep_method	Text(20)			RVF	Laboratory sample preparation method name or description.
	prep_date	DateTime				Beginning date and time of sample preparation in 'MM/DD/YYYY HH:MM' format.
	leachate_method	Text(15)				Laboratory leachate generation method name or description.
	leachate_date	DateTime				Beginning date and time of leachate preparation in 'MM/DD/YYYY HH:MM' format.
	lab_name_code	Text(20)			RVF	Unique identifier of the laboratory.
	qc_level	Text(10)			ENUM	May be either 'screen' or 'quant'.
	lab_sample_id	Text(20)				Laboratory LIMS sample identifier.
	percent_moisture	Text(5)				Percent moisture of the sample portion used in this test.
	subsample_amount	Text(14)				Amount of sample used for test.
	subsample_amount_unit	Text(15)			RVF	Unit of measurement for

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
						subsample amount.
	analyst_name	Text(50)				
	instrument_id	Text(60)				Instrument identifier.
	comment	Text(2000)				Comments about the test.
	preservative	Text(20)			RVF	Sample preservative used.
	final_volume	Numeric				The final volume of the sample after sample preparation. Include all dilution factors.
	final_volume_unit	Text(15)			RVF	The unit of measure that corresponds to the final volume.
	cas_rn	Text(15)	Y	PK	RVF	Use values in analyte valid value table.
	chemical_name	Text(255)	Y			Use the name in the analyte valid value table.
	result_value	Numeric				Analytical result reported at an appropriate number of significant digits. May be blank for non-detects.
	result_error_delta	Text(20)				Error range applicable to the result value; typically used only for radiochemistry results.
	result_type_code	Text(10)	Y		RVF	Must be either 'TRG' for a target or regular result, 'TIC' for tentatively identified compounds, 'SUR' for surrogates, 'IS' for internal standards, or

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
						'SC' for spiked compounds.
	reportable_result	Text(10)	Y		ENUM	Must be either 'Yes' for results which are considered to be reportable, or 'No' for other results.
	detect_flag	Text(2)	Y		ENUM	May be either 'Y' for detected analytes, 'N' for non-detects or 'TR' for trace.
	lab_qualifiers	Text(20)				Qualifier flags assigned by the laboratory.
	validator_qualifiers	Text(20)				Qualifier flags assigned by the validation firm.
	interpreted_qualifiers	Text(20)			RVF	Qualifier flags assigned by the validation firm.
	organic_yn	Text(1)	Y		ENUM	Must be either 'Y' for organic constituents, or 'N' for inorganic constituents.
	method_detection_limit	Text(20)				Method detection limit.
	reporting_detection_limit	Numeric				Concentration level above which results can be quantified with confidence.
	quantitation_limit	Text(20)				Concentration level above which results can be quantified with confidence.
	result_unit	Text(15)			RVF	Unit of measurement for the result.
	detection_limit_unit	Text(15)			RVF	Unit of measurement for the detection limit(s).

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
	tic_retention_time	Text(8)				Retention time in seconds for tentatively identified compounds.
	result_comment	Text(2000)				Result-specific comments.
	lab_sdg	Text(20)				Sample Delivery Group (SDG) identifier.
	qc_original_conc	Numeric				The concentration of the analyte in the original (un-spiked) sample.
	qc_spike_added	Numeric				The concentration of the analyte added to the original sample.
	qc_spike_measured	Numeric				The measured concentration of the analyte.
	qc_spike_recovery	Numeric				The percent recovery calculated as specified by the laboratory QC program.
	qc_dup_original_conc	Numeric				The concentration of the analyte in the original (un-spiked) sample.
	qc_dup_spike_added	Numeric				The concentration of the analyte added to the original sample.
	qc_dup_spike_measured	Numeric				The measured concentration of the analyte in the duplicate.
	qc_dup_spike_recovery	Numeric				The duplicate percent recovery calculated.
	qc_rpd	Text(8)				The relative percent difference calculated.

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
	qc_spike_lcl	Text(8)				Lower control limit for spike recovery.
	qc_spike_ucl	Text(8)				Upper control limit for spike recovery.
	qc_rpd_cl	Text(8)				Relative percent difference control limit.
	qc_spike_status	Text(10)			ENUM	Used to indicate whether the spike recovery was within control limits.
	qc_dup_spike_status	Text(10)			ENUM	Used to indicate whether the duplicate spike recovery was within control limits.
	qc_rpd_status	Text(10)			ENUM	Used to indicate whether the relative percent difference was within control limits.

TestBatch_v1

POSITION	FIELD NAME	DATA TYPE	REQUIRED?	PRIMARY KEY?	REFERENCE VALUE?	DESCRIPTION
	sys_sample_code	Text(40)		PK		Unique sample identifier.
	lab_anl_method_name	Text(20)		PK	RVF	Laboratory analytical method name or description.
	analysis_date	DateTime		PK		Date and time of sample analysis in 'MM/DD/YYYY HH:MM' format.
	total_or_dissolved	Text(10)		PK	RVF	Must be either 'D' for dissolved or filtered [metal] concentration, 'T' for total or undissolved, or "N" for everything else.
	column_number	Text(2)				Values include either '1C' for first-column analyses, '2C' for second-column analyses, or 'NA' for tests for which this distinction is not applicable.
	test_type	Text(10)		PK	RVF	Type of test.
	test_batch_type	Text(10)	Y	PK	RVF	Laboratory batch type. Valid values include 'Prep', 'Analysis', and 'Leach'. This is a required field for all batches.
	test_batch_id	Text(20)	Y			Unique identifier for all laboratory batches.

“REQUIRED WHEN APPLICABLE” FIELDS

Some “Required When Applicable” fields are data driven and are, therefore, not listed below.

SAMPLE LEVEL

	BD	BS	EB	FB	FD	LB	LD	LR	MB	MS	N	RB	SD	TB
PARENT_SAMPLE_CODE	X				X		X	X		X			X	
SAMPLE_DATE			X	X	X					X	X	X	X	X
SAMPLE_TIME			X	X	X					X	X	X	X	X
SAMPLE_RECEIPT_DATE			X	X	X					X	X	X	X	X
SAMPLE_RECEIPT_TIME			X	X	X					X	X	X	X	X

RESULT LEVEL-TARGET & SPIKED RESULTS (TRG & SC)

	BD	BS	EB	FB	FD	LB	LD	LR	MB	MS	N	RB	SD	TB
QC_ORIGINAL_CONC		X			X			X		X				
QC_SPIKE_ADDED		X								X				
QC_SPIKE_MEASURED		X								X				
QC_SPIKE_RECOVERY		X								X				
QC_DUP_ORIGINAL_CONC													X	
QC_DUP_SPIKE_ADDED													X	
QC_DUP_SPIKE_MEASURED	X												X	
QC_DUP_SPIKE_RECOVERY	X												X	
QC_RPD	X							X					X	

RESULT LEVEL-SURROGATE RESULTS (SUR)

	BD	BS	EB	FB	FD	LB	LD	LR	MB	MS	N	RB	SD	TB
QC_SPIKE_ADDED		X	X	X		X		X	X	X	X	X		X
QC_SPIKE_MEASURED		X	X	X		X		X	X	X	X	X		X
QC_SPIKE_RECOVERY		X	X	X		X		X	X	X	X	X		X
QC_DUP_SPIKE_ADDED	X												X	
QC_DUP_SPIKE_MEASURED	X												X	
QC_DUP_SPIKE_RECOVERY	X												X	

APPENDIX C

EQUIS STANDARD REPORTS

EQuIS Standard Reports

Novemberr 2017

Introduction

The purpose of this document is to describe the standard reports provided with EQuIS version 6.6.

Action Level Reports

Action Level Exceedance

The Action Level Exceedance Report compares values from a saved Analytical Results Report against one or more action levels (*e.g.*, regulatory limits).

Action Level Exceedance (by EDD)

This version of the Action Level Exceedance Report is used for checking exceedances within an EDD (instead of within a saved report), and is commonly used as an Environmental Information Agent (EIA), or trigger, within EQuIS Enterprise

Analyte Exceedance (Over Time)

The Analyte Exceedance Report provides a simple way to find results for a chemical that exceeds a specified value.

Action Level Exceedance II by EDD

This version of the Action Level Exceedance II Report is used for checking exceedances within an EDD (instead of within a saved report), and is commonly used as an Environmental Information Agent (EIA), or trigger, within EQuIS Enterprise

Action Level Exceedance II by User Report

This report allows you to run an Action Level Exceedance Report by selecting a saved user report as well as the additional action level parameters.

Action Level Exceedance II - Percent Variance

The Action Level Exceedance II - Percent Variance Report is designed to flag analytical results within a given EDD that vary by more than the listed percentage from the historical average for each chemical and location

Action Level Exceedance II with Parameters

The Action Level Exceedance II with Parameters Report displays all of the parameters from the Analytical Results II Report, thus allowing you to create the Analytical Results Report and the Action Level Exceedance Report together (displayed once in the Action Level Exceedance format).

Action Level Exceedance Format I

The Action Level Exceedance Format I Report generates a report with or without action level exceedances. Its row headers are Constituent, action levels and units. Its column headers are

Location ID, Sample Date, Sample Time, Sampled Interval, Sample ID, Laboratory and Lab. Number. It can report up to a maximum of three action level codes. The units of action levels can be used as final units of the report. Checking results against summed action levels can be done in the report. It is a class report based on the Analytical Results II Report.

Action Level Exceedance Format III

The Action Level Exceedance Format III Report generates cross-tabbed analytic results with or without action level exceedances. The row headers are Analyte, Units, Limits, and action levels, if selected. Its column headers are Station ID, Sample ID, Matrix, and Sample Date. This allows you to add lab qualifiers after results and export RT_QUALIFIER.REMARK as a footnote. Two types of action level comparisons are possible.

ALE II Crosstab - Row-based

The report generates cross-tabbed analytic results with or without action level exceedances.

ALE II Crosstab - Column-based

The report generates cross-tabbed analytic results with or without action level exceedances

Analytical Results Reports

Analytical and Water Results

Analytical and Water Results runs the Analytical Results II* and Water Level (Extra Fields) reports, and combines the output rows so the water level data are reported as CAS_RN results. This enables direct comparison in crosstab reports.

Analytical Results by EDDs

The Analytical Results by EDDs Report is an advanced version of the Analytical Results II* Report. This report includes a new group of input parameters, "EDD." If the "Use EDD Date Range" input parameter is checked, the date range specified in the EDD input parameter group will override the date range specified in the Sample input parameter group. The EDD date range will query Analytical Results on the dates the results were loaded to EQuIS.

Analytical Results Crosstab (Chemicals by Location)

This report creates a Crosstab Report in Microsoft Excel that displays location, sample date and sample type as column headers, and chemicals as row headers.

Analytical Results (Extra Fields)

It provides "additional fields" for users to select extra fields, except for all the fields of the Analytical Results.

Analytical Results (QC)

This report is identical to the Analytical Results Report, except it also includes all of the DT_RESULT_QC fields in the output. The report is designed for users that need to report QC information.

Analytical Results with Sample Parameter (Table)

The Analytical Results with Sample Parameter (Table) Report combines the Analytical Results Report and the Sample Parameter Report

Analytical Results II

The core function for reporting analytical data in EQuIS Professional. You can execute this function standalone and also use it within several other reports.

Analytical Results II - No Sample Taken

The sample must still satisfy the defined parameters (date range, sample type, *etc*.). All of the other parameters are related to samples/test/results (date range, sample type, *etc*.). This report also includes sample data, even if that sample does not have any tests/results

Basic Results Profile

The Basic Results Profile is a result of cross tabbing the Basic Results Report so that the measured results of chemicals vs. their sampling dates and depths can easily be read. The results of each location are placed in their own Excel worksheet.

Basic Results II

In addition to reporting the content of DT_BASIC_RESULT, the Basic Results II Report also provides measured results with unit conversion, if users provide a unit over the user interface.

Gauging and Analytical Report

This report creates a Crosstab Report in Microsoft Excel. The columns include water level (i.e. gauging data) information, followed by the selected analytes.

Database Tables Tools

Client Metrics Report

The Client Metrics Report summarizes how many records are available in several main tables, and how many total records in DT_/AT_/RT_ tables of each facility listed in DT_FACILITY are in the EQuIS database, and the number of records in the tables without the FACILITY_ID field in DT_/AT_/RT_ tables

Database Diagnostics

Database Diagnostics Report provides information on the owner, type and CREATED_DATETIME of a selected object or the name, owner, and type of all objects in the database if you do not select a specific object.

EQuIS Data Audit

The report reports the questionable (location, sample, test, result and reference *etc.*) data information under the facilities and/or the locations that are involved in checking items.

EQuIS Enterprise Report Usage

The EQuIS Enterprise Report Usage Report generates a report on the information of users and the report names used during a range of date

Reference Values

A report that lists all the reference values with a status flag of “R” in all reference tables. This report exports all the reference tables to individual worksheets in Microsoft Excel. The worksheets are named for each reference table. You may select to export records with all or any specific individual status flags.

Table Row Counts

The Table Row Counts Report generates the total number of rows per table in the database (TOTAL_ROWS), the number of these rows in the current FACILITY_ID or facility group (IN_FACILITY), the number of reference values per reference table with STATUS_FLAG="A" and "R" (STATUS_FLAG_A and STATUS_FLAG_R, respectively).

EnviroInsite Reports

EnviroInsite Boring Log

This report creates a boring log in EnviroInsite according to the selected template file. The report queries the data in EQuIS, opens EnviroInsite and compiles the log

EnviroInsite Site Diagram

Site diagram report is an alternative report for the EnviroInsite Data Export. It is a simplified report that lets you automate steps in EnviroInsite to create tables, contours, etc.

EnviroInsite Spider Diagram

The EnviroInsite Spider Diagram Report allows you to create spider diagrams using EnviroInsite for data within EQuIS. Water Level and Analytical Results can be outputted as spider diagrams

Google Earth Reports

Google Earth 3D Action Levels

This report lets the user select a saved Analytical Results Report and an action level. The output of the report shows concentrations of each chemical represented as a vertical cylinder at each location. The height of the cylinder represents the amount of concentration (taller cylinders show greater amount of chemical).

Google Earth 3D Action Level Sample Parameters

This report lets you select a saved Sample Parameter Report, and an action level. The output of the report shows concentrations of each parameter represented as a vertical cylinder at each location. The height of the cylinder represents the parameter value (taller cylinders show greater value).

Google Earth 3D Analyte Aggregates

This report prompts you to select a saved Analytical Results Report. You then select whether you want to aggregate values by group or individual. You may also select the aggregate function you want to use (default is maximum). The report displays vertical cylinders representing the aggregate value at each location, along with a label showing the numeric value

Google Earth 3D Analytical Results (3D Cylinders)

This report prompts you to select a saved Analytical Results Report. The output of the report shows concentrations of each chemical represented as a vertical cylinder at each location. The height of the cylinder represents the amount of concentration (taller cylinders show greater amount of chemical). Each chemical is displayed in a different color. You can select which chemical to view by clicking in the circle next to the desired chemical name. This report includes data over the selected date range. You can drag the time slider, or press the Play button, to watch the values change over time

Google Earth 3D Basic Results (XYZ Plot)

This report is computationally intensive, and interpolates a unique grid for each parameter and date. For example, a site may have only 100 different records, but 25 different dates. In this case the report would interpolate 25 different grids, and potentially consume vast system resources. Please also note that there are limitations to the size and complexity of KML/KMZ files supported in Google Earth.

Google Earth Analytical Results (Aggregate) Pie Charts

The output of this report shows pie charts illustrating the sum of each of the chemicals. If you choose to aggregate by group, then the pie charts will show the sum of each group.

Google Earth Analytical Results (XYZ Plot)

This Google Earth Report uses a saved Analytical Results Pick Report as the primary input parameter. The Analytical Results output is exported into to a *.kmz, and separated by chemical with each sampling date. Multiple sampling dates can be displayed in animation using Google Earth's time animation bar.

Google Earth Location Parameter (XYZ Plot and Contour)

This report prompts you to select a date range and one (or more) location parameters. The output of this report shows values of each parameter represented as a three dimensional contour. The Places tree lists each parameter. Underneath each parameter there are folders for each of the days where values exist for that parameter. Values from each day are interpolated using a Nearest Neighbor algorithm. The interpolated values are then displayed using a color palette ranging from blue (low) to red (high). Each color in the palette is shown as a folder, so the user can check/uncheck that folder to show/hide values in that range.

Google Earth Locations

The purpose of this report is to show locations from an EQuIS facility in Google Earth. Each location is labeled with the DT_LOCATION.SYS_LOC_CODE. The Places tree in Google Earth groups each location by type (*i.e*. DT_LOCATION.LOC_TYPE). The report output can also include DT_LOCATION.LOC_DESC in the 'callout box' when a location is clicked

Google Earth Sample Parameters (3D Cylinders)

This report prompts you to select a saved Sample Parameter Report. The output of the report shows values of each parameter represented as a vertical cylinder at each sampling location. The height of the cylinder represents the parameter value (taller cylinders show greater values). Each parameter is displayed in a different color. You can select which parameter to view by clicking in the circle next to the desired parameter name.

This report includes data over the selected date range. You can drag the time slider or press the Play button to watch the values change over time.

Google Earth Water Levels (3D Cylinders)

This report prompts you to select a saved Water Level Report.

The output of the report shows the water level as a vertical cylinder at each location. The height of the cylinder represents the water level (taller cylinders show greater water elevation).

This report includes data over the selected date range. You can drag the time slider or press the Play button to watch the values change over time.

Google Earth Water Levels (XYZ Plot)

The output of this report shows the water level represented as a three dimensional contour. The Places tree contains folders for each of the days on which water level measurements exist. Values from each day are interpolated using a Nearest Neighbor algorithm. The interpolated values are then displayed using a color palette ranging from blue (low) to red (high). Each color in the palette is shown as a folder, so the user can check/uncheck that folder to show/hide values in that range.

In addition to the color palette, the elevation of each point (distance from the ground) represents the relative value to other points. For example, the lower valued points are close to the ground; whereas the higher valued points are farther above the ground. This relative distance from the ground makes it possible to view a 2D contour (by reducing the tilt in Google Earth to look straight down from above) or to view a 3D surface (by increasing the tilt in Google Earth to look from the side).

This report includes data over the selected date range. You can drag the time slider, or press the Play button, to watch the values change over time. The report provides the option to create Contours, Color grids, Dot Plots or Surface Plots.

Google Earth Weather - Wind Speed and Direction

This report creates an animated "wind sock" at each location. The sock (*i.e*. red line) points in the direction the wind is blowing and the length of the sock indicates the relative wind speed. This report includes data over the selected date range. You can drag the time slider, or press the Play button, to watch the values change over time.

Location Parameter Reports

Location Information

The Location Information Report is the class report based off of the database procedure Location Information Report. It provides metadata about sample locations (wells, boreholes, *etc.*), including the matrices by which locations have been sampled as well as the screened interval.

Location Parameter “Real Time” Ticker Charts

This report creates ticker charts based on location parameter data.
This report is deployed as a web page and requires EQuIS Enterprise.

Location Parameter Exceedance

The report compares PARAM_VALUE of DT_LOCATION_PARAMETER with a value provided over the user interface and generates an exceedance report. It calls the Location Parameters report

Location Parameters

Location Parameter Standard Report has been improved to fill non-numeric results as PARAM_TEXT in their respective outputs.

Location Parameters (Action Level Exceedance)

This report checks PARAM_VALUE of the Location Parameters report against the action levels of the Action Levels Report and then generates an Action Level Exceedance Report.

Location Parameters (Extra Fields)

The Location Parameters (Extra Fields) Report generates the location parameter information from DT_LOCATION_PARAMETER and other selectable fields from DT_FACILITY, DT_LOCATION_PARAMETER, DT_PRECIPITATION, VW_LOCATION and VW_WELL

Location Parameters (Most Recent)

The Location Parameters (Most Recent) Report compiles the PARAM_VALUES along with other parameters in DT_LOCATION_PARAMETER that are obtained most recently. It uses the Location Parameters Report

Location Parameters (Rollup)

The Location Parameters (Rollup) Report compiles the hourly, daily, weekly or monthly average values of PARAM_VALUES in DT_LOCATION_PARAMETER based on selected parameters. It uses the Location Parameters Report

Sample Parameter Reports

Analytical Results with Sample Parameter (Tables)

The Analytical Results with Sample Parameter (Table) Report combines the Analytical Results Report and the Sample Parameter Report.

Sample Parameters

This report queries data from the DT_SAMPLE_PARAMETER table. The Sample Parameter standard report has been improved to fill non-numeric results as PARAM_TEXT in their respective outputs

Sample Parameters (Action Level Exceedance)

The Sample Parameters (Action Level Exceedance) Report is similar to the Sample Parameters (Exceedance) Report with the exception that it uses a saved Sample Parameters Report, action levels from DT_ACTION_LEVEL and DT_ACTION_LEVEL_PARAMETER rather than a user-entered action level value over the user interface, and more output fields.

Sample Parameters (Exceedance)

The Sample Parameters (Exceedance) Report examines PARAM_VALUES of DT_SAMPLE_PARAMETER a user-entered action level value over the user interface and generates a report with exceedances.

Sample Parameters (Extra Fields)

This report adds the functionality of reporting more selective fields.

Sample Parameters (Most Recent)

Sample Parameters (Most Recent) II Report compiles the PARAM_VALUE along with other parameters in DT_SAMPLE_PARAMETER that are obtained most recently.
Sample Parameters (Most Recent) II

It compiles the PARAM_VALUE along with other parameters in DT_SAMPLE_PARAMETER that are obtained the most recently. It uses the Sample Parameters (Extra Fields) Report to get raw data.

Statistics Reports

Analytical Results – Statistics

The Analytical Results (Statistics) Report is a new report based from the standard Analytical Results (Aggregate) Report. It computes various statistical functions not found in the aggregate report, namely: minimum, maximum, mean, median, sum, standard deviation, variance, skewness, Mann-Kendall S, Sen slope, confidence (90%, 95%, 99%, and 95%) and 95% Student's-t UCL (UCL = mean + student_t *sd/n).

Analytical Results with Sample Calculations

The Analytical Results with Sample Calculations (Table) Report generates the results of the Analytical Results, and the results from the calculations of balance and summation of the results of the Analytical Results.

Analytical Statistics

This report allows you to compare results to historical data from the specified statistical date range. It includes the option to highlight exceedances and results that fall outside the range of the historical values as well as display the information in graphical form.

ChemStat Report

The ChemStat Report generates a table that presents a statistical analysis for the selected analytes. The report summarizes the entire dataset into a single table with the rows representing each analyte in the dataset, and the columns representing the summary statistics. It allows you to focus in on those analytes and use the spatial and temporal querying tools provided, to understand what is going on. It does not show the report by location or by sample, but allows you to easily identify what analytes exceed the LOD and Action Levels, and the statistics associated with these exceedances. It uses Analytical Results report to get source data

Facility Results II

Facility Results II provides a broad overview of the analytical result information for the selected locations, along with the sample depth and screened interval

Facility Samples (Summary by EDD Date)

For all facilities which the user is subscribed to, this report will return the date of the most recent sample entered, the number of samples within the date range, and the number of samples that have been loaded year-to-date

Flow Rate

The Flow Rate Report calculates the volumes and rates of instant flow and cumulative flow per selected time interval based on the data from DT_FLOW. It also compares flow rate (for Flow-Inst) or flow volume (for Flow-Daily etc.) to action levels, if action level data are provided.

Lithology Summary

The Lithology Summary Report generates a table that summarizes maximum depths, minimum depths, maximum thicknesses and minimum thicknesses of each GEO_UNIT_CODE1 of location groups

Location Analyte Review

This report creates a Crosstab Report in Microsoft Excel that displays summary information about which locations have been sampled for specific chemicals during the specified date range. The report also indicates whether the chemical was detected or not.

Relative Percent Difference

The Relative Percent Difference Report (RDP) determines the difference between analytical results reported in primary, duplicate, and triplicate samples

Relative Percent Difference II

Relative Percent Difference II Report (RDP) determines the difference between analytical results reported in primary, duplicate, and triplicate samples.

Relative Percent Difference III

The Relative Percent Difference III Report determines the difference between analytical results reported in primary, duplicate, and triplicate samples (SYS_SAMPLE_CODE) as defined by user selection.

Sample Summary by Analyte Group

The Sample Summary by Analyte Group Report generates analysis information of collected samples included in various groups of analytes. The analysis information is represented by a combination of x/X, e/E, s/S, t/T, a/A, z/Z, which marks a sample as detected/non-detected regular results as well as if the results use special leachate methods

Sanitas

The Sanitas Report generates necessary data used by the Sanitas statistics software

Statistics: Analytical Statistics (by Location)

The report generates the statistics information of Mean, UCL, Median, Standard Deviation, Coefficient of Variation, Skewness, Minimum, Maximum, Count (n), Mann-Kendall S, Trend analysis (at 80% confidence, 90% confidence, 95% confidence, 99% confidence) and Sen Slope based on a saved Analytical Results Report.

Statistics: Analyte by Sample (Lithology)

This report creates a Crosstab Report in Microsoft Excel that displays lithology samples down the side, and analytes across the top. Below the crosstab are summary statistics for each analyte. The report can also report action level violations if the Action Level input is selected.

Statistics: Samples, Statistics and Exceedances

This report creates a Crosstab Report in Microsoft Excel that displays samples down the side, and analytes across the top. Below the crosstab are summary statistics for each analyte. This report is similar to "Statistics: Analyte by Sample (Lithology)" with the exception that it does not have the information on the depths of lithology.

Statistics: Samples, Statistics and Exceedances of Each Location

The report lists sample values and calculates the statistics, such as the Number of Samples, the Number of Detects, Maximum, Mean, 95% UCL, and Minimum and Standard Deviation based on a saved Analytical Results Report. The report can also report action level exceedances, if the Action Level input is selected.

Water Level Reports

Water Level Report Basics

The Water Level Reports return the field measured water level elevations as stored directly in EQuIS or as calculated or estimated water level elevation based on user inputs if LNAPL thickness and density are stored in the database

Non-Detect Trend Report

The Non-Detect Trend Report produces an Excel spreadsheet that includes non-detects and detects as trend lines for multiple compounds

LNAPL Column Report

The LNAPL Column Report creates a visual display of daily LNAPL thickness and water levels in the selected wells. A series of wells are presented on a single MS Excel Column chart that displays the depth of air (white), LNAPL (brown), and water (blue). The vertical extent of each column represents the total depth of the well. The locations are organized in both alphanumeric and chronological order

Water Level Aggregate vs Location Plot (2d, 3d, or Bubble)

Water Level Aggregate vs. Location Plot (2d, 3d, or Bubble) generates surface 2d contours, surface 3d contours, and bubble charts of an aggregation (max, min, avg, or sum) of the water level vs locations.

Water Level Elevation Trend Plot

Water level Trend Plot Report generates charts of water level elevations. In addition, an analyte can be added to water level charts. It uses Water Levels report and Analytical Results report to retrieve source data

Water Level Information

The Water Level Info Report generates water level (DT_WATER_LEVEL.EXACT_ELEV) data of selected locations in the form of graphs, plus other location information such as well diameter, installation date, top of casing, depth, purpose and owner.

Water Levels

The Water Levels Report conveys information about water levels, LNAPLs, and DNAPLs stored in the DT_WATER_LEVEL table. This report uses specific logic for computing the corrected water level elevation based on input parameters selected by the user

Water Levels (Extra Fields)

The Water Levels (Extra Fields) Report generates water level information. It is an improved Class Report version of the Water Levels (EQuIS func) Report. The Water Levels Report conveys information about water levels, LNAPLs, and DNAPLs stored in the DT_WATER_LEVEL table. This report uses specific logic for computing the corrected water level elevation based on input parameters selected by the user.

Water Levels (Most Recent)

The Water Levels (Most Recent) Report uses the Water Levels report to show the most recent water level elevation for each location

Contact List Export

Export EQuIS st_user, dt_person, and rt_company information as a contact list suitable for import to eMail or Client Resource Management (CrM) system.

Downhole Point Parameters

This report converts the downwhole point parameter values into numeric values and allows you to plot the parameters in an x-y chart, and save a template

Execute Scheduled Report

The "Execute Scheduled Report" report allows you to run a scheduled EIA Report. You choose which scheduled EIA to run, then click the Go button. There is no output for the report, it simply tells workflow to start the scheduled report now instead of waiting for the scheduled time. The report will continue to run on the originally designated schedule.

Facility Detects by Chemical

This report uses Analytical Results as input and performs a crosstab that counts the number of detects for each chemical across the entire facility.

Facility Parameters

The Facility Parameters Report generates the facility parameter information from DT_FACILITY_PARAMETER and other selectable fields

License Use

The report allows users to investigate license uses in details or in a summary.

ProUCL_data

The EQuIS ProUCL Report export allows EQuIS users to export analytical data in a format that can be used in ProUCL (a third party statistical application developed by the US EPA)

Risk Assessment - SADA

Description: This is a report that will automatically interface with the University of Tennessee Knoxville's Spatial Analysis and Decision Assistance (SADA) Software

Sample Holding Time II

The Sample Holding Time II Report displays time spent from sampling to analyzing the samples plus other items, which can also be obtained in the Analytical Results II** Report

Service Provider Licensing - Usage Report

The Service Provider Licensing Usage Report reports on product usage and billing rate information for EarthSoft Resellers

Tag Cloud - Chemical Concentrations

This report creates a tag cloud, based on overall chemical concentrations for the current facility
Unsubscribed User Report

This report can be used to notify managers and admins of users not subscribed to facilities
VLA - PPU Usage and Billing Statement

Generate usage information for invoicing purposes. This report is only required for usage-based Viewer License Agreements.

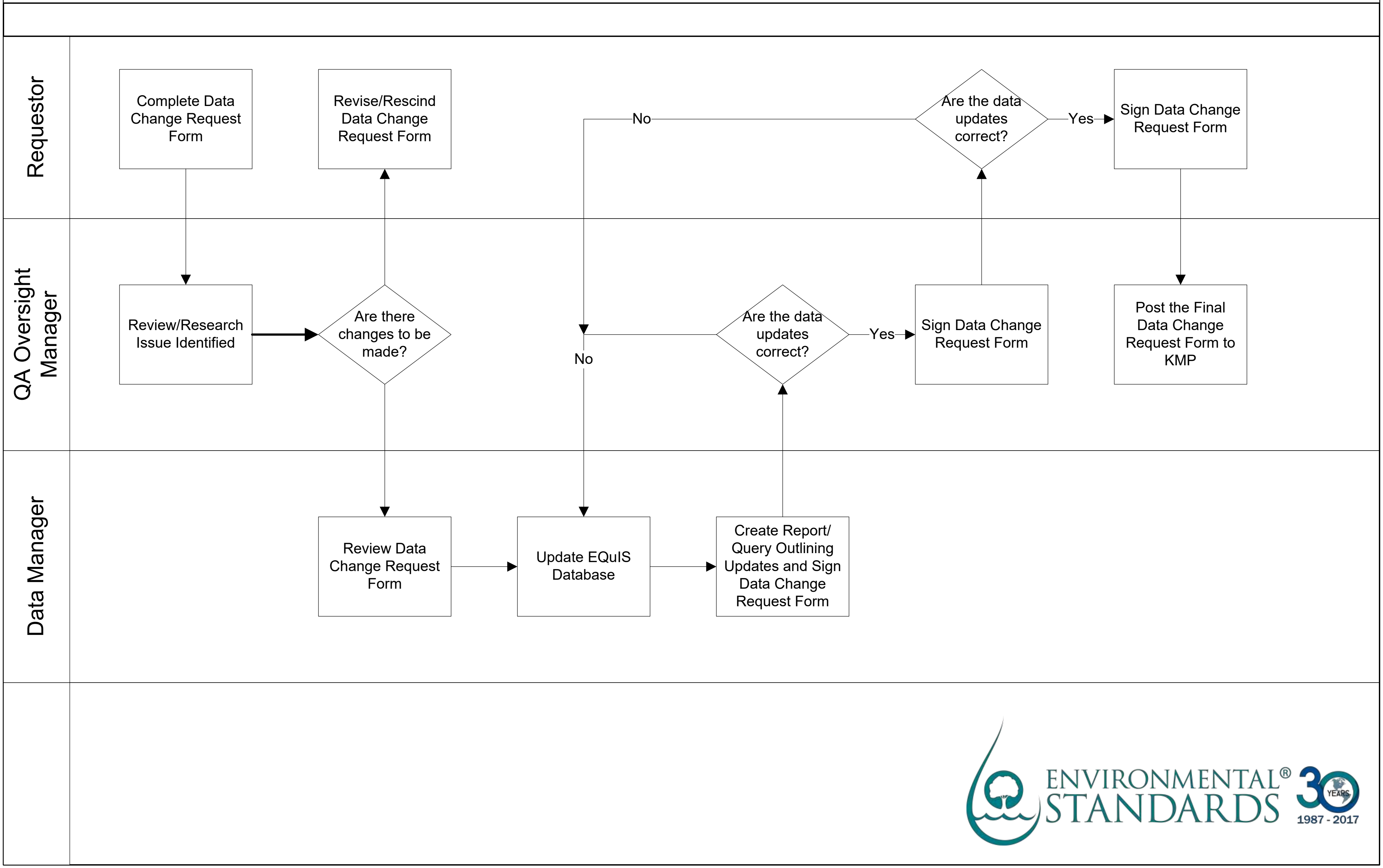
Well Construction

Well Construction Report is a class and Igrid Report that outputs well construction information from DT_WELL, DT_LOCATION, DT_COORDINATE, and DT_WELL_SEGMENT with default SEGMENT_TYPE='SCREEN'.

APPENDIX D

DATA CHANGE REQUEST WORKFLOW DIAGRAM

Data Change Request Process



APPENDIX E

TVA DATA CHANGE REQUEST FORM

Tennessee Valley Authority
Data Change Request Form

The Data Change Request Form will serve to document the data request and time-table for delivery.

Steps:

- Fill out Data Change Request Form and associated files to further explain the request.
- Attach the form and associated files in an e-mail to the Data Manager
- The subject of the e-mail should be- "**Data Change Request [Date].**"
- The Data Manager will be in contact to confirm information and delivery date.

<table>
<tr><td colspan="2"><u>Requestor Information</u></td><td>Data Manager use:</td></tr>
<tr><td colspan="2"></td><td rowspan="7"></td></tr>
<tr><td colspan="2">Date:</td></tr>
<tr><td colspan="2">Proposed Completion Date:</td></tr>
<tr><td colspan="2">Name:</td></tr>
<tr><td>Company:</td><td>Phone:</td></tr>
<tr><td colspan="2">E-mail:</td></tr>
<tr><td colspan="2">Description of Request: File Attached? Y N
(Below)</td></tr>
<tr><td colspan="2">Summary:

Proposed Solution:</td><td>Date Completed:</td></tr>
</table>

Data Manager/QA Oversight Manager

Signature ___________________________________ **Date:** _______________

Signature ___________________________________ **Date:** _______________

Data Change Requestor

Signature ___________________________________ **Date:** ______________

Stakeholders to Notify:

APPENDIX X
PUBLIC COMMENTS

Johnsonville Fossil Plant – Environmental Investigation Plan

Public Comments

TDEC accepted JOF EIP Revision 3 for public comment on August 13, 2018. The public comment period was held from September 26, 2018 to November 9, 2018. A public meeting was held in New Johnsonville on October 18, 2018. No public comments were received.