Environmental Investigation Plan
Bull Run Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Bull Run Fossil Plant
Clinton, Tennessee

December 17, 2018

REVISION LOG

Revision	Description	Date
0	Issued for TDEC Review	January 9, 2017
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	October 27, 2017
2	Addresses January 29, 2018 TDEC Review Comments and Issued for TDEC Review	March 30, 2018
3	Addresses May 22, 2018 TDEC Review Comments and Issued for TDEC Review	July 13, 2018
4	Addresses Applicable Programmatic Revisions and Issued for TDEC Approval	December 17, 2018

ENVIRONMENTAL INVESTIGATION PLAN
BULL RUN FOSSIL PLANT

TITLE AND APPROVAL PAGE

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Bull Run Fossil Plant
Tennessee Valley Authority
Clinton, Tennessee

Prepared By: Tennessee Valley Authority

Effective Date: December 17, 2018 Revision 4

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Abbreviations

BTV	Background Threshold Value
BRF	Bull Run Fossil Plant
CARA	Corrective Action/Risk Assessment
CCR	Coal Combustion Residuals
CCR Parameters	CCR Constituents in 40 CFR 257, Appendices III and IV and the five inorganic constituents listed in Appendix I of Tennessee Rule 0400-11-01-.04
CCR Rule	EPA Final Rule on Disposal of Coal Combustion Residuals from Electric Utilities
CFR	Code of Federal Regulations
CPT	Cone Penetration Test
DMP	Data Management Plan
DPT	Direct Push Technology
DSWM	Tennessee Division of Solid Waste Management
EAR	Environmental Assessment Report
EIP	Environmental Investigation Plan
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency

FEMA	Federal Emergency Management Agency
GPS	Global Positioning System
NPDES	National Pollutant Discharge Elimination System
PLM	Polarized Light Microscopy
QA	Quality Assurance
QAPP	Quality Assurance Project Plan (BRF QAPP)
QC	Quality Control
SAP	Sampling and Analysis Plan
TDEC	Tennessee Department of Environment and Conservation
TDEC Order	Commissioner's Order OGC15-0177
TI	Technical Instruction
TOC	Total Organic Carbon
TVA	Tennessee Valley Authority
WET	Whole Effluent Toxicity

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 Bull Run Fossil Plant (BRF) on July 13-14, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at BRF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On September 13, 2016, TDEC issued a follow-up letter, which provided specific questions and tasks for TVA to address as part of the Environmental Investigation Plan (EIP). On January 9, 2017 TVA submitted BRF EIP Revision 0.

On June 22, 2017, TDEC issued a letter to TVA regarding the TDEC Order and attached to the letter were environmental investigation plan comments for the TVA BRF site. According to this letter and subsequent discussions between TVA and TDEC, the specific questions and tasks found in the June 22, 2017 TDEC letter were to supersede the original site-specific questions and tasks found in TDEC's September 13, 2016, letter. The General Guidelines for Environmental Investigation Plans provided to TVA as Attachment A in the September 2016 letter remain at TDEC's request. TVA submitted a subsequent revision to the EIP based on site-specific questions and General Guidelines as provided by TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the Revision Log.

1.1 PURPOSE

The purpose of this EIP is to comply with Section VII.A.d. of the TDEC Order, which requires TVA, upon receiving requests for 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 BRF dated September 13, 2016 and June 22, 2017. The Environmental Assessment Report (EAR), to be submitted at a later date following completion of the environmental investigation identified in the EIP, shall provide "an analysis of the extent of soil, surface water, and groundwater contamination by CCR at the site" and thus shall 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 for TVA to address at each investigation conference.
- On July 1, 2016, TVA provided TDEC with an Investigation Conference Data Transmittal. This transmittal included electronic and hard copies of supporting information files (and a file directory).
- TVA held the Investigation Conference at BRF on July 13-14, 2016. The Investigation Conference included a site reconnaissance and presentation that addressed the questions provided by TDEC on September 22, 2015.
- On September 13, 2016, TDEC provided an Investigation Conference Response Letter. The letter requested additional data, and the EIP.
- On January 9, 2017, TVA submitted Revision 0 of the EIP to TDEC.
- On June 22, 2017, TDEC provided a follow-up letter including a list of revised information requests specific to the BRF EIP. This letter also documents conference dates and EIP delivery dates. In addition to addressing the specific information requests, TVA will provide additional information that provides further characterization of BRF. The deadline for the submittal of the revised BRF EIP was set for October 27, 2017.
- TVA submitted BRF EIP Revision 1 to TDEC on October 27, 2017.
- TDEC provided BRF EIP Revision 1 review comments to TVA in a letter dated January 29, 2018. The deadline for submittal of BRF EIP Revision 2 was set for March 30, 2018.
- TVA submitted BRF EIP Revision 2 to TDEC on March 30, 2018.
- TDEC provided BRF EIP Revision 2 review comments to TVA in a letter dated May 22, 2018.
- TVA addressed TDEC's comments from the May 22, 2018 letter and submitted BRF EIP Revision 3 to TDEC on July 13, 2018.
- TVA approved BRF EIP Revision 3 for public comment on August 7, 2018.
- TDEC hosted a meeting with interested parties on September 5, 2018 to discuss the proposed EIP before the public comment period stated in the Order.

- TVA provided public notice of the EIP published in a manner specified by TDEC and allowed a minimum of 30 days for public comment. The public comment period for BRF EIP Revision 4 began on September 19, 2018 and concluded on November 2, 2018.

- TDEC and TVA hosted a public comment meeting in Clinton, Tennessee on October 4, 2018.

- TDEC and TVA reviewed proposed changes to be incorporated into BRF EIP Revision 4 on December 7, 2018.

- TVA provided responses to public comments to TDEC on December 17, 2018, and are also provided in Appendix W.

1.3 EIP IMPLEMENTATION (INVESTIGATION)

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

- TDEC will review and approve BRF EIP Revision 4 or will provide TVA a list of comments to be addressed in a subsequent future EIP revision.

- TVA will address additional comments from TDEC as they become available, submitting additional revisions and repeating the process until TDEC approves the EIP and schedule.

- 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.

1.4 BRF BACKGROUND INFORMATION

1.4.1 Site History

TVA constructed BRF from 1962 to 1967 and commenced operations in 1967. The initial CCR disposal area was constructed during the same timeframe, with initial dike construction occurring prior to the Melton Hill Dam and Reservoir existing. The initial CCR disposal area was operated for the disposal of wet-sluiced bottom ash, fly ash, and gypsum materials when the Bull Run Fossil Plant was originally constructed. In the 1970s, the dikes of the disposal area were raised to increase disposal capacity. The CCR disposal area has been developed into several distinct areas since

the initial construction to form the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond and Fly Ash Stilling Pond 2C.

In the 1980s, the Railroad Loop Disposal Area was constructed to receive dredged fly ash from Disposal Area 2 (Gypsum Disposal Area 2A and Main Ash Pond). In 1995, TVA closed the Railroad Loop Disposal Area with a soil cap under a non-registered site permit.

In the 1980s, TVA also constructed the Dry Fly Ash Stack, dividing the facility into 2 phases – Phase 1 and Phase 2. The Dry Fly Ash Stack Phase 1 was closed and covered in 1993 based on Tennessee Division of Solid Waste Management (DSWM) Permit No. IDL 01-103-0080. TVA completed a lateral expansion of the Dry Fly Ash Stack and closure of Phase 2 in 2015. The Main Ash Pond ceased receiving CCR materials in 2010, while the Bottom Ash Disposal Area and Gypsum Disposal Area 2A ceased receiving CCR materials in September 2015.

1.4.2 Current Operations and Closure Plans

TVA currently operates BRF utilizing a dewatering facility and dry stacking CCR materials into the Dry Fly Ash Stack Lateral Expansion. On February 27, 2018, TVA submitted to TDEC a request for a minor permit modification for the closure plans for the Gypsum Disposal Area 2A and Bottom Ash Disposal Area. As noted in the modification request, closure activities for these areas will not occur until the TDEC Order activities run their course. For the Main Ash Pond and the Fly Ash Stilling Pond 2C, TVA is reviewing proposed actions to comply with the CCR Rule (EPA 2015a) and to facilitate plans for future waste water treatment. Additional permit modifications and closure plan submittals will be in accordance with National Pollutant Discharge Elimination System (NPDES) and Solid Waste Management requirements for TDEC approval.

1.4.3 Regulatory Framework

Table 1 summarizes relevant permits to this EIP issued by TDEC to TVA for the operation of BRF.

Table 1. Summary of Relevant Permits Issued by TDEC

Permit No.	TDEC Division	Permitted Activities
TN0005410	Water	Discharges via NPDES Outfalls including Outfall 001 at the Fly Ash Stilling Pond 2C
IDL 01-000-0208	Solid Waste	Bottom Ash Disposal Area and Gypsum Disposal Area 2A
IDL 01-103-0080	Solid Waste	Dry Fly Ash Stack

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 are developed by:

1. **Stating clear objectives and goals of the EIP Response.**

   This will be accomplished by re-stating each 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 conducted numerous studies at BRF 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 considerations, where applicable

- 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. 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 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 main body of the EIP document. Regulatory correspondence is provided as Appendix B. Public comments and responses are provided in Appendix W. TVA will work with TDEC and revise the EIP until a final version is approved.

As stated in the June 22, 2017 Investigation Conference Response Letter, this Plan will address the:

- Dry Fly Ash Stack (IDL 01-103-0080)
- Railroad Loop Disposal Area
- Bottom Ash Disposal Area (IDL 01-000-0208)
- Gypsum Disposal Area 2A (IDL 01-000-0208)

- Main Ash Pond, and
- Fly Ash Stilling Pond 2C

These areas are shown on Exhibit 1 (Appendix C) and will collectively be referred to as the "Study Area" with responses included in Sections 3 and 4.

Section 3 includes the 28 site-specific questions from TDEC's June 22, 2017 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 TDEC letters and this EIP.

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, provided in Appendix A, assumes work will begin when TDEC approves the EIP. The schedule numbering matches each information request in the sequence presented in TDEC's June 22, 2017 Letter 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 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 according to Part VII.C of the TDEC Order. 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 BRF environmental investigation Quality Assurance Project Plan (BRF QAPP) in Appendix D has been developed to ensure that the BRF investigation objectives are met by TVA and its contractors through the generation of documented, high-quality, and reliable investigative/analytical data. The BRF QAPP describes QA procedures and QC measures to be applied to investigation activities. The BRF QAPP also governs the investigation-specific SAPs and TVA Technical Instructions (TIs).

The BRF QAPP describes the QA implementation for the investigation and identifies the obligations of the various entities responsible for generating environmental data. The BRF QAPP 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 BRF QAPP establishes an overall environmental QA framework for the investigation and provides quantitative 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 BRF 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 BRF QAPP appendices present requirements and quantitative objectives for analytical data for each investigation. Analytical data intended for use under the BRF 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 an Environmental Investigation Data Management Plan (DMP). On March 8, 2018, TVA submitted a revised DMP (Appendix E) 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 Field Sampling Personnel 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

3.0 TDEC SITE-SPECIFIC ENVIRONMENTAL INVESTIGATION REQUESTS

3.1 GENERAL INFORMATION

3.1.1 TDEC General Information Request No. 1

Bedding Planes dip 30-40 degrees to the southeast. Groundwater will typically flow in the direction of dip. Was the bedding planes considered when TVA selected locations for groundwater monitoring wells? TVA should demonstrate how the underlying strata near the Bull Run property influence the direction of groundwater flow. TVA's monitoring well locations at all ash disposal areas should be selected based on these findings.

TVA Response

The bedding plane dips at the BRF plant have been primarily controlled by the Copper Creek Thrust Fault. The Copper Creek Thrust Fault trends in a northeasterly direction and can be traced from northwest Georgia to Central Virginia. In the BRF area, the Lower Cambrian Rome Formation has been thrust northwestward over the younger Chickamauga Formation (Kellberg 1959). As reported by Kellberg in his 1962 report on the "Foundation Investigations for the Bull Run Steam Plant", the predominant dip of the bedding of the Chickamauga Limestone, beneath the Dry Fly Ash Stack Phases 1 and 2, is to the southeast, with an average dip of 30 degrees (Kellberg 1962). To the southeast of the Copper Creek Thrust Fault, and under the northern half of the Bottom Ash Disposal Area, the Rome Formation dips gently to the southeast at angles from 5 to 20 degrees; however, southeast of the Rome Formation is the relatively incompetent Conasauga Group that consists of the Nolichucky Shale, the Maryville, Rogersville, and Rutledge Formations and Pumpkin Valley Shale. The dips are obscured by many folds and shears and range from horizontal to vertical (Kellberg 1959). The Conasauga Group underlies the southern half of the Bottom Ash Disposal Area, Gypsum Disposal Area, Main Ash Pond, Fly Ash Stilling Pond 2C and the Railroad Loop Disposal Area,

TVA has been monitoring the groundwater conditions at BRF since 1980 and has performed several hydrogeological studies in that time period (TVA 1996, TVA 2004, TVA 2006). The results of these investigations indicate that groundwater in the vicinity of the Dry Fly Ash Stack flows to the southeast towards the Worthington Branch with the predominant pathway for potential migration beneath the dry ash stack being the heavily weathered and fractured portions of the shallow bedrock. This interval is more permeable and more highly interconnected than the underlying, more competent bedrock.

In the Bottom Ash Disposal Area, Gypsum Disposal Area and the Main Ash Pond Area, the investigative results indicate that groundwater in the overburden material flows generally in a southwesterly direction towards the Clinch River. In the case of the Railroad Loop Disposal Area, the groundwater flows south towards Bull Run Creek (TVA 1995).

TVA has used the data from these investigations to place their existing network of monitoring wells around the CCR units such that at least one well is hydraulically upgradient and two or three wells are downgradient of the units. The existing groundwater monitoring well locations are presented on Exhibit 2 (Appendix C).

In addition, TVA will conduct a hydrogeological characterization of the site to further evaluate the groundwater flow conditions beneath the BRF property. Prior groundwater investigations have indicated that groundwater flow is potentially influenced by bedding planes and fractures within the bedrock. As part of this investigation, eighteen new pilot holes will be drilled. Nine pilot holes are proposed to be paired with nine existing shallow monitoring wells (I, G, J, 47, 48, 50, S, BRF-104 and 2) and four with proposed new overburden wells around the Railroad Loop Disposal Area (BRF-108, BRF-109, BRF-110 and BRF-111).

Two pilot holes will be drilled along the northwest boundary of the Dry Fly Ash Stack Phase 2 to further investigate the hydrogeological conditions upgradient of the Dry Fly Ash Stack and help the understanding of groundwater flow in this area. Prior to performing drilling activities, surface geophysics will be utilized to investigate the bedrock surface. TVA proposes to use electrical resistivity imaging (ERI) to identify potential zones of preferential groundwater flow. Based on the findings of the survey, the locations of the two proposed pilot holes will be identified.

Two pilot holes paired with two sets of proposed overburden and bedrock wells will be drilled north and west of the Former Disposal Area and Chemical Pond. One of these pilot holes will be drilled near the former location of closed wells O and R and the second pilot hole will be drilled near the north end of the Former Disposal Area. If ash is encountered in these areas, then the well locations may need to be moved. If the wells need to be moved more than 25 feet from the proposed locations, then TVA will jointly review alternative locations with TDEC prior to installing the wells. TVA will install wells at the alternate locations after receiving concurrence from TDEC. One pilot hole paired with a deep well will be drilled southwest of the Dry Fly Ash Stack Lateral Expansion near the former locations of closed wells Q and K.

The pilot holes will be drilled in upgradient and downgradient locations shown on Exhibit 3 (Appendix C) and are proposed to be extended to depths of approximately 60 feet below the overburden/bedrock contact. Downhole geophysical techniques, including acoustic televiewer, gamma logging, caliper logging, heat pulse flowmeter, and fluid resistivity will be used to characterize bedrock and groundwater flow within the pilot holes.

Other parameters, including conductivity, dissolved oxygen, pH, and temperature will be collected to evaluate the groundwater conditions beneath the site. These data will allow TVA to evaluate the influence that the fractures and bedding planes encountered in the pilot holes have on groundwater flow. After the geophysical tests are complete, packer tests will be conducted to further characterize the bedrock hydrogeology. From the above data, it is anticipated that groundwater flow direction and permeability data will be recorded. The Hydrogeological Investigation SAP (Appendix F) includes descriptions of procedures necessary to achieve the scope of the exploration.

Upon completion of the pilot hole tests, the pilot holes located around the Bottom Ash Disposal Area, Gypsum Disposal Area, and Fly Ash Stilling Pond 2C, will be converted into monitoring wells. Three of the six pilot holes around the Dry Fly Ash Stack will either be converted into monitoring wells or vibrating wire piezometers pending the results of the geophysical and hydrogeological investigations, two pilot holes will be converted into vibrating wire piezometers and one pilot hole will be converted into a monitoring well.

When the wells are completed, the screened interval will be determined by the findings of the geophysical analysis of the core hole and geological structures mapped in the geological core. Portions of the pilot hole below the screen will be grouted. In the Railroad Loop Disposal Area, the pilot holes will be completed as vibrating wire piezometers and new groundwater monitoring wells will be installed in the overburden in close proximity to the pilot holes if the overburden is saturated with groundwater. These new monitoring wells will consist of two background wells and two downgradient wells.

Currently, the Bottom Ash Disposal Area and Gypsum Disposal Area 2A have one active groundwater sampling program, and the Dry Fly Ash Stack Phases 1 and 2 and Dry Fly Ash Stack Lateral Expansion have a second active groundwater sampling program for compliance with TDEC regulations. Data from the Main Ash Pond and Fly Ash Stilling Pond 2C is currently submitted to TDEC with the bottom ash/gypsum report. Both units are regulated by TDEC Division of Water Resources under a NPDES permit and the CCR Rule as inactive impoundments. Modifications to existing groundwater monitoring plans will be in compliance with state requirements.

The results of the hydrogeological investigations will be provided in the EAR. The hydrogeological characterization portion of the report will include a summary of the regional geology and hydrogeology from existing published reports. The site-specific section of the report will include a description of the geology and hydrogeology based on previous, ongoing, and proposed investigations completed at BRF. The report will also include groundwater contour maps that will show flow directions near each CCR unit and surface water elevations from the Clinch River and Bull Run Creek.

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 pilot holes or groundwater monitoring wells further characterize the hydrogeology.

3.1.2 TDEC General Information Request No. 2

Two fault lines were identified on crossing the TVA Bull Run property. Were the faults considered when TVA selected locations for groundwater monitoring wells? TVA should demonstrate how the direction of groundwater flow is or could be influenced by the underlying faults at the Bull Run property and show how the well locations were selected. If groundwater is flowing along these fault lines, TVA should place monitoring wells at adequate locations to properly monitor it.

TVA Response

Although TVA has not directly drilled into the two faults crossing the BRF site, the locations of the fault zones have been considered when selecting sites for monitoring wells. As mentioned previously in Section 3.1.1, the predominant fault at the BRF site is the Copper Creek Thrust Fault that runs along Bull Run Ridge and trends in a northeasterly direction. The second fault is a younger, smaller, and unnamed strike-slip fault that follows the path of the original Clinch River and trends in a northwesterly direction offsetting the Copper Creek Thrust Fault underneath the Clinch River. The Copper Creek Thrust Fault is not adjacent to the Dry Fly Ash Stack Phases 1 and 2 and Dry Fly Ash Stack Lateral Expansion and dips away from those units; therefore, it is not expected to influence groundwater flow at the perimeter of the units. Because of its location and orientation, this fault is not a primary siting factor for installing monitoring wells around the Dry Fly Ash Stack Phases 1 and 2 and Dry Fly Ash Stack Lateral Expansion CCR units. In addition, it is expected that the Copper Creek Thrust Fault occurs at a depth below the Railroad Loop Disposal Area and does not influence shallow groundwater flow near this CCR unit.

As part of TVA's plan to further characterize the groundwater conditions in the bedrock near the Clinch River, it is proposed to attempt to drill pilot holes 47-D, 48-D and BRF-112-D (see Exhibit 3 – Appendix C) through the estimated location of the unnamed strike-slip fault zone that is mapped near the Bottom Ash Disposal Area. Prior to installation of these borings, frequency domain electromagnetics (FDEM) and electrical resistivity imaging (ERI) surface geophysical methods will be utilized in an effort to identify the location of the inferred fault. If the results of this drilling indicate that the fault could be a preferential flow path for groundwater, then further investigation of the fault may be proposed.

If additional information is needed to characterize the fault, TVA may use surface geophysics, such as seismic and resistivity, to locate the fault and establish its delineation. Once the results have been gathered and interpreted, if deemed necessary, a targeted drilling program will be undertaken to supplement existing data.

3.1.3 TDEC General Information Request No. 3

The off-site water use survey needs to be updated and all potential supply sources verified whether used for human consumption or otherwise.

TVA Response

TVA previously conducted a survey of domestic water supplies within 1 mile of the boundary of the BRF property in 1999 and a subsequent survey was conducted in 2014 centered on the eastern portion of the site. These surveys will be updated to explore the possibility that new domestic water supplies have been installed since the time of the previous survey.

TVA's Water Use Survey SAP (Appendix G) includes details to complete a water survey for the BRF property. TVA will review existing documentation and the state database to identify existing water supply wells within one mile of the center of the different CCR units within the BRF property, including water well inventory records on file with TDEC for Anderson County. TVA will also review the local Clinton City Public Utilities water service map area to identify water service hookup locations in the search area.

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 one mile of the center of the CCR units within the BRF property, 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 global positioning system (GPS) reading of both 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 submittal to TDEC

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 (Attachment C of Appendix G) will be developed by TVA for use during field verifications.

TVA and TDEC will discuss the construction, depth (if known), 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.

Groundwater samples will be collected as detailed in the Groundwater Investigation SAP in Appendix H and will be analyzed for 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 Tennessee 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 I 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." Groundwater samples will also be analyzed for major cations/anions for geochemical evaluation. Major cations/anions not included in the CCR Parameters will be added to the analysis of groundwater samples for the Groundwater Investigation SAP. The additional geochemical parameters include magnesium, potassium, sodium, carbonate, and bicarbonate.

Because the BRF water use survey groundwater monitoring event is intended to be a one-time sampling event to characterize the identified water supply sources for CCR constituent impacts, it will not be added to the periodic sampling program established for the BRF groundwater monitoring network. Analytical sampling results will be provided in the EAR, along with the supporting documentation. If water samples collected from domestic water wells identified during the Water Use Survey indicate the presence of CCR constituents from BRF, a groundwater monitoring program will be implemented to monitor the water supplies as part of the Corrective Action/Risk Assessment (CARA) Plan.

3.1.4 TDEC General Information Request No. 4

The Groundwater Use Survey identifies multiple residential wells and municipal water intakes within one mile of the landfill. The water supply points within the one-mile range must be evaluated and sampled to determine if the water is impacted from CCR waste.

TVA Response

This information request is similar to Section 3.1.3. However, instead of conducting a water use survey solely within one mile of the center of the landfill, the survey will be conducted within one mile of the center of the different CCR units within the Study Area.

3.1.5 TDEC General Information Request No. 5

Settlement analysis reference on page 84 of the multisite order presentation appears to have been misinterpreted from a previous TDEC questions. Please provide available documents relating to foundation settlement that may have or is calculated to occur as a result of the CCR loading on the natural foundation.

TVA Response

Slide 84 of the Investigation Conference presentation discusses settlement related to total suspended solids within the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C. This information request clarifies that TDEC is requesting information related to foundation settlement at each unit. Foundation settlement could occur due to three primary factors:

1. Immediate (i.e., elastic) settlements that occur immediately, in response to an increase in stress (load). Such settlements are relatively small and have already occurred in units no longer receiving CCR. Therefore, elastic settlements are not discussed herein.

2. Consolidation settlement that is time-dependent and typically associated with increasing effective stresses within saturated, low hydraulic conductivity soils. The rate of consolidation is a function of the hydraulic conductivity of the soil and the length of the drainage path.

3. Settlement that occurs due to loss of support from the underlying foundation soil and/or rock. This could be due to mechanisms such as internal erosion or collapse of voids in rock.

Foundation settlement beneath a unit could be non-uniform due to variations in several factors, such as imposed stresses, consolidation properties, foundation soil thickness or geometry of voids in rock. Differential settlements may be relevant when such lateral variations occur over a relatively short distance.

Due to the lengthy discussion necessary to address this information request, the full response for each unit is provided in the Evaluation of Existing Geotechnical Data (Appendix I). The conclusion of the response is as follows:

Additional settlement analyses are only anticipated for Gypsum Disposal Area 2A and the Dry Fly Ash Stack Lateral Expansion (including consideration of the culvert beneath the unit). The analyses for the Gypsum Disposal Area 2A will be performed as part of the ongoing closure design process. The analyses for the Lateral Expansion will be performed as part of the ongoing CCR Rule Unstable Areas Location Restriction demonstration. The analyses for the Main Ash Pond have been performed as part of the ongoing closure design process (AECOM 2017a).

In addition to other required submittals to TDEC, TVA will submit pertinent data and information from other activities used in the Environmental Investigation in the EAR. For the other units, the potential for future settlements is judged to be low, and additional analyses are not warranted.

3.1.6 TDEC General Information Request No. 6

Provide seismic stability calculations for Phase I of the Dry Fly Ash Stack, the Bottom Ash Disposal Area, and the Gypsum Disposal Area 2A.

TVA Response

Dry Fly Ash Stack Phase 1: Review of the available documents did not identify seismic stability calculations for existing conditions. A Stability SAP (Appendix J) has been prepared to describe the methodology and acceptance criteria for seismic slope stability analyses. Existing data will be utilized to develop (or update existing) representative cross-section(s) for current conditions. The seismic analyses will include pseudostatic slope stability (global and veneer), liquefaction triggering assessment, and post-earthquake slope stability (global) analysis. Veneer stability is specific to the final cover. The development of the material parameters, cross-section(s), and results of the analyses will be presented in the EAR.

Bottom Ash Disposal Area and Gypsum Disposal Area 2A:

Updated seismic analyses were completed in 2017 for existing conditions at the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, and Main Ash Pond (Geocomp 2017). These updated analyses were performed, in part, to address a recommendation from EPA during their 2011 site assessment. A letter (dated September 19, 2017) to EPA presenting the results is included in Appendix B. The analyses, summarized below, supplement the pseudostatic stability analysis, liquefaction analysis, and seismic deformation analysis included in the Operations Manual (TVA 2005a), which was approved by TDEC on January 11, 2006 as part of Solid Waste Permit No. IDL 01-0208.

The Geocomp (2017) 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 the Bottom

Ash Disposal Area and Gypsum Disposal Area 2A meets the appropriate acceptance criteria. Additional information regarding this evaluation is included in Appendix I.

The existing conditions analyzed by Geocomp (2017) are representative of the future closed conditions, except that the closed units will have a final cover installed. The final cover will have a negligible effect on the global stability of the units, except that long-term phreatic levels within the unit should decrease. Decreased phreatic levels will improve global stability, so the existing conditions analysis is conservative.

General: Based on the amount and context of data available to support a response and analysis planned, additional field work is not necessary to answer this information request.

3.2 DRY ASH STACK – IDL 01 103 0080

3.2.1 TDEC Dry Ash Stack Information Request No. 1

Residuum and upper bedrock hydrogeology and geotechnical properties appear to be adequately characterized. However, water-bearing zones in deeper bedrock are not characterized. The potential for downward vertical migration of CCR ash-derived contaminants, the potential for their migration along deeper structural and stratigraphic interfaces, and any bedrock migration fate and transport considerations have not been evaluated. To fully understand potential contaminant migration and risks to potential receptors, the vertical gradients and flow patterns need to be established.

TVA Response

As outlined in the Hydrogeological Investigation SAP (Appendix F) and mentioned in section 3.1.1, TVA plans to conduct additional hydrogeological characterization of the site to augment the understanding of groundwater flow conditions and groundwater quality, including the water bearing zones in the bedrock underlying the Dry Fly Ash Stack. The additional groundwater characterization will include the evaluation of the presence and character of groundwater in the bedrock below the existing monitoring well depths, including assessment of water bearing zones, aquifer properties and vertical gradients.

As part of the hydrogeological investigation, five pilot holes will be drilled around the perimeter of the Dry Fly Ash Stack (Exhibit 3 – Appendix C) to a depth of 60 feet below the top of bedrock. The two proposed locations northwest of the Dry Fly Ash Stack will be located after completion of a surface geophysical survey using electrical resistivity imaging (ERI). The goal of the surface geophysics will be to identify potential zones of preferential groundwater flow. The following downhole geophysical techniques will be used to evaluate the bedrock and groundwater conditions within each borehole: acoustic televiewer, gamma logging, caliper logging, heat pulse flowmeter, fluid resistivity, specific conductivity, dissolved oxygen, pH, and temperature.

In addition to the geophysical testing, aquifer tests will also be performed in the form of packer tests. These techniques will allow TVA to identify water bearing fractures and bedding planes encountered in the pilot holes and evaluate their hydraulic properties.

TVA will provide the results of the hydrogeological characterization in the EAR.

Additional field work is also proposed to better characterize the uppermost foundation soils (regarding the potential for a preferential seepage pathway) in the immediate vicinity of a mapped, pre-construction channel of an unnamed tributary of Worthington Branch within Phase 1 of the Dry Fly Ash Stack. The Exploratory Drilling SAP (Appendix M) and Exhibit 4 (Appendix C) shows the proposed cone penetration tests (CPTs) and the historical alignment of the unnamed tributary. There are also existing borings along/near the mapped tributary alignment (see Exhibit 4). Refer to the Exploratory Drilling SAP for additional details of the proposed CPTs.

3.2.2 TDEC Dry Ash Stack Information Request No. 2

8 monitoring wells were installed from 1983 to 1990, and 6 observation wells were installed from 2005 to 2006. Where are these wells and are they still being used? Reference page 90 of the multisite order presentation.

TVA Response

TVA is developing a database that will include the location and current condition for existing, closed, and proposed monitoring wells. Of the 14 wells previously constructed at the site, six wells remain (Wells G, H, I, J, F-45R and MW-3H). They are located around the Dry Fly Ash Stack Phases 1 and 2, and the Dry Fly Ash Stack Lateral Expansion (Exhibit 2 -Appendix C). Five of the remaining wells (wells G, I, J, F-45R and MW-3H) are part of the current State compliance groundwater monitoring program, and three of the remaining wells (wells I, J and MW-3H) were included in the CCR Rule groundwater monitoring program. The remaining wells have been closed. A summary of existing information on the closed wells is included in Appendix K.

Exhibit 2 shows the locations of the monitoring wells included in the existing groundwater monitoring program for the Dry Fly Ash Stack. For reference, eight of the monitoring wells noted in this information request were shown on Slide 115 of the Investigation Conference presentation. The locations of 13 of the 14 monitoring wells have previously been submitted to TDEC in the hydrogeological report for the Lateral Expansion of the Dry Fly Ash Stack (TVA 2006, Figure 2). Well F was not included on that figure; however, it was included in Figure 1.2 of the Bull Run Fossil Plant Groundwater Assessment written in 1996 (TVA 1996).

In addition, as part of the hydrogeological characterization, the status of the monitoring and observation wells cited in this Information Request will be provided in the EAR. If required, changes proposed to the existing TDEC-approved groundwater monitoring program will be submitted as a Permit Modification request to TDEC.

3.2.3 TDEC Dry Ash Stack Information Request No. 3

The DSWM SW Rules requires that all permitted facilities that go into assessment submit a Ground Water Quality Assessment Plan. TVA should submit this plan and incorporate all comments/concerns addressed in this review.

TVA Response

TVA submitted a Groundwater Quality Assessment Plan to the DSWM for the Dry Fly Ash Stack on October 27, 2017. In a letter dated December 5, 2017, the DSWM stated that the Groundwater Quality Assessment Plan was received and reviewed by the TDEC Field Office. A copy of the DSWM letter dated December 5, 2017 is found in Appendix B.

3.2.4 TDEC Dry Ash Stack Information Request No. 4

Please provide the current permitted version for drawing 10W299-11 as indicated on page 162 of the multisite order presentation. Please clarify if TVA plans to submit a vertical expansion overlaying phases I & II as indicated in the May 11, 2012 letter to Rick Brown. This expansion is also noted in Volume II of III of the Phase III Expansion permit document for IDL01-0080. This will direct the landfill's regulation under the Federal CCR rule and will also provide guidance on future closure plan submittals. Please confirm volumes and projected landfill life calculations presented in the approved permit documents and that site operations have the final approved plans.

TVA Response

TVA submitted the most recent permit drawings including 10W299-11 for the Dry Fly Ash Stack Lateral Expansion to TDEC in September 2016. TVA will resubmit these drawings and current landfill capacity and projected landfill life estimates in the EAR. As documented in the September 2016 permit submittal, TVA is not pursuing vertical expansion of the Dry Fly Ash Stack at this time. If in the future TVA decides to pursue vertical expansion, TVA will do so through the TDEC permitting process. TVA confirmed the BRF Civil Construction team responsible for CCR operations has the most recent permit drawings.

3.2.5 TDEC Dry Ash Stack Information Request No. 5

The document provided to TDEC identified as BRF47_102-229 Slope Stability Analyses Revised 082911 is not the final permitted stability calculations for the Dry Fly Ash Stack. The permitted stability calculations were submitted as on April 4, 2012. Please verify the current landfill geometry with the permitted documents and provide stability calculations for Phase I of the Dry Fly Ash Stack.

TVA Response

An amended version of the Dry Fly Ash Stack Operations Manual prepared by Civil & Environmental Consultants (CEC 2012) contains the referenced April 4, 2012 static and seismic slope stability analyses, which omit the earlier proposed vertical expansion over the Phase 1 area. TVA provided updated design drawings showing the amended landfill geometry to TDEC in June 2012. A copy of these drawings was also sent to TDEC's Knoxville field office in September 2016.

Static stability analyses for existing conditions of the Phase 1 area were performed by Stantec (2013) as part of the Dry Fly Ash Stack Stabilization Project. The results met the necessary acceptance criteria. TVA will perform seismic stability analyses for existing conditions of the Phase 1 area per Section 3.1.6.

3.2.6 TDEC Dry Ash Stack Information Request No. 6

Justify using a peak ground acceleration of 0.21g in the seismic stability analysis for the Dry Fly Ash Stack.

TVA Response

The Dry Fly Ash Stack Operations Manual (CEC 2012) documents the derivation of the "maximum horizontal acceleration" of 0.21 g. This value is used in the design of the Dry Fly Ash Stack Lateral Expansion in three different instances:

1. Judging if the site is in a seismic impact zone
2. As the horizontal seismic coefficient in pseudostatic seismic stability analyses
3. As the maximum horizontal acceleration in simplified seismic displacement analyses

The basis for selecting and utilizing the value of 0.21 g appears to be consistent with the methodology and example calculation in the DSWM Earthquake Evaluation Guidance Document (unknown date). A contour map of acceleration values is published in the document, and the value of 0.21 g is based on interpolating between contours for the BRF site location. The map in the guidance document is titled "USGS Map of Maximum Horizontal Accelerations (90 Percent Probability of Not Being Exceeded in 250 Years)." The original source of this map is Algermissen et al. (1990) and the accelerations are representative for rock at the ground surface, where the rock has a shear wave velocity between 750 and 900 meters per second.

3.2.7 TDEC Dry Ash Stack Information Request No. 7

Provide documentation and drawing illustrating the limits of closure for Phase I for the Dry Fly Ash Stack

TVA Response

The 10W293 drawing series show the design contours and details for the Phase 1 cap. TVA (2005c) includes an Operation Manual with Phase 1 Closure Drawings. These drawings also show the existing (as of 1990) contours and proposed final contours and details for the Phase 1 cap. The 10W293 drawing series and the Phase 1 Closure Drawings from TVA (2005c) are provided in Appendix L.

3.3 RAILROAD LOOP

3.3.1 TDEC Rail Loop Information Request No. 1

No hydrogeologic, geotechnical, or structural stability assessments have been conducted at the Rail Loop site. Full subsurface characterization needs to be conducted to understand any potential groundwater or surface water impacts, contaminant fate/transport considerations and structural instability issues there may be.

TVA Response

TVA will use the information obtained from the hydrogeological characterization discussed in Section 3.1.1 to develop a response to the hydrogeological portion of this information request for the Railroad Loop Disposal Area. As part of the hydrogeological investigation, four pilot holes will be drilled around the perimeter of the Railroad Loop Disposal Area (Exhibit 3 – Appendix C) to a depth of 60 feet below the top of bedrock. The following geophysical techniques will be used to evaluate the bedrock and groundwater conditions: acoustic televiewer, gamma logging, caliper logging, heat pulse flowmeter, fluid resistivity, specific conductivity, dissolved oxygen, pH, and temperature. In addition to the geophysical testing, aquifer tests will also be performed in the form of packer tests. These techniques will allow TVA to identify water bearing fractures and bedding planes encountered in the pilot holes and evaluate their hydraulic properties.

In addition, TVA proposes to install four overburden monitoring wells (two background wells and two downgradient wells) (see Exhibit 5 – Appendix C) and four bedrock vibrating wire piezometers. The piezometers will be installed in the pilot holes. The monitoring wells and piezometers will be paired with each other to provide data to evaluate vertical gradients. The Hydrogeological Investigation SAP (Appendix F) provides details regarding the selection of screen intervals and piezometer depths.

TVA will collect groundwater samples from the monitoring wells as detailed in the Groundwater Investigation SAP (Appendix H) and have them analyzed for CCR constituents. The hydrogeological characterization will include an evaluation of the distribution of CCR constituents in groundwater, if detected. Methods for determining the fate of CCR constituents may include the installation of additional monitoring wells or use of other analytical tools, such as groundwater flow and transport models. The need for and proposed methods of additional investigations will be based on the results of the investigations proposed in this EIP. TVA will provide the results of the hydrogeological characterization in the EAR.

With respect to the geotechnical/structural stability aspects of this information request, review of the available documents did not identify applicable analyses of current conditions at the Railroad Loop Disposal Area. Geotechnical data, including boring data, subsurface geometry, and laboratory testing results is available for the Railroad Loop Disposal Area (TVA 1985b, 1985c, 1985d, 1987a, 1987b). Collection of additional geotechnical data, to support slope stability analysis, is presented in the Exploratory Drilling SAP (Appendix M).

A Stability SAP (Appendix J) has been prepared to describe the methodology and acceptance criteria for static and seismic slope stability analyses. Existing data will be utilized to develop representative cross-section(s) (Exhibits 6 and 7 – Appendix C) for current conditions. The static analyses (global and veneer) will represent long-term, steady state conditions. The seismic analyses will include pseudostatic slope stability (global and veneer), liquefaction triggering assessment, and post-earthquake slope stability (global) analysis. The development of the material parameters, cross-section(s), and results of the analyses will be presented in the EAR.

3.3.2 TDEC Rail Loop Information Request No. 2

The Draft EIS for TVA Bull Run Fossil Plant Landfill Environmental Review, Project Number 2012-33, makes reference to a spring at The Rail Loop site. Please locate this feature on a map in relationship to the CCR limits.

TVA Response

TVA has reviewed information related to comments about a spring at the Railroad Loop Disposal Area and determined that there have been historical reports of poorly graded wet areas, but no springs. The mention of a spring in the draft environmental impact statement (EIS) was retracted because investigation of the source of use of that term led back to meeting minutes, and it was determined that use of the word "spring" was a misstatement. Therefore, the final EIS (TVA 2016b) does not reference the spring. Documentation or location of a spring has not been identified. If TVA locates a spring during routine inspections, then a Seep SAP will be implemented per Section 4.5.5.

3.4 BOTTOM ASH/GYPSUM PONDS - IDL 01 000 0280

3.4.1 TDEC Bottom Ash/Gypsum Ponds Information Request No. 1

When the Ash Ponds were originally constructed, and the initial wastes placed, the pond bottoms were natural soil (elevation approx. 788 MSL) above the reservoir water level elevation (approx. 768 MSL). The current reservoir level is approximately 795 MSL. Despite claims that natural soils and dykes are composed of low permeability clays that affect "separation" of waste from the reservoir, the reservoir elevation and groundwater elevations in monitoring wells at the site indicate waste is likely to be submerged in groundwater at the lower levels of the fill.

TVA Response

As mentioned in Sections 3.1.1, 3.2.1 and 3.3.1, TVA will perform a hydrogeological characterization of the site including the proposed work in the Hydrogeological Investigation and Groundwater Investigation SAPs in Appendices F and H, respectively. As part of those investigations, the groundwater levels will be established around the perimeter of the Bottom Ash/Gypsum Ponds (information from the Bottom Ash Disposal Area can be used to characterize the adjacent perimeter of the Former Disposal Area and Chemical Pond).

In addition, as discussed in Section 4.1.5, TVA has drafted an Exploratory Drilling SAP (Appendix M) that provides details regarding proposed drilling and installation of temporary wells within the CCR units. TVA proposes to install temporary wells screened in saturated CCR material at the lower CCR surface within the Bottom Ash Disposal Area, Gypsum Disposal Area 2A and Main Ash Pond at locations shown on Exhibit 8 (Appendix C) to evaluate water levels in saturated material. 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. Monthly water level monitoring will be conducted for 6 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 to estimate saturation levels in CCR. Details regarding water level monitoring field activities are provided in the CCR Material Characteristics SAP (Appendix N).

The data collected in the referenced studies will be used to evaluate the potential interaction of porewater within the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and groundwater. The Material Quantity SAP (Appendix O) will be followed to identify saturated levels and material volumes.

TVA will provide the results of the characterization in the EAR.

3.4.2 TDEC Bottom Ash/Gypsum Ponds Information Request No. 2

The Uppermost Aquifer cannot be adequately defined if water level data reflect saturated zones influenced by the ponds, sluice channels, saturated ash, and river elevations.

TVA Response

As part of the site-wide groundwater characterization, TVA will investigate the groundwater conditions at the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C (Groundwater Investigation SAP, Appendix H). The existing data (provided in Appendix K) and data compiled as part of the groundwater characterization study will be reviewed, and TVA will evaluate the correlation between groundwater, surface water and other hydraulic features of these CCR units.

The information and evaluation will be reported in the EAR.

3.4.3 TDEC Bottom Ash/Gypsum Ponds Information Request No. 3

The nature of groundwater flow and hydraulic interconnection between the waste, dykes, natural soils, and the ultimate discharge to the reservoir or deeper geologic formations are unknown. Vertical gradients between saturated waste, groundwater in unconsolidated deposits, and groundwater in bedrock have not been characterized. The dynamics of groundwater flow through the waste, dykes, pond floor and underlying soils, and bedrock need to be characterized to determine if potential contaminants from the waste fill migrate (or have the potential to migrate) from the unit and not be monitored by the existing shallow groundwater monitoring network.

TVA Response

TVA will perform a site wide groundwater characterization study of the site described in Section 3.1.1 to better understand the groundwater flow conditions beneath the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C at BRF, the details of which are presented in the Hydrogeological SAP (Appendix F) and Groundwater Investigation SAP (Appendix H). The groundwater characterization study, in combination with past and concurrent studies, has been designed to evaluate groundwater flow and hydraulic interconnection between these CCR units and groundwater. Additional elements of the groundwater study, including bedrock pilot holes, downhole geophysical techniques, and bedrock monitoring wells, are designed to characterize groundwater flow conditions and potential migration pathways in bedrock.

As part of this investigation, six pilot holes, shown on Exhibit 3 (Appendix C), will be advanced outside of the perimeter of the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C to characterize the groundwater conditions in the bedrock (two upgradient: 2-D and BRF-104-D, and four downgradient: 47-D, 48-D, 50-D and S-D). The pilot holes are paired with existing monitoring wells and are proposed to be drilled to a depth of approximately 60 feet into bedrock. The following geophysical techniques will be used to evaluate the bedrock and groundwater conditions: acoustic televiewer, gamma logging, caliper logging, heat pulse flowmeter, fluid resistivity, specific conductivity, dissolved oxygen, pH, and temperature. In addition to the geophysical testing, aquifer tests will also be performed in the form of packer tests. These techniques will allow TVA to identify water bearing fractures and bedding planes encountered in the pilot holes and evaluate their hydraulic properties.

The pilot holes will be converted into monitoring wells in accordance with the Hydrogeological Investigation SAP (Appendix F) and will be used to monitor groundwater elevations and collect groundwater samples. The wells will be paired with shallow groundwater monitoring wells to provide information on vertical gradients between overburden and bedrock. Groundwater samples will be collected and analyzed per the Groundwater Investigation SAP (Appendix H) to evaluate the potential presence of CCR Parameters.

TVA will provide the results of the hydrogeological characterization in the EAR.

During the October 4, 2017, EIP update meeting, TDEC requested more information regarding the potential for preferential seepage pathways through the foundation soils via stream channels that were present prior to development of the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C. In particular, historical TVA drawing 10N213-14 (included on Exhibit 9 – Appendix C) shows the pre-construction channels of Bull Run Creek and Worthington Branch crossing the CCR unit perimeters at several different locations.

There is limited information available on how the foundation was prepared during original perimeter dike construction. It is unclear if more pervious stream deposits were present, and if so whether they were excavated or otherwise treated prior to placing fill. The limited boring data available in the immediate vicinity of the mapped stream channels indicate the uppermost foundation soils are mostly clay and some silt (Exhibit 13 – Appendix C). A more detailed review of the available information is presented in Appendix I.

Additional field work is proposed to better characterize the uppermost foundation soils in the immediate vicinity of the mapped, pre-construction channels of Bull Run Creek and Worthington Branch. The use of various surface geophysical methods was considered, but because the locations are known to a reasonable degree of certainty (based on historical drawings) a targeted subsurface exploration is proposed that should provide more definitive results. At each stream crossing location along the perimeter dike system, a series of closely spaced CPT soundings is proposed.

The CPT data, correlated to existing nearby boring logs, can be used to differentiate relatively sandy (i.e., more pervious) foundation soils, if present. The proposed CPT layout is shown on Exhibit 9 (Appendix C), and the detailed plan is presented in the Exploratory Drilling SAP (Appendix M).

The need for, and proposed methods of, additional investigations will be based on the results of the subsurface exploration proposed herein. TVA will provide the results of the exploration in the EAR.

3.4.4 TDEC Bottom Ash/Gypsum Ponds Information Request No. 4

Historical groundwater data from sampled monitoring wells around the ponds complex indicates numerous statistically significant exceedances of monitored constituents above background. Likewise, there have been periodic MCL exceedances. These have typically been attributed to "naturally occurring" elements, excessive turbidity in groundwater samples, and/or laboratory/analysis-related interferences. Stated advantages of the Closure Plan include "improved groundwater quality". It is unclear to the reviewer to what extent the waste ponds have affected groundwater quality, to what extent offsite resources are impacted, and what basis the Owner has for stating that Closure will result in improved groundwater quality.

If the facility has caused groundwater degradation that Closure is purported to alleviate, the Owner needs to state to what the extent groundwater has been degraded, how the Closure will improve the degradation, and to what extent.

TVA Response

TVA will continue to work with TDEC to determine if groundwater quality has been impacted at the Bull Run site and assess the effect of closure of the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C. TVA's Ash Impoundment Closure EIS states closure-in-place and closure-by removal have a beneficial cumulative impact to groundwater quality (TVA 2016b). EPA acknowledges in the preamble to the CCR Rule that most facilities will close with CCR in-place and states that closure-in-place can be as protective as closure-by-removal provided it is properly conducted.

TVA will use the information from the hydrogeological characterization discussed in Sections 3.1.1 and 3.4.3 along with pertinent data from past studies to evaluate existing impacts to groundwater quality, if any, resulting from operation of the Bottom Ash Disposal Area and the Gypsum Disposal Area 2A. The evaluation will include a statistical comparison of the analytical results of groundwater samples collected from downgradient monitoring wells to the results from upgradient monitoring wells. 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 TVA TIs.

As part of the closure of the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C, TVA will modify groundwater monitoring plans as needed to include closure monitoring requirements. These plans will be submitted to TDEC in accordance with requirements for the Solid Waste Permit IDL 01-0208.

TVA will provide the results of the hydrogeological characterization in the EAR.

3.4.5 TDEC Bottom Ash/Gypsum Ponds Information Request No. 5

TVA must install monitoring wells screened in bedrock and located in appropriate locations to adequately define the potentiometric surface and monitor groundwater.

TVA Response

This request is similar to the request in Section 3.4.3. TVA will conduct additional hydrogeological investigation of bedrock around the Bottom Ash Disposal Area and the Gypsum Disposal Area 2A. Sections 3.1.1 and 3.4.3 provide a discussion of the proposed bedrock monitoring wells.

The Hydrogeological Investigation SAP (Appendix F) provides the locations and drilling and installation methods for the proposed wells. The Groundwater Investigation SAP (Appendix H) provides the groundwater elevation measurement, sample collection and analysis procedures.

The data from the investigations will be used to develop groundwater contour maps for the bedrock monitoring wells. The results of the investigations will be provided in the EAR.

3.4.6 TDEC Bottom Ash/Gypsum Ponds Information Request No. 6

The DSWM SW Rules requires that all permitted facilities that go into assessment submit a Ground Water Quality Assessment Plan. TVA should submit this plan and incorporate all comments/concerns addressed in this review.

TVA Response

TVA submitted a Groundwater Quality Assessment Plan to the DSWM for the Gypsum Ash Disposal Area 2A and the Bottom Ash Disposal Area on January 9, 2017. In a letter dated February 9, 2017, the DSWM stated that the Groundwater Quality Assessment Plan meets Division Rules, is consistent with compliance history at the site, and incorporates 40 CFR Part 257 Appendix III and IV monitoring requirements. A copy of the DSWM letter dated February 9, 2017 is found in Appendix B.

3.4.7 TDEC Bottom Ash/Gypsum Ponds Information Request No. 7

Please provide locations and inverts for the French drains installed in the Gypsum Disposal Area 2A.

TVA Response

Locations and inverts for the French drains installed in Gypsum Disposal Area 2A are shown on the 10W508 Series Record Drawings provided in Appendix L. These French drains are located within the perimeter of Gypsum Disposal Area 2A and discharge to the Main Ash Pond.

3.4.8 TDEC Bottom Ash/Gypsum Ponds Information Request No. 8

Please clarify the Gypsum Stack volume on page 160 of the multisite order presentation. The CCR volume and size provided indicate an average depth of 10 to 11 feet. Section I-I' on page 78 of the multisite order presentation does not identify gypsum in the disposal unit's stratigraphy. TVA shall provide details of the stratigraphy of the Gypsum Disposal Area 2A, from the final grade to bedrock. TVA shall provide stability calculations that include the Gypsum's material properties and account for the Gypsum in the analysis.

TVA Response

The referenced cross-section (I-I') from the presentation is from Stantec (2010b) and was developed based on borings completed in 2009. Gypsum storage did not begin until late 2008 at the Gypsum Disposal Area 2A. Therefore, it is only present at the top and towards the interior of the unit, and this location was beyond the extents of the cross section. In general, due to its location, the gypsum did not significantly influence the perimeter slope stability modeled in the 2010 analyses (Stantec 2010b). More recent slope stability analyses, which did model the gypsum, are discussed below.

TVA prepared a Material Quantity SAP, provided as Appendix O, 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 and estimating CCR volume at Gypsum Disposal Area 2A. The Material Quantity SAP is summarized in Section 4.1.5.

Slope Stability

Updated static and seismic analyses were completed in 2017 for existing conditions at the Gypsum Disposal Area 2A (Geocomp 2017). The Geocomp (2017) study included subsurface exploration, laboratory testing, subsurface characterization, development of material parameters and analysis cross sections, and static and seismic slope stability analyses. Static analyses are discussed below, while seismic analyses are discussed in Section 3.1.6.

Cross section I-I' (Figure 1), oriented perpendicular to the Gypsum Disposal Area 2A western perimeter dike, was utilized for the updated analyses. The section modeled the perimeter dike system (starter dike, raised dike, ash dike), CCR (sluiced fly ash, stacked bottom ash, and sluiced gypsum), and foundation material (alluvial clay and bedrock). The analysis demonstrates that the static slope stability of the Gypsum Disposal Area 2A meets the appropriate acceptance criteria.

Cross section I-I' (which is representative of the unit) demonstrates how the location of the gypsum does not influence the perimeter slope stability. The gypsum is located above elevation 820 and approximately 300 feet inboard of the starter dike crest. The critical static slope stability failure surface (shown on Figure 1) does not intersect the gypsum material; therefore, the gypsum material has minimal (if any) impact on the static slope stability results. This is true for the seismic slope stability results as well (Section 3.1.6). Additional information regarding this evaluation is included in Appendix I.

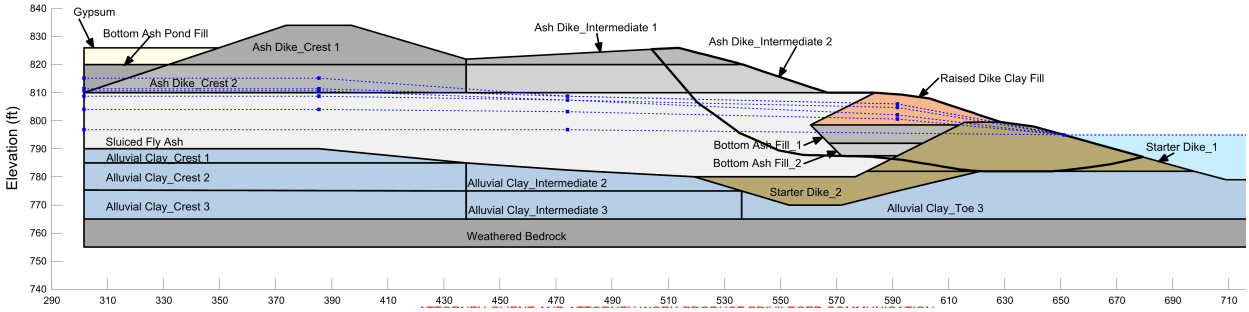

Figure 1. Cross Section I-I' and Static, Long-Term Slope Stability Analysis (Geocomp 2017)

3.4.9 TDEC Bottom Ash/Gypsum Ponds Information Request No. 9

Clarify the ratio of sluiced fly ash to bottom ash for material; contained in the Bottom Ash Disposal Area. Section D-D' on page 76 of the multisite order presentation indicates a majority of the CCR depth is sluiced fly ash. Would the CCR closure elevations indicated on page 155 of the multisite order intersect (excavate into) the sluiced fly ash? Please provide a detail of the stratigraphy of the Bottom Ash Disposal Area from the final grade to bedrock.

TVA Response

TVA prepared a Material Quantity SAP (Appendix O) 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 the sluiced fly ash and bottom ash in the Bottom Ash Disposal Area and CCR closure elevations to evaluate whether CCR closure elevations intersect sluiced fly ash. The Material Quantity SAP is summarized in Section 4.1.5.

3.4.10 TDEC Bottom Ash/Gypsum Ponds Information Request No. 10

Please provide a schedule for determining the Stilling Pond CCR volume and the test methods that will be used to determine the types and amounts of CCR materials in the Stilling Pond.

TVA Response

TVA prepared a Material Quantity SAP (Appendix O) 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 and estimating CCR volume at Fly Ash Stilling Pond 2C. The Material Quantity SAP is summarized in Section 4.1.5.

3.4.11 TDEC Bottom Ash/Gypsum Ponds Information Request No. 11

Identify the test methods to be used (in situ or remolded) to determine the permeability of clay below the CCR disposal areas. Explain why permeability tests were not performed below the Gypsum Disposal Area 2.

TVA Response

The alluvial clay is the uppermost foundation soil beneath the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C (Exhibit 13 – Appendix C). In-situ and laboratory testing data from these units will be considered for purposes of material characterization, with emphasis given to data from beneath Gypsum Disposal Area 2A.

A review of hydraulic conductivity testing by Stantec (2010b) shows that one laboratory test (D5084) was performed on an undisturbed sample of the alluvial clay beneath Gypsum Disposal Area 2A. Stantec (2010b) also documents four slug tests (D4044) in piezometers screened in the alluvial clay soil beneath Gypsum Disposal Area 2A. Exhibit 13 shows the location of the available hydraulic conductivity testing (laboratory and slug) on the uppermost alluvial clay. Because most of the previous subsurface exploration programs of this unit have been focused on slope stability, analyses were not sensitive to hydraulic conductivity values and thus few tests were performed.

To supplement the available hydraulic conductivity data for the alluvial clay beneath the Gypsum Disposal Area 2A, new undisturbed samples will be collected and tested in the laboratory per ASTM D5084. Specifically, undisturbed alluvial clay samples will be obtained when installing selected temporary wells (Exhibit 8 – Appendix C) in the Gypsum Disposal Area 2A. In addition, surplus undisturbed alluvial clay samples from the Geocomp (2017) geotechnical investigation will be examined and tested. The surplus samples are from nine separate borings across three cross-sections and are identified as BRF-B-2A, BRF-D-2A, BRF-D-2B, BRF-I-2A, BRF-I-2B, BRF-I-2E, BRF-I-2F, BRF-S-2A, and BRF-S-2B (as shown on Exhibit 10 – Appendix C). The use of these surplus undisturbed samples assumes that they are still suitable for testing. Suitability cannot be confirmed until samples are extruded from the tubes and visually evaluated. Even if 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.

The Exploratory Drilling SAP (Appendix M) provides additional details on the proposed sampling and testing. If any of the above data becomes available through other ongoing projects prior to execution of the SAP, TVA will incorporate this information into the EAR in lieu of repeating the same testing. The results of the testing will be provided in the EAR.

3.4.12 TDEC Bottom Ash/Gypsum Ponds Information Request No. 12

Clarify if the ash disposal line presented on page 19 of the multisite order presentation has been abandoned. TDEC requests that TVA verify the location of seep investigations that have been conducted, the repairs made to the seeps and whether any seeps continue to flow including TVA repaired seeps.

TVA Response

The historic ash disposal lines coming from the plant shown on the drawing on page 19 of the TDEC Investigative Conference Presentation have been removed. Concrete supports for the disposal lines are still visible. Based on a review of available information, the pipe sleeves and interior piping have been removed or retired.

2012 Seepage Log

In 2012, the BRF Seepage Log described the following seven seeps:

1. Boils along the southwest corner of the Gypsum Disposal Area 2A
2. Multiple sloughs and boils along the south toe of the Gypsum Disposal Area 2A
3. Red water seeps along the west slope of the Main Ash Pond
4. Seeps noted in the past along the south slope of the Main Ash Pond
5. Multiple seeps along the lower northeast slope of the Dry Fly Ash Stack
6. Multiple sloughs and seeps along the east toe of the Gypsum Disposal Area 2A along the sluice channel
7. Red water seeps at the toe of the west side of the Dry Fly Ash Stack

These seeps are listed as repaired.

2014 Annual Inspection

The 2014 annual inspection report of CCR storage facilities and ponds at BRF noted evidence of a red water seep at the Bottom Ash Disposal Area 1. This seep was observed at the toe of the south slope of the area just above the drainage channel. It was recommended that the red water seep be monitored in accordance with the BRF Seepage Plan.

In the Gypsum Disposal Area 2A, a red water seep flowing into the sluice channel which discharges into the Main Ash Pond was observed. A recommendation for continued monitoring of this area was noted in the report. Staining on the exterior slopes in the sluice ditch east of Gypsum Disposal Area 2A was observed, and it was recommended that the staining in the sluice ditch be monitored in accordance with the BRF Seepage Plan.

Seep No. 4 was observed on the southern exterior slope of Fly Ash Pond Area 2.

Seeps were not observed at the Dry Fly Ash Stack.

Activities and Improvements Noted During 2014 Annual Inspection

At the Gypsum Disposal Area 2A, the original design and construction included a subdrain system located within the base (floor) of the stack with outlet pipes extending through the east, south and west sides of the stack. The pipes extending through the south side were later plugged but, reportedly, the outlet pipes extending through the east and west sides remained in place. The downstream end of several of these outlet pipes were found during the construction of the project to stabilize the east and west slopes of the stack. The exposed pipe ends were extended and day-lighted into crushed stone blankets placed over the slopes for stabilization purposes.

A French Drain system to collect seepage from the elevated wet disposal area has also been installed on the east, north, and west sides of the stack, and daylights at the corners of the area. The outlet of a French drain may be seen at the southwest corner of the stack, a French drain cleanout is located on the lower slope east of the stack, and a lateral drain outlet is visible on the west slope above the road.

The divider dike between the Main Ash Pond and Fly Ash Stilling Pond 2C has been lowered, widened and rip-rapped, in conjunction with the lowering of the pool in the Main Ash Pond, and the key way has been replaced by a concrete weir. The trees on the exterior slopes along Bull Run Creek and the Melton Hill Reservoir have been removed and the perimeter dikes have been rip-rapped/buttressed. The spillway risers have been lowered, stabilized with concrete encasement, and new weir rings and skimmers have been installed.

2016 Intermediate Inspection

The 2016 intermediate inspection report shows that no wet areas of interest were discovered at the dike toe areas, nor were seeps found at the following units:

- Bottom Ash Disposal Area
- Dry Fly Ash Lateral Expansion
- Dry Ash Stack Phases 1 & 2
- Gypsum Disposal Area 2A
- Main Ash Pond (Fly Ash Stilling Pond 2C, Sluice Channel, and Stilling Pond)

3.4.13 TDEC Bottom Ash/Gypsum Ponds Information Request No. 13

The stability calculations should evaluate the south corner of Gypsum Disposal Area 2A. This area is of interest due to its proximity to the original flow path of Bull Run Creek and because it is not known if clay foundation soils are present in this area.

TVA Response

Prior to construction of Ash Disposal Area 2 (which was later subdivided into multiple units, including Gypsum Disposal Area 2A) the Bull Run Creek channel flowed through the unit footprint from the east, towards the Clinch River as shown on Figure 2. Based on the approximate locations of the current disposal areas (also shown on Figure 2), the channel entered the Clinch River in the vicinity of the southwest corner of the Gypsum Disposal Area 2A.

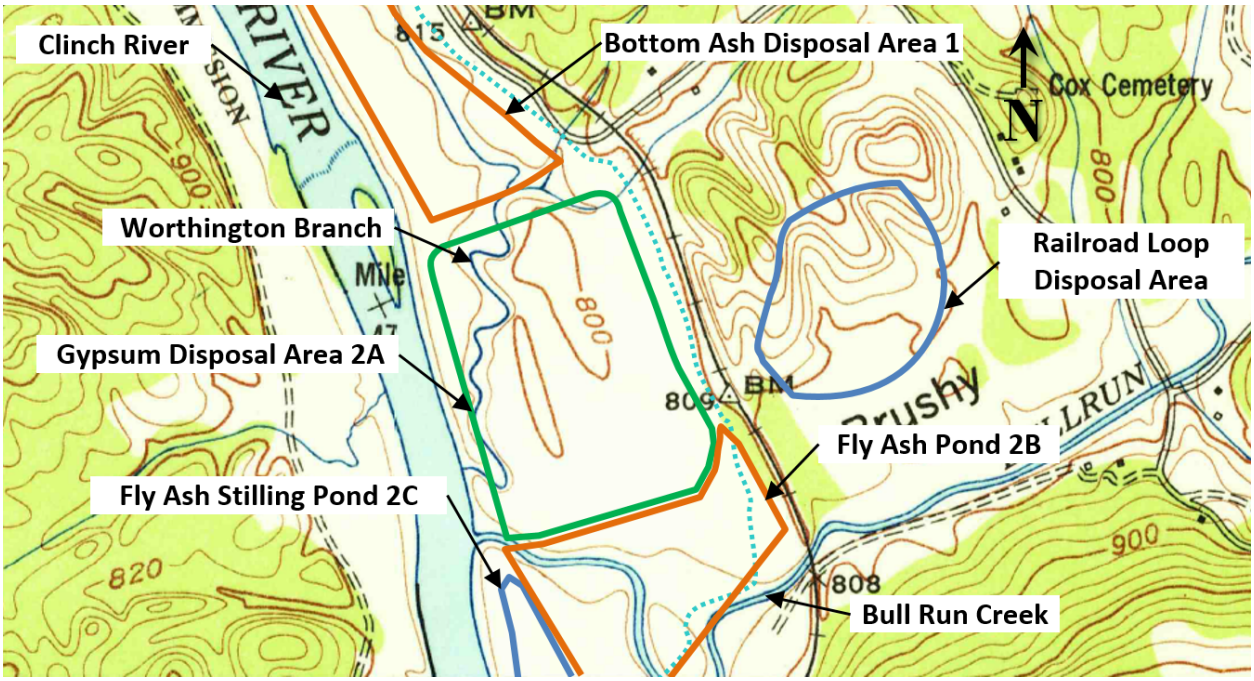

Figure 2. Original Topography at Bull Run Fossil Plant Site

Based on the Gypsum Disposal Area 2A subsurface characterization in Stantec (2010b), foundation soils generally consist of alluvial clays over alluvial sands and gravels. The alluvial clays are typically thicker than the underlying alluvial sands and gravels. Exhibit 13 (Appendix C) denotes the uppermost foundation soil type in each boring. While STN-43 only encountered the alluvial sand, it is apparent that this is a unique condition in this area. Several other borings in the vicinity, performed during multiple subsurface exploration programs, encountered the alluvial clay soil. Therefore, the stratigraphy present at STN-43 is judged to not be laterally extensive and would not be representative to model a slope stability cross section through this area.

Slope stability was not evaluated at the southwest corner of the Gypsum Disposal Area 2A through boring STN-43, but two cross-sections (I-I' and L-L') are located on either side of the area in question (Figure 3). Cross Section I-I' (Figure 1) is oriented perpendicular to the western perimeter dike, and Section L-L' (Figure 4) is oriented perpendicular to the south Gypsum Disposal Area 2A dike. Static slope stability was analyzed for the existing conditions at these two sections and met the acceptance criteria (URS 2010, Geocomp 2017). Seismic slope stability was analyzed for existing conditions at Section I-I' (which was judged to be the critical section for Gypsum Disposal Area 2A) and met the acceptance criteria (Geocomp 2017).

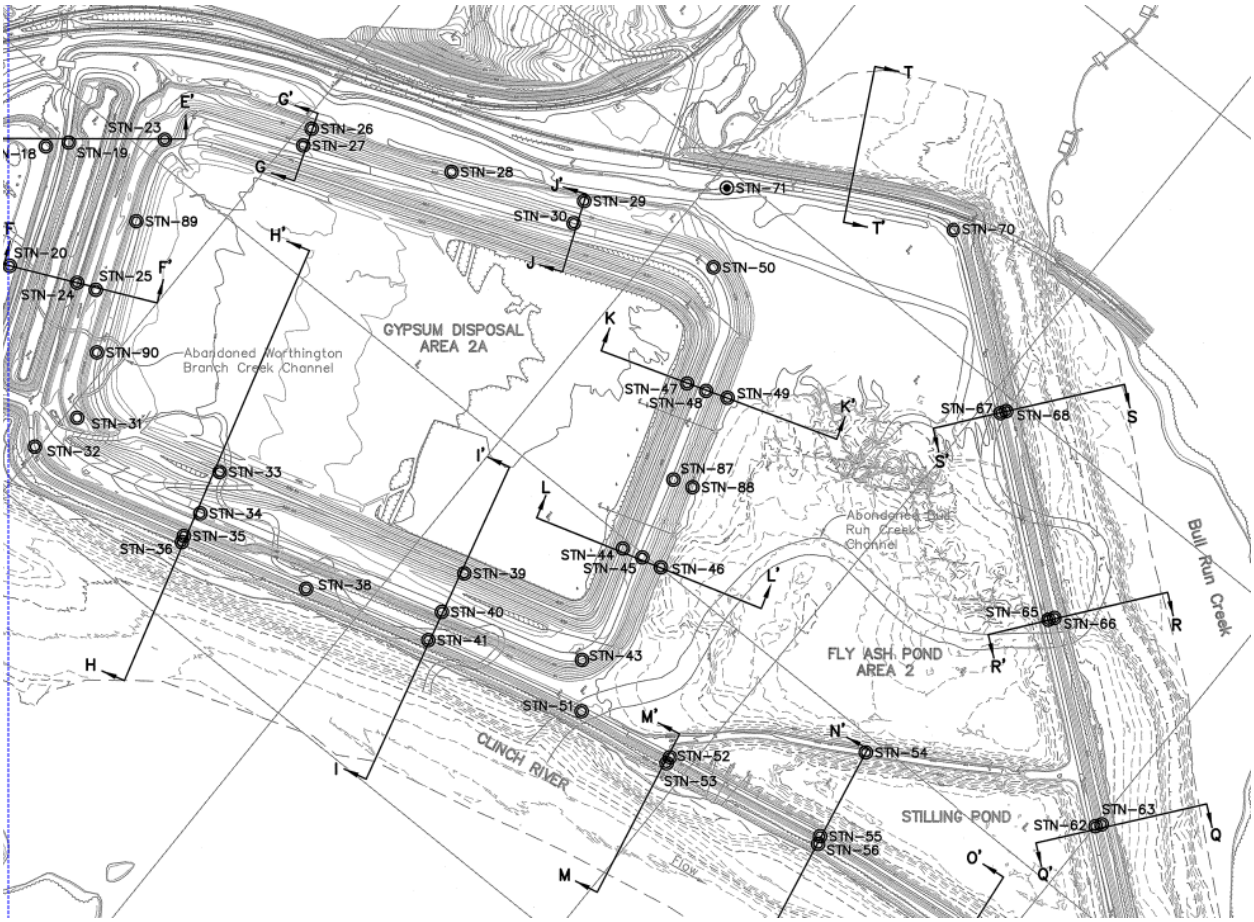

Figure 3. Gypsum Disposal Area 2A Cross Section Locations (Stantec 2010b)

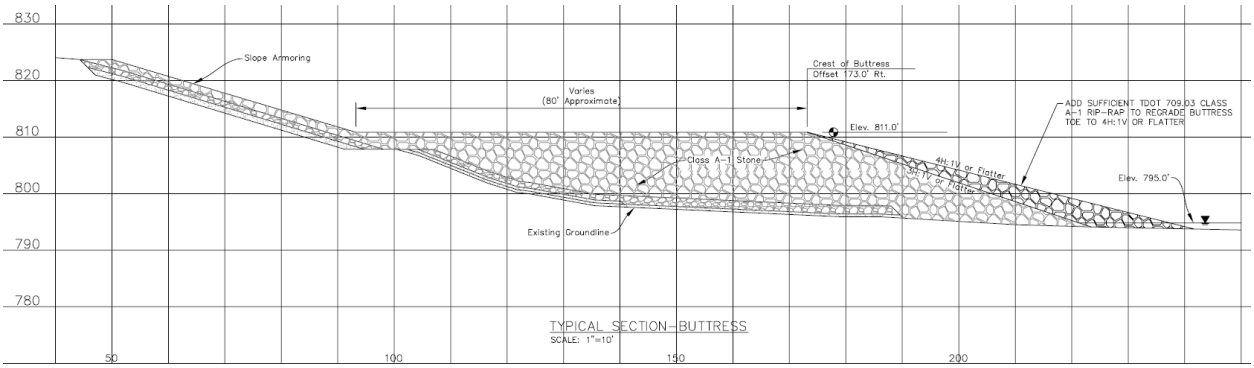

Figure 4. Cross Section L-L' Rock Buttress Design (URS 2010)

A cross section at the southwest corner of the Gypsum Disposal Area 2A through boring STN-43 would more likely resemble Cross-Section I-I' but with the additional South Perimeter Rip Rap berm as shown on Cross Section L-L'. The presence of the rip rap berm would improve the slope stability, relative to Section I-I'. In addition, the surface slope of a cross section through the southwest corner would be flatter, and thus more stable, than Section I-I' which is perpendicular to the steeper slope along the western perimeter. As discussed above, the absence of alluvial clay at STN-43 is not representative for purposes of slope stability modeling in this vicinity.

In summary, there is sufficient subsurface information to characterize foundation soil variations that may be related to the pre-construction alignment of Bull Run Creek, as it relates to slope stability in the vicinity of the southwest corner of Gypsum Disposal Area 2A. Further, there are sufficient analyses to demonstrate adequate slope stability in this vicinity. Therefore, no additional field work or analyses are necessary to answer this information request.

4.0 TDEC GENERAL GUIDELINES FOR EIP

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

TVA shall provide 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 III Detection Monitoring and Appendix IV Assessment Monitoring found on page 21500 of the Friday, April 17, 2015 Federal Register (Appendix III and IV 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 BRF to evaluate the background levels of constituents of concern, previously defined as CCR Parameters.

TVA has prepared a Background Soil SAP (Appendix P) to characterize background soils on TVA property in the vicinity of the TVA BRF 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 constituent levels. The surficial soil at each location will additionally be analyzed for percent ash, to determine the presence or absence of windblown CCR.

The Background Soil SAP establishes the procedures necessary to conduct investigation activities associated with the sampling and analysis of background soils. Exhibit 14 (Appendix C) depicts the locations of eighteen proposed background soil sampling locations, selected for collecting background soil data.

Exhibit 15 (Appendix C) shows the positions 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, and the sample location criteria previously set forth by TDEC.

Proposed sampling locations were evaluated for past placement of CCR material on those areas and to TVA's 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 BRF were additionally excluded.

Prior to mobilization for sample collection, the eighteen sampling locations will be field-verified for access and surveyed using the GPS. 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 similar 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 extended until 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 P).

In addition to the soil data that will be collected from the eighteen proposed sampling locations, TVA will review the background soil data previously collected during the soils study conducted as part of the implementation of Assessment Monitoring Phase III at the Bull Run Gypsum/Coal landfill Area facility (IDL 01-0208) in 2009 (TVA 2009). Additionally, TVA will collect soil samples through the well screen interval at locations of proposed background monitoring wells. Background soil samples collected as part of these efforts will be reviewed in accordance with the QAPP and analytical results will be compiled in the EAR if the quality of the data is acceptable.

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.

BTVs 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 unimpacted site-specific reference areas and represent an upper threshold of background concentration(s) expected to exist naturally in an environment similar to that of BRF.

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 2015b).

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 a CCR unit. The approach will include the collection and analysis of both pore water and CCR material from the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, and the Main Ash Pond.

Temporary wells will be installed, then filtered and unfiltered pore water samples will be collected from the phreatic zone at the base of a unit and from above any applicable drainage layer 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 temporary wells during their installation, from both saturated and unsaturated zones in the CCR unit. These samples will be analyzed for the parameters described below, using the most applicable method based on emerging science in the industry, which could include the Synthetic Precipitation Leaching Procedure method. The proposed sampling locations are shown on Exhibit 8 (Appendix C).

The pore water and CCR material samples will be analyzed for the previously defined 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.

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

- Verify proposed sampling locations using GPS
- Develop temporary wells in the ash disposal area (drilling and installation procedures of the temporary wells are outlined in the Exploratory Drilling SAP – Appendix M)
- Collect CCR material samples during installation of the temporary wells
- Collect pore water samples from the temporary wells
- Conduct laboratory testing and analysis

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. Conclusions and recommendations will be addressed 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

The Melton Hill Reservoir Dam, located approximately 22 miles downstream of BRF on the Clinch River, was constructed in 1963. TVA began constructing CCR units at BRF in 1962. The Geologic Map and Mineral Resources Summary of the Clinton Quadrangle (Swingle 1964) is provided as Exhibit 16 (Appendix C) with the approximate boundary of the CCR units added for clarity.

The 1952 Clinton Topographic Quadrangle, and TVA Drawings 10W289-1, 10N213-1, and 10W293-1 are provided as Exhibits 17 through 20 (Appendix C) with the approximate boundary of the CCR units added for clarity. TVA will review these maps during the Investigation and discuss surface water features and the flow direction of streams before BRF 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

As part of the Investigation, TVA will review the following documents and summarize the design and materials used to construct Ash Disposal Areas No. 1 and 2 (which were later subdivided to construct the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C). TVA will also use this information to estimate the original surface elevation at these locations. TVA will report this information in the EAR. It should be noted the Railroad Loop Disposal Area and Dry Fly Ash Stack were not operated as CCR surface impoundments.

- **Record Drawings:** TVA will use Record Drawing 10N213 (shown on Exhibit 19) to estimate the original surface elevation for Ash Disposal Areas No. 1 and 2. Record Drawings 10N213 and 10N214 provide plan views and cross sections for the construction of Ash Disposal Areas No. 1 and No. 2.

- **Geotechnical Reports:** Stantec (2010b) provides cross-sections which depict the configuration of the starter dikes as well as material classifications and consistency descriptions.

Based on the amount and context of data available to support a response, additional field work is not anticipated at this time to answer this information request.

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 O, 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. The objectives and approach for the Material Quantity SAP are summarized below.

Proposed TDEC Order Borings and Wells

TVA proposes installing multi-purpose borings, temporary wells, vibrating wire piezometers, and groundwater monitoring wells at locations shown on Exhibits 3, 4, 5, 8, 9, and 21 (Appendix C) to supplement existing data and answer various information requests including those regarding CCR material quantity, groundwater elevations, saturation levels, and subsurface conditions. To evaluate water levels in saturated material, the vibrating wire piezometer and temporary well borings will be screened in saturated material within the CCR units. As described in the Hydrogeological Investigation SAP (Appendix F), TVA plans to install new bedrock monitoring wells to characterize groundwater flow at BRF.

Details regarding proposed drilling, sampling, temporary well and piezometer installation activities are provided in the Exploratory Drilling SAP (Appendix M). Details regarding proposed drilling, sampling, and groundwater well installation activities are provided in the Hydrogeological Investigation SAP (Appendix F).

Three-Dimensional Models

Three-dimensional models of Dry Fly Ash Stack Phases 1 and 2, Dry Fly Ash Stack Lateral Expansion, Railroad Loop Disposal Area, Bottom Ash Disposal Area, Former Disposal Area, Chemical Pond, Sluice Channel, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C will be developed to depict subsurface conditions from ground surface to bedrock. The models will be developed using the data summarized below which includes data from the proposed exploratory borings, piezometers, and wells discussed above, as well as other relevant data collected during the Investigation.

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

2. TVA surveyed slopes, embankments, and benches to develop stability cross-sections. TVA will use this topographic data with the most recent aerial survey data to model the geometry of the dikes and benches.

3. Contour data from the most recent aerial and hydrographic surveys, borings shown on Exhibits 4, 5, 8, 10, 11, 21, 22, 23 (Appendix C) and as-built survey data from the Railroad Loop Disposal Area closure will be used to model the upper CCR surface.

4. Record drawings documenting the drainage/capillary break layer will be used to model the lower CCR surface of the Dry Fly Ash Stack Lateral Expansion. Pre-construction topographic information from TVA drawings and data from borings that penetrated the lower boundary of the CCR surface shown on Exhibits 4, 8, 21, 22, and 23 will be used to model the lower CCR surface at the remaining units.

5. Data from borings shown on Exhibits 8,19, and 23 will be used to model sluiced ash and bottom ash in the Bottom Ash Disposal Area.

6. Data from borings that encountered foundation soils shown on Exhibits 4, 5, 8, 9, 12, 13, and 21 will be used to model the foundation soils underlying each site.

7. Data from borings that encountered top of bedrock shown on Exhibits 5, 8, 21, 24, and 25 will be used to model the top of bedrock surface.

8. Estimated piezometric levels of saturation discussed above will be incorporated into the models.

9. Groundwater levels obtained as part of the hydrogeological investigation described in the Hydrogeological Investigation SAP (Appendix F) will be incorporated into the models.

The three-dimensional models 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 models of the facilities.

Drawings

After the three-dimensional models are finalized, they will be used to produce drawings of the Dry Fly Ash Stack Phase 1 & 2, Dry Fly Ash Stack Lateral Expansion, Railroad Loop Disposal Area, Bottom Ash Disposal Area, Former Disposal Area, Chemical Pond, Sluice Channel, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C showing the following:

- Subsurface material types, properties, elevations, and thickness from the ground surface to top of bedrock
- 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 Fly Ash Stilling Pond 2C
- Sluiced fly ash and bottom ash in the Bottom Ash Disposal Area
- Proposed Bottom Ash Disposal Area CCR closure elevations

Volumetric Estimates

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

Reporting and Deliverables

The 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.

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 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

The request for a water balance analysis for active surface impoundments is not applicable, as there are no active CCR surface impoundments at BRF.

The Fly Ash Stilling Pond 2C and the Main Ash Pond are inactive CCR surface impoundments, and the notices of intent to initiate closure were dated December 15, 2015 and posted to the Operating Record.

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.

TVA Response

This information request is similar to the information requests that is addressed in Section 3.1.3. Refer to that section for details on the proposed Water Use Survey SAP.

4.3 C. GROUNDWATER MONITORING AND MAPPING

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

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 data from existing and closed groundwater monitoring wells at the site. This information is provided in Appendix K in tabular form. This data has been collected for a variety of reasons since approximately 1981. TVA may use these historical data for qualitative purposes but will use such data only after evaluating it in accordance with the BRF QAPP. A figure showing existing and closed monitoring wells that correspond to the tables is included in Figure 1 of Appendix K.

In addition to the analytical data, the construction information, location of existing and closed groundwater monitoring wells and well closure rationale is included in tabular form in Appendix K. Available well closure records are also included in Appendix K.

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. If found, the newly identified springs will be added to the groundwater monitoring plan for the monitoring networks, as described in Section 3.1.1.

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 information request is similar to other information requests that are addressed in Sections 3.1.1, 3.3.1 and 3.4.3. Refer to those sections for details on proposed background monitoring wells.

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 ground water flow and direction.

TVA Response

This information request is similar to other information requests that are addressed in Sections 3.1.1, 3.2.1, 3.3.1 and 3.4.3. Refer to those sections for details on proposed new monitoring well and piezometer locations.

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 information request is similar to other information requests that are addressed in Sections 3.1.1, 3.2.1, 3.3.1 and 3.4.3. Refer to those sections and the Hydrogeological Investigation SAP (Appendix F) for details on proposed drilling, logging, well construction and well development methods.

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

BRF currently has active groundwater compliance monitoring for the Dry Fly Ash Stack Lateral Expansion (the only active unit at the site) and for the following inactive units:

- Bottom Ash Disposal Area and Gypsum Disposal Area 2A
- Dry Fly Ash Stack Phase 1 and 2

TVA has prepared a Groundwater Investigation SAP (Appendix H) that includes the following information:

- Methods used to collect groundwater samples;
- Methods used for groundwater sample analyses; and
- Chain-of-custody procedures used for sample transportation from point of collection to the laboratory. TVA will identify a qualified laboratory after approval of the EIP by TDEC.

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

The request regarding the estimation of the amount of CCR material below the groundwater surface is similar to the information requested in Sections 3.1.1, 3.2.1, 3.3.1, 3.4.1, 3.4.3 and 4.1.5. Refer to those sections for proposed investigations to collect groundwater level data to prepare groundwater contour maps and estimate the three-dimensional profile of CCR material.

The request regarding the collection of pore water samples is similar to the information requested in Section 4.1.2. TVA will research and review existing reports and studies for pore water data. The CCR Material Characteristics SAP is described in Section 4.1.2. Information identified in the review and collected in the investigation will be evaluated and summarized in the EAR.

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

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

TVA Response

As described in Sections 3.1.1, 3.2.1, 3.3.1 and 3.4.3, TVA will prepare a hydrogeological characterization report of the geology and hydrogeology of the site and will include an evaluation of analytical data for CCR constituents in groundwater at the site. The report will provide an understanding of the groundwater flow system at BRF, a review of existing wells conditions, and modification recommendations to the well network. The hydrogeological characterization report will be provided in the EAR.

The initial phase of the environmental investigation is to characterize the site by assessing current subsurface conditions at BRF. Potential groundwater impacts will be identified by collecting background and downgradient groundwater. 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 TVA Technical Instruction for Monitoring Well and Piezometer Installation and Development (ENV-TI-05.80.25). New monitoring wells will be monitored bi-monthly for one year (six events).

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.

If additional monitoring wells are proposed to be installed, then TVA will revise the Hydrogeological Investigation SAP to reflect changes to the groundwater monitoring network, including the rationale, location, construction and drilling and installation methods for any new wells. If required, the proposed changes to the existing TDEC-approved groundwater monitoring program and IDL network will be submitted as a Minor Permit Modification request to TDEC.

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., Kellberg 1962, MACTEC 2004 and 2006, Stantec 2010a, 2010b, 2011a, and 2011b, TVA 2005a, URS 2005, TVA 2006), as well as construction and facility performance records will be reviewed. In particular, the review will focus on information related to geologic lithology, geologic features, solution channeling, and/or springs at the BRF site. The response will discuss how the geologic lithology influences the construction and performance of the different units.

In addition, data collected during implementation of the hydrogeological characterization of BRF will be included in the geological characterization of the facility. Certain proposed investigations will provide geological information. Sections 3.1.1, 3.2.1, 3.3.1 and 3.4.3 provide proposed investigations of bedrock with an objective of identifying bedding planes, fractures, or other structures.

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

Maps showing the locations of springs within the Study Area are not known to exist (see also Section 3.3.2). If springs are observed during investigative activities or routine inspections of CCR units, then they will be documented and reported to TDEC.

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 listed in the response to D.1 to describe the geologic structure beneath the CCR units with a focus on faults, fractures, and bedding planes.

The locations of known faults near or at BRF will be provided based on existing literature and site-specific investigations. Observations regarding fractures and bedding planes identified in rock cores collected during previous investigations will be summarized. TVA will use this existing information to describe the geologic structure below BRF, including the proximity of faults below the CCR units and the degree of infilling of fractures and bedding planes.

In addition, data collected during implementation of the hydrogeological characterization of BRF will be included in the geological characterization of the facility. Certain proposed investigations will provide geological information. Sections 3.1.1, 3.2.1, 3.3.1 and 3.4.3 provide proposed investigations of bedrock with an objective of identifying bedding planes, fractures, or faults.

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 groundwater 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 O, 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 M).

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 applies to Ash Disposal Areas No. 1 and 2 which were divided to construct the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C. TVA will review and summarize the following documents to describe in the EAR how Ash Disposal Areas No. 1 and 2 were divided into individual units.

- **Drawings:** Drawings 10W286, 10N213, 10N214, and the 10W297 Series Drawings depict how Ash Disposal Areas No. 1 and 2 were divided into individual units.

- **Annual Inspection Reports:** TVA will review and summarize information from annual inspection reports that describe how Ash Disposal Areas No. 1 and 2 were divided into individual units similar to the history of the units presented in the TDEC Investigation Conference Presentation.

- **Geotechnical Data:** Stantec (2010b) provides stability cross sections which depict the configurations of the starter, raised, and CCR dike systems.

Based on the amount and context of data available to support a response, additional field work is not anticipated at this time to answer this information request.

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 applies to the Gypsum Disposal Area 2A, Bottom Ash Disposal Area and Dry Fly Ash Stack. This information request does not apply to the Railroad Loop Disposal Area, Main Ash Pond, or Fly Ash Stilling Pond 2C because disposal structures were not constructed above original disposal areas.

Gypsum Disposal Area 2A: TVA will use the 10W297 Series Drawings including 10W297-27A, 10W297-5A, and 10W297-32A, historical borings, and stability analyses documented in the Stability SAP (Appendix J) to describe the interfaces between ash and gypsum in Gypsum Disposal Area 2A in the EAR.

This topic is closely related to identifying the drainage layer interface as discussed in Section 4.4.7. Discussion will be added to the EAR regarding how the findings of the geotechnical borings compares to the interface geometry shown on the referenced drawings.

As long as the boring locations and elevations are documented, and the boring logs have sufficient detail to distinguish the interface, then the age of the borings does not impact their value. The existing information will be supplemented in the EAR by the proposed borings and borings completed recently for other ongoing projects as outlined in the EIP.

In addition to borings, the permit drawings (10W297 series) document the interface with a reasonable degree of confidence. These drawings were part of the TDEC-approved permit application for Class II Landfill No. IDL 01-0208.

Finally, the EAR will provide explanation that a more accurate delineation of the gypsum/ash interface is not critical to the slope stability analysis of the unit. The stability is not controlled by the exact elevation of the interface. The available information (existing and proposed) will locate the interface to a sufficient degree of accuracy such that no additional borings are necessary.

Bottom Ash Disposal Area: TVA will use the 10W297 Series Drawings, historical borings, and stability analyses documented in the Stability SAP (Appendix J) to describe the interface between sluiced ash and stacked ash in the Bottom Ash Disposal Area in the EAR.

Discussion will be added to the EAR regarding how the findings of the geotechnical borings compare to the interface geometry shown on the referenced drawings. As long as the boring locations and elevations are documented, and the boring logs have sufficient detail to distinguish the interface, then the age of the borings does not impact their value.

The existing information will be supplemented in the EAR by the proposed borings and borings completed recently for other ongoing projects as outlined in the EIP.

In addition to borings, the permit drawings (10W297 series) document the interface with a reasonable degree of confidence. These drawings were part of the TDEC-approved permit application for Class II Landfill No. IDL 01-0208.

Finally, the EAR will provide explanation that a more accurate delineation of the sluiced ash/stacked ash interface is not critical to the slope stability analysis of the unit. The stability is not controlled by the exact elevation of the interface. The available information (existing and proposed) will locate the interface to a sufficient degree of accuracy such that no additional borings are necessary.

Dry Fly Ash Stack: TVA will use Drawings 10W297-6 and 10W297-7 and stability analyses documented in the Stability SAP (Appendix J) to describe the interface between Phase 1 and 2 in the Dry Fly Ash Stack in the EAR. TVA will use the 10W299 Series Drawings, surveys, and stability analyses documented in the Stability SAP to describe the interface between the Phase 2 and Lateral Expansion in the EAR.

This topic is closely related to identifying the drainage layer interfaces as discussed in Section 4.4.7. Regarding the Phase 1 and 2 interfaces, the permit drawings (10W297 series) document the interface with a reasonable degree of confidence. These drawings were part of the TDEC-approved permit application for Class II Landfill No. IDL 01-103-0080.

Regarding the Phase 2 and Lateral Expansion interface, the record drawings for the leachate collection system improvements (Stantec 2015) document the interface with a reasonable degree of confidence. In addition, much of the interface is currently at the surface and has been surveyed to a reasonable degree of accuracy.

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 J), 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 I (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. 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 J). 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 Railroad Loop Disposal Area to answer this information request. Refer to the Exploratory Drilling SAP (Appendix M) for more information.

Bottom Ash Disposal Area: Existing analyses are available for the Bottom Ash Disposal Area, from the following sources:

- Stantec (2010b): Static stability analyses of existing conditions, incorporating results of additional geotechnical exploration
- TVA (2005a): Static stability, seismic stability, and liquefaction triggering analyses for permitted geometry (included in application documents for TDEC-approved Solid Waste Permit No. IDL 01-0208)

- Stantec (2012): Pseudostatic stability analyses of existing conditions, to support EPA's assessment of TVA's CCR disposal facilities

- Geocomp (2017): Static, pseudostatic, and post-earthquake stability and liquefaction triggering analyses of existing conditions, incorporating results of additional geotechnical exploration

The existing analyses are sufficient to address each of the necessary load cases. Updated static global and static veneer stability analyses are being developed as part of the ongoing closure design. In addition to other required submittals to TDEC, TVA will submit pertinent data and information from other activities used in the Environmental Investigation in the EAR.

Gypsum Disposal Area 2A: Existing analyses are available for the Gypsum Disposal Area 2A, from the following sources:

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

- Stantec (2010c): Static stability analyses for design of a buttress along the south slope

- TVA (2005a): Static stability, seismic stability, and liquefaction triggering analyses for permitted geometry (included in application documents for TDEC-approved Solid Waste Permit No. IDL 01-0208)

- Stantec (2012): Pseudostatic stability analyses of existing conditions, to support EPA's assessment of TVA's CCR disposal facilities

- Geocomp (2017): Static, pseudostatic, and post-earthquake stability and liquefaction triggering analyses of existing conditions, incorporating results of additional geotechnical exploration

The existing analyses are sufficient to address each of the necessary load cases. Updated static global and static veneer stability analyses are being developed as part of the ongoing closure design. In addition to other required submittals to TDEC, TVA will submit pertinent data and information from other activities used in the Environmental Investigation in the EAR.

Main Ash Pond: Existing analyses are available for the Main Ash Pond, from the following sources:

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

- Stantec (2012): Pseudostatic stability analyses of existing conditions, to support EPA's assessment of TVA's CCR disposal facilities

- URS (2011a): Static stability analyses of proposed conditions, to support design of perimeter rock buttress

- Geocomp (2017): Static, pseudostatic, and post-earthquake stability and liquefaction triggering analyses of existing conditions, incorporating results of additional geotechnical exploration

- AECOM (2017a): Static stability analyses of proposed conditions, to support closure design

Seismic stability analyses are not available for the proposed closed conditions and will be performed in accordance with the Stability SAP (Appendix J). However, after the closure design is finalized, it will be compared against analyses for the existing conditions. The existing conditions analyses may prove adequate to represent the closed conditions. A summary of these analyses will be included in the EAR.

Fly Ash Stilling Pond 2C: Existing analyses are available for Fly Ash Stilling Pond 2C, from the following sources:

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

- Stantec (2012): Pseudostatic stability analyses of existing conditions, to support EPA's assessment of TVA's CCR disposal facilities

- URS (2011a): Static stability analyses of proposed conditions, to support design of perimeter rock buttress

- AECOM (2017b): Static stability analyses of proposed conditions, to support closure design

Seismic stability analyses are not available for the proposed closed conditions and will be performed in accordance with the Stability SAP (Appendix J). However, after the closure design is finalized, it will be compared against analyses for the existing conditions. The existing conditions analyses may prove adequate to represent the closed conditions. A summary of these analyses will be included in the EAR.

Railroad Loop Disposal Area: This Information Request is addressed as part of Railroad Loop Disposal Area – TDEC Information Request No. 1 (Section 3.3.1). Refer to that section regarding existing and proposed stability analyses.

Dry Fly Ash Stack Phase 1 and 2: Existing analyses are available for the Dry Fly Ash Stack Phase 1 and 2, from the following sources:

- Stantec (2011a): Static stability analyses of existing conditions, incorporating results of additional geotechnical exploration

- Stantec (2011b): Static stability analyses of existing conditions, incorporating results of additional geotechnical exploration (beyond explorations from Stantec (2011a))

- Stantec (2013): Static stability analyses for design of a buttress along the toe of much of the Phase 1 perimeter and a smaller portion of the Phase 2 perimeter

Note that static stability analyses in Stantec (2013) reflect the current existing conditions for Phase 1 and Phase 2. Seismic stability analyses are not available for the existing closed conditions for Phase 1 and Phase 2 and will be performed in accordance with the Stability SAP (Appendix J). A summary of the analyses will be presented in the EAR.

Dry Fly Ash Stack Lateral Expansion: Existing analyses are available for Dry Fly Ash Stack Lateral Expansion, from the following sources:

- CEC (2012): Static and seismic slope stability and seismic deformation analyses were included in the Lateral Expansion Operations Manual. These analyses were included in application documents for TDEC-approved Solid Waste Permit No. IDL 01-103-0080. As noted in Section 3.2.4, the amended analyses omit the earlier proposed vertical expansion.

Static veneer, seismic veneer, liquefaction triggering, and post-earthquake analyses are not available for the future build-out conditions and will be performed in accordance with the Stability SAP (Appendix J). A summary of these analyses 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

Bottom Ash Disposal Area: This unit was permitted as a solid waste facility under TDEC Solid Waste Permit No. IDL 01-0208. This unit does not have a drainage layer; therefore, this information request does not apply to this unit.

Gypsum Disposal Area 2A: This unit was permitted as a solid waste facility under TDEC Solid Waste Permit No. IDL 01-0208. An underdrain system was installed when the unit was converted from a surface impoundment to a gypsum stack. The underdrains discharge into the Main Ash Pond and ultimately through permitted NPDES outfall DSN001. TVA (2005a) and TVA drawing series 10W297 describe the underdrain system.

A series of subsurface drains (i.e., French drains) installed around the perimeter of the unit was completed in 2012. The system is described in the Basis of Design report (URS 2011a) and Construction Record Documentation Report, which includes TVA record drawing series 10W508 (URS 2012a).

With regard to slope stability, the key issue is whether or not representative (or conservative) pore water pressures within the unit are used in the stability analyses. The existing piezometers and proposed temporary wells and piezometers to be installed as part of the Investigation and/or other ongoing projects will aid in understanding this issue.

Discussion will be added to the EAR regarding how the findings of the geotechnical borings compares to the interface geometry shown on the referenced drawings. As long as the boring location and elevations are documented, and the boring logs have sufficient detail to distinguish the interface, then the age of the borings does not impact their value.

The existing information will be supplemented in the EAR by the proposed borings and borings completed recently for other ongoing projects as outlined in the EIP.

In addition to borings, the permit drawings (10W297 series) document the interface with a reasonable degree of confidence. These drawings were part of the TDEC-approved permit application for Class II Landfill No. IDL 01-0208.

Finally, the EAR will provide explanation that a more accurate delineation of the gypsum/ash interface is not critical to the slope stability analysis of the unit. The stability is not controlled by the exact elevation of the interface. The available information (existing and proposed) will locate the interface to a sufficient degree of accuracy such that no additional borings are necessary.

Main Ash Pond, Fly Ash Stilling Pond 2C, Railroad Loop Disposal Area: These units are not permitted CCR landfills, and do not have drainage layers; therefore, this information request does not apply to these units.

Dry Fly Ash Stack Phase 1 and 2: Phase 2 of this unit was permitted as a solid waste facility under TDEC Solid Waste Permit No. IDL 01-103-0080. A geocomposite drainage layer was installed along the sloping interface between Phases 1 and 2. The drainage layer discharges to a collector pipe, to a perimeter ditch, to a sedimentation pond, and ultimately through a permitted NPDES outfall. The system is described in the Phase 2 Operations Manual (TVA 2005b) and is illustrated on TVA drawing series 10W297.

With regard to slope stability, the key issue is whether or not representative (or conservative) pore water pressures within the unit are used in the stability analyses. The existing piezometers and proposed piezometers to be installed as part of the Investigation and/or other ongoing projects will aid in understanding this issue.

The permit drawings (10W297 series) document the interface with a reasonable degree of confidence. These drawings were part of the TDEC-approved permit application for Class II Landfill No. IDL 01-103-0080.

The EAR will include descriptions of the above system.

Dry Fly Ash Stack Lateral Expansion: The lateral expansion of this unit was permitted as a solid waste facility under TDEC Solid Waste Permit No. IDL 01-103-0080. The design includes a leachate collection system, consisting of a geocomposite drainage net (connected to a collection pipe network and sump) beneath a capillary break layer of soil.

The pipe network discharges to a leachate collection pond (CEC 2012). Improvements to the leachate collection system were completed in 2015 (Stantec 2015).

With regard to slope stability, the key issue is whether or not representative (or conservative) pore water pressures within the unit are used in the stability analyses. The existing piezometers will aid in understanding this issue.

The record drawings for the leachate collection system improvements (Stantec 2015) document the interface with a reasonable degree of confidence.

The EAR will include descriptions of the above system.

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 Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, Fly Ash Stilling Pond 2C, Railroad Loop Disposal Area, Dry Fly Ash Stack Phase 1 and 2, and Dry Fly Ash Stack Lateral Expansion 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 BRF.

Regarding the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, and Railroad Loop Disposal Area, 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 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."

Throughout their service life, TVA has constructed and operated the Bottom Ash Disposal Area and Gypsum Disposal Area 2A in compliance with the state and/or federal regulatory frameworks in effect at the time.

In 2006, TDEC issued Class II landfill permit IDL 01-000-0280 to allow portions of the existing surface impoundments to be transitioned to the Bottom Ash Disposal Area and Gypsum Disposal Area 2A. Since 2006, TDEC has approved various permit modifications for these CCR units.

As discussed in Section 3 of the EIP, the Bottom Ash Disposal Area and Gypsum Disposal Area 2A are inactive landfills as defined by the CCR Rule. The CCR Rule became effective in 2015 and does not apply retroactively to the surface impoundments that were transitioned to landfills in compliance with the 2006 TDEC permit.

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

Bottom Ash Disposal Area: Recent geotechnical explorations have characterized the CCR materials present in this unit. Shear strengths were developed from field sampling and laboratory testing data in the Report of Geotechnical Exploration (Stantec 2010b) as provided in the Investigation Conference transmittal. Stantec (2010b) also considered prior drilling and testing results in the vicinity of this unit (MACTEC 2004; TVA 1985a; Tri-State Testing and Drilling 1989). Geocomp (2017) included drilling, lab testing, and development of shear strength parameters. Boring locations are shown on multiple exhibits in Appendix C. The EAR will present a summary of the existing data and characterization of the CCR shear strengths for this unit.

Gypsum Disposal Area 2A: Recent geotechnical explorations have characterized the CCR materials present in this unit. Shear strengths were developed from field sampling and laboratory testing data in the Report of Geotechnical Exploration (Stantec 2010b) as provided in the Investigation Conference transmittal. Stantec (2010b) also considered prior drilling and testing results in the vicinity of this unit (MACTEC 2004; TVA 1985a; Tri-State Testing and Drilling 1989).

Geocomp (2017) included drilling, lab testing, and development of shear strength parameters. Boring locations are shown on multiple exhibits in Appendix C. The shear strength of the gypsum has been estimated based on testing of similar materials at other TVA gypsum disposal units. It should be noted that the slope stability of Gypsum Disposal Area 2A is not sensitive to the strength of the gypsum, because the gypsum is located at the top and interior of the unit. The EAR will present a summary of the existing data and characterization of the CCR shear strengths for this unit.

Main Ash Pond: Recent geotechnical explorations have characterized the CCR materials present in this unit. Shear strengths were developed from field sampling and laboratory testing data in the Report of Geotechnical Exploration (Stantec 2010b) as provided in the Investigation Conference transmittal. Stantec (2010b) also considered prior drilling and testing results in the vicinity of this unit (MACTEC 2004; TVA 1985a). Geocomp (2017) and AECOM (2017b) included drilling, lab testing, and development of shear strength parameters. Boring locations are shown on multiple exhibits in Appendix C. The EAR will present a summary of the existing data and characterization of the CCR shear strengths for this unit.

Fly Ash Stilling Pond 2C: Recent geotechnical explorations have characterized the CCR materials present in this unit. Shear strengths were developed from field sampling and laboratory testing data in the Report of Geotechnical Exploration (Stantec 2010b) as provided in the Investigation Conference transmittal. Stantec (2010b) also considered prior drilling and testing results in the vicinity of this unit (MACTEC 2004; TVA 1985a). AECOM (2017b) included drilling, lab testing, and development of shear strength parameters. Boring locations are shown on multiple exhibits in Appendix C. The EAR will present a summary of the existing data and characterization of the CCR shear strengths for this unit.

Railroad Loop Disposal Area: Shear strength parameters for stacked ash were developed by TVA (1987b) based on results of prior geotechnical explorations (TVA 1985b, 1985c, 1985d, 1987a). Boring locations are shown on multiple exhibits in Appendix C. Sluiced ash in the Railroad Loop Disposal Area footprint was dredged and sluiced from the former Area 2 ash pond in the footprint of the Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C (Stantec 2009). Thus, the sluiced ash shear strength parameters from samples obtained in the Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C can be applied to the sluiced ash in the Railroad Loop Disposal Area. The EAR will present a summary of the existing data and characterization of the CCR shear strengths for this unit.

Dry Fly Ash Stack Phase 1 and 2: Recent geotechnical explorations have characterized the CCR materials present in this unit. Shear strengths were developed from field sampling and laboratory testing data by Stantec (2011a, 2011b). Stantec (2011b) was provided in the Investigation Conference transmittal. Stantec (2011a, 2011b) also considered prior drilling and testing results in the vicinity of this unit (Young and Beard 1989; Law Engineering 1991; MACTEC 2006).

Boring locations are shown on multiple exhibits in Appendix C. The EAR will present a summary of the existing data and characterization of the CCR shear strengths for this unit.

Dry Fly Ash Stack Lateral Expansion: Recent geotechnical explorations performed within the footprint of this unit pre-date its operation and the presence of CCR materials. Boring layouts are included in Appendix C. However, the CCR materials (and method of placement) in the Lateral Expansion are represented by those present in Phase 1 and 2 of the Dry Fly Ash Stack.

Thus, for design and permitting purposes the stacked ash to be placed in the Lateral Expansion was assigned parameters developed from field sampling and laboratory testing data for the stacked ash in Phase 1 and 2 of the Dry Fly Ash Stack (Stantec 2011a, 2011b; CEC 2012). The EAR will present a summary of the existing data and characterization of the CCR shear strengths for this unit.

General: Based on the amount and context of data available to support a response, additional field work is not anticipated at this time to answer this information request.

The proposed exploratory drilling to install temporary wells or geotechnical borings (Appendix M) does provide supplemental borings from the top of each unit to the base of CCR or to the original ground surface below each unit. Disturbed and undisturbed samples collected during exploratory drilling will be subjected to index tests. As discussed in the response, new shear strength testing is not necessary but could be added if unexpected soil or CCR materials are encountered.

4.4.10 D.10 TDEC Site Conditions Request No. 10

TVA shall provide the stability calculations for final permitted design elevations for Landfills that are defined by the Federal Regulations as overfills. If the stability calculations have not been completed, then TVA shall provide stability calculations 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 Response

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

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 Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Railroad Loop Disposal Area, Dry Fly Ash Stack Phase 1 and 2, and Dry Fly Ash Stack Lateral Expansion do not constitute dams, as defined by TVA Standard Programs and Processes manual on Dam Safety (TVA 2016a). Likewise, the units do not constitute a dam under Federal Emergency Management Agency (FEMA) guidelines, which consider both dam height and impounding capacity.

The above listed units at BRF 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.

However, the existing Main Ash Pond and Fly Ash Stilling Pond 2C do meet the definition of a dam. Also, the perimeter dike system around the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C is included in TVA's Dam Safety Program (due to the nature of historic and existing operations). TVA has applicable Standard Programs and Processes that govern the dam safety analysis. TVA's Dam Safety Governance and Oversight department provides TVA with procedural standards for managing dam safety activities, oversight, and support. Objectives of the program include:

- Establish and maintain a complete inventory of all TVA dams and impoundments
- 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 non-registered 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 as part of the DSWM permitting process for the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, and Dry Fly Ash Stack Lateral Expansion.

While the BRF Study Area (with the exception of the Dry Fly Ash Stack Lateral Expansion) is not subject to the CCR Rule for active units, as noted in Section 4.4.8, an industry-standard slope stability evaluation will be performed. The program will consider static and seismic slope stability, as well as liquefaction triggering, as applicable. Existing and proposed (i.e., closed-in-place) seismic stability assessments are outlined in Sections 3.1.5 and 4.4.6. Proposed analyses will be performed per the Stability SAP (Appendix J). Results will be presented in the EAR.

The Dry Fly Ash Stack Lateral Expansion is subject to the CCR Rule as an active landfill, therefore CFR 257.63 does not apply. The requirements of CFR 257.64 for Unstable Areas assessment do apply to the Lateral Expansion and will be completed by the CCR Rule deadline. Results will be summarized 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

The BRF Study Area (with the exception of the Dry Fly Ash Stack Lateral Expansion) 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 Manuals (TVA 2005a, 2005b; CEC 2012) for the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Dry Fly Ash Stack Phase 1 and 2, and Dry Fly Ash Stack Lateral Expansion and the TDEC-approved Closure Plan for the Railroad Loop Disposal Area (TVA 1995) addressed many aspects of structural integrity listed in the CCR Rule CFR 257.73(d) such as erosion protection, vegetative cover, and spillway adequacy.

The perimeter dike system, which surrounds portions of the Chemical Pond, Former Disposal Area, Sluice Channel, Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C was improved (with respect to river bank erosion protection), as documented by URS (2011b). Spillway structures in the Stilling Pond have been modified and the operating pool levels in the Main Ash Pond and Stilling Pond have been lowered to improve stability (URS 2012b). Settlement will be evaluated as discussed in Section 3.1.5.

The on-going closure design for the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, Fly Ash Stilling Pond 2C, and Sluice Channel will also consider various structural integrity aspects.

A summary of the above-mentioned studies will be provided in the EAR.

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 J) 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 existing condition. Relevant information from Sections 4.4.1 and 4.4.2, including results of proposed investigations, will also be considered. 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 a 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 shall also describe in the EIP how it will assess any impact CCR material and/or dissolved CCR constituents may have on water quality and/or the impact on fish and aquatic life.

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

Since 1991, sediment sampling of the Melton Hill Reservoir has been conducted in association with TVA's Reservoir Ecological Health Monitoring Program. Eighteen sampling events at mile marker CRM 24.0, and sixteen sampling events at mile marker CRM 45.0 have been performed under the program. Samples have been collected and total analyses performed for fourteen different metals. TVA will continue to conduct a records search for additional streambed sediment investigations of the Clinch River, Bull Run Creek, and Worthington Branch streambeds adjacent to the BRF site. TVA will review available data and provide a discussion regarding CCR deposition in the aforementioned streambeds 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 Appendix 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

A Benthic SAP (Appendix Q) has been prepared to characterize sediment chemistry, benthic macroinvertebrate (invertebrate) community composition, and benthic invertebrate bioaccumulation in surface streams on or adjacent to the site to determine if CCR material has migrated from the BRF site into surface streams.

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. Finalize a sediment sampling location map
3. Finalize Sediment 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 Q). Phase 1 will include:

- Conduct three Vibracore borings at each of fourteen 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-two 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 samples for percent ash, using PLM

- Analyze all of the top six-inch sediment samples for the CCR Parameters

- Hold the remaining deeper sediment samples for potential analyses under Phase 2 if > 20% ash in Phase 1 samples

Proposed sediment sampling locations for the Benthic SAP have been selected to investigate areas in the Clinch River and Bull Run Creek upstream of the site, areas bordering the site including areas in the Clinch River, Worthington Branch, and/or Bull Run Creek where mitigated or potentially active seeps are located, and areas downstream of the site in the Clinch River.

A map of proposed sediment sampling transects is provided as Exhibit 26 (Appendix C), and a complete description of the sampling methods and protocols is provided in the Benthic SAP, which can be found in Appendix Q.

Quantitative benthic invertebrate samples will be collected during Phase 1 and are included in the Benthic SAP in Appendix Q. The benthic invertebrate samples will be collected along transects at the locations depicted on Exhibit 27 (Appendix C). 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 28 (Appendix C). 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 (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.

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 composited sediment core sample(s), at sampling locations that exceeded the 20 percent ash content, for CCR Parameters

- Preparation of a 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 composited sediment core samples for CCR Parameters and percent ash

Phase 2 sampling will follow the same sampling methods and protocols as Phase 1.

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 BRF 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 identified from existing information or during future sampling events, then the results will be used to prepare maps showing the distribution and depth of CCR material in the Clinch River, Bull Run Creek, and/or Worthington Branch adjacent to the BRF site. If applicable, 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

The results of the hydrogeological characterization study, including the hydrogeologic report and sampling results, along with identified surface water sampling results, will be reviewed, compiled, and evaluated to understand the movement of groundwater flow into surface streams and the presence of CCR constituents. A report summarizing the current information available will be provided in the EAR.

Surface water sampling was performed at BRF Outfalls 001, 002, and IMP 004 between December 2011 and November 2012 in accordance with NPDES Permit TN0005410 and in July of 2012 in preparation for the permit renewal request (TVA 2013). All sampled outfalls discharge to the Clinch River. Parameters tested in these sampling events include the following: biochemical oxygen demand; chemical oxygen demand; TOC; total suspended solids; ammonia (as nitrogen); flow rate; temperature (both winter and summer readings); pH; chlorine; fluoride; nitrates; total organic nitrogen; oil and grease; total phosphorus; sulfate; sulfide; surfactants; aluminum; barium; boron; cobalt; iron; magnesium; molybdenum; manganese; tin; titanium; antimony; arsenic; beryllium; cadmium; chromium; copper; lead, mercury, nickel; selenium, silver, thallium, zinc, cyanide; phenols; volatile compounds; acidic, basic and neutral compounds; as well as a Whole Effluent Toxicity (WET) determination.

TVA conducted heavy metal monitoring at the West Knox District Intake on a semi-annual basis from 2006 through 2012 (TVA 2013), pursuant to a requirement of the BRF NPDES Permit TN0005410 during that time. Limits were set by the Tennessee drinking water supply classification under Rule 1200-4-3.

A report from 1990 (Hauser et al.) examined the effects various pool levels of impoundments may have on water quality in downstream waterbodies, with special attention paid to temperature of release flows and how this affects dissolved oxygen levels.

In addition, NPDES sampling data is provided as supplemental information in Appendix R.

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 Appendix 3 and 4 of the federal CCR regulations.

TVA Response

This response has been broken into two parts, one addressing seeps and one addressing surface streams.

Seep Characterization Study and Associated SAP

Currently there are no active seeps at the site. A historic seepage summary is provided in Appendix S. TDEC has requested a sampling plan to characterize seeps on the TVA site and/or adjacent to the TVA site at BRF, for the CCR Parameters. To this end, TVA will investigate mitigated and active seeps or areas historically noted as seeps that have occurred in the CCR unit dikes and berms. The analytical results from located seep water and soil samples will be evaluated and the information provided to help inform assessment of potential movement of groundwater with dissolved CCR Parameters into surface streams on or adjacent to the TVA site.

The objective of the seep characterization study is to assess the potential for transport of CCR constituents from CCR units to surface streams on or adjacent to the TVA site by water from seeps.

TVA's approach in conducting the 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 T) based on active seep location map

5. Collect seep soil and/or water samples from active seeps

6. Record sample location using GPS

7. Analyze seep soil and/or water samples (taken from active seeps) for CCR Parameters per the Seep SAP in accordance with the BRF QAPP

8. Review and evaluate existing and new analytical data

9. Prepare the EAR

As part of the Seep SAP (Appendix T), a seep investigation will be conducted to discover whether active seeps or continued seepage from mitigated seep areas are present and will focus on repaired seep areas. Field investigation will include inspecting dike areas for the following signs of potential seepage:

- Soil and/or vegetation discoloration
- Flowing water
- Unnatural saturation of the soil
- Plant growth

Inspection of mitigated areas may require the use of a boat since mitigation riprap often extends to the bank and/or waterline. The inspection will include examining the bank at the base of the riprap to determine if there are continuing water discharges at those locations. In addition, the stream channel and surface water at the water's edge shall be field-tested for pH, temperature, dissolved oxygen, and conductivity using a multiparameter Sonde. By using the protocol outlined in the Seep SAP, if field testing indicates a significant difference between the stream channel samples and samples adjacent to the stream bank, further investigation will be required to determine if there is a seepage flow that is not visible.

Should active seeps be discovered, a seep sampling location map will be finalized and added to the Seep SAP for implementation. Field sampling activities will include verifying the seep sampling location(s) using GPS and collecting seep soil and seep water samples as described in the Seep SAP. Filtered and unfiltered water samples will be taken. Samples will be analyzed for the CCR Parameters. A complete description of the sampling methods and protocols is provided in the Seep SAP (Appendix T).

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 BRF QAPP. The evaluation and seepage history will be reported in the EAR.

Surface Stream SAP

The Surface Stream SAP (Appendix U) has been prepared to assess potential environmental impacts of CCR constituents to the Clinch River/Melton Hill Reservoir, Bull Run Creek, and Worthington Branch to assist in providing a comprehensive view of BRF site conditions. The purpose of the Surface Stream SAP is to characterize water quality on or adjacent to the BRF 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 in situ using a Hydrolab® multi-probe water quality meter along fifteen transects in the Clinch River/Melton Hill Reservoir, Bull Run Creek, and Worthington Branch. Hydrolab data will be evaluated in the field to determine the presence of thermal stratification and lateral water quality variations across the transects. As described below, we are currently planning to collect discrete water quality samples from the thalweg (deepest point) of each transect; however, if Hydrolab results indicate lateral water quality variations along a transect, water quality samples will be collected from up to four equally spaced locations along the transect to characterize the variability in water quality across the transect. Based on the results of field measurements, one of the following sample plans will be implemented:

  Clinch River/Melton Hill Reservoir

- Thermally Stratified. If the Clinch River/Melton Hill Reservoir is thermally stratified, discrete surface water quality samples will be collected at the thalweg of each transect (STR-CR01 through STR-CR09) at the following depths: the near-bottom (epibenthic; 0.5 m above streambed), mid-hypolimnion (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;

- Not Thermally Stratified. If the Clinch River/Melton Hill Reservoir is not thermally stratified, discrete surface, mid-depth, and epibenthic water quality samples will be collected at the thalweg of each transect (STR-CR01 through STR-CR09).

  Bull Run Creek and Worthington Branch

- A discrete mid-depth surface water quality sample will be collected at the thalweg of each transect on Bull Run Creek (STR-BRC01 through STR-BRC04) and Worthington Branch (STR-WB01 and STR-WB02).

Samples will be analyzed for total and dissolved CCR Parameters. A map of proposed surface stream sampling locations is provided on Exhibit 29 (Appendix C). Sample locations often correspond with sample locations as described in the Benthic SAP and Fish Tissue SAP.. 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 Q). 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 impacts. 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 BRF 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

Maps identifying the proposed surface stream sampling locations are provided in the Surface Stream SAP. After samples have been analyzed, new maps will be provided to include the analytical results. BRF is located at River Mile 47. Based on a review of the Clinch River Navigation Charts, the closest downstream intake is near River Mile 41.5, a distance of 5.5 miles from the plant. The charts were originally published in 2013, and updated in 2016, with the results the same for both editions.

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 recent biological monitoring (specifically from the Clinch River) to TDEC in the Investigation Conference (Slides 129-145) 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 macroinvertebrate communities, and visual encounter surveys for wildlife along the shoreline.

TVA will discuss in the EAR the studies and the results of the fish and benthic invertebrate sampling summarized in previously completed historical biological monitoring reports. The biological monitoring data and information described 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 BRF site activities on fish and/or aquatic life in surface streams adjacent to the site, and to assist in providing an overall view of BRF site conditions.

The objective of the fish tissue sampling is to characterize moisture content and metals from the CCR constituent list (excluding radium), and strontium in fish tissues collected near BRF.

Four surface water reaches have been selected for the collection of fish and associated fish tissue sampling (Exhibit 30 – Appendix C). These four sites are 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 BRF have higher concentrations of CCR-related constituents than fish from reference locations not adjacent to or downstream from WBF. The results from implementation of the Fish Tissue SAP will be evaluated and addressed in the EAR.

Other biological studies TVA developed as part of the biological investigation include a benthic invertebrate sediment study developed to assess the status of the benthic community, and a bioaccumulation study on mayflies. The methodologies for these studies are included in the Benthic SAP (Appendix Q).

5.0 ENVIRONMENTAL ASSESSMENT REPORT (EAR)

The EIP and EAR process is described in the 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 and addressed by TVA in response to TDEC's September 22, 2015 letter, September 13, 2016 letter, June 22, 2017 letter and TDEC's comments to the revisions of the EIP.

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 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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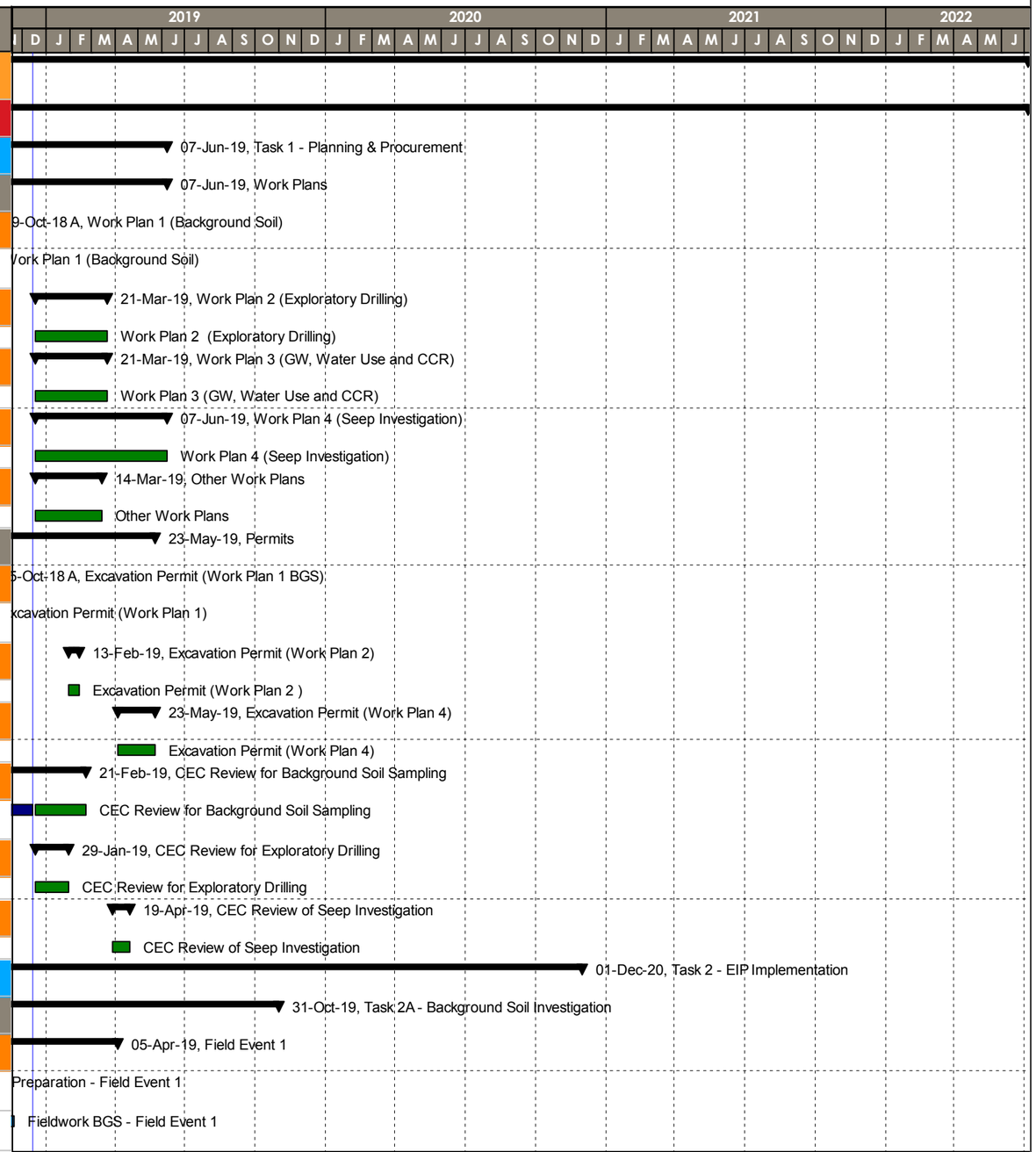
APPENDIX A
IMPLEMENTATION SCHEDULE

ST612105-003 TDEC Order BRF Phase 2-TDEC Reporting

Activity ID	Activity Name	Remaining Duration	Start	Finish
TDEC Order BRF Phase 2		892d	26-Sep-18 A	06-Jul-22
Environmental Investigation		892d	26-Sep-18 A	06-Jul-22
Task 1 - Planning & Procurement		120d	26-Sep-18 A	07-Jun-19
Work Plans		120d	04-Oct-18 A	07-Jun-19
Work Plan 1 (Background Soil)		0d	04-Oct-18 A	19-Oct-18 A
STN-11015	Work Plan 1 (Background Soil)	0d	04-Oct-18 A	19-Oct-18 A
Work Plan 2 (Exploratory Drilling)		65d	17-Dec-18	21-Mar-19
STN-11115	Work Plan 2 (Exploratory Drilling)	65d	17-Dec-18	21-Mar-19
Work Plan 3 (GW, Water Use and CCR)		65d	17-Dec-18	21-Mar-19
STN-11215	Work Plan 3 (GW, Water Use and CCR)	65d	17-Dec-18	21-Mar-19
Work Plan 4 (Seep Investigation)		120d	17-Dec-18	07-Jun-19
STN-11315	Work Plan 4 (Seep Investigation)	120d	17-Dec-18	07-Jun-19
Other Work Plans		60d	17-Dec-18	14-Mar-19
STN-11415	Other Work Plans	60d	17-Dec-18	14-Mar-19
Permits		110d	26-Sep-18 A	23-May-19
Excavation Permit (Work Plan 1 BGS)		0d	01-Oct-18 A	15-Oct-18 A
STN-12115	Excavation Permit (Work Plan 1)	0d	01-Oct-18 A	15-Oct-18 A
Excavation Permit (Work Plan 2)		10d	31-Jan-19	13-Feb-19
STN-12215	Excavation Permit (Work Plan 2)	10d	31-Jan-19	13-Feb-19
Excavation Permit (Work Plan 4)		35d	05-Apr-19	23-May-19
STN-12315	Excavation Permit (Work Plan 4)	35d	05-Apr-19	23-May-19
CEC Review for Background Soil Sampling		45d	26-Sep-18 A	21-Feb-19
STN-12615	CEC Review for Background Soil Sampling	45d	26-Sep-18 A	21-Feb-19
CEC Review for Exploratory Drilling		29d	17-Dec-18	29-Jan-19
STN-12715	CEC Review for Exploratory Drilling	29d	17-Dec-18	29-Jan-19
CEC Review of Seep Investigation		16d	29-Mar-19	19-Apr-19
STN-12815	CEC Review of Seep Investigation	16d	29-Mar-19	19-Apr-19
Task 2 - EIP Implementation		492d	22-Oct-18 A	01-Dec-20
Task 2A - Background Soil Investigation		221d	22-Oct-18 A	31-Oct-19
Field Event 1		76d	22-Oct-18 A	05-Apr-19
STN-21096	Preparation - Field Event 1	0d	22-Oct-18 A	29-Oct-18 A
STN-21010	Fieldwork BGS - Field Event 1	0d	29-Oct-18 A	19-Nov-18 A

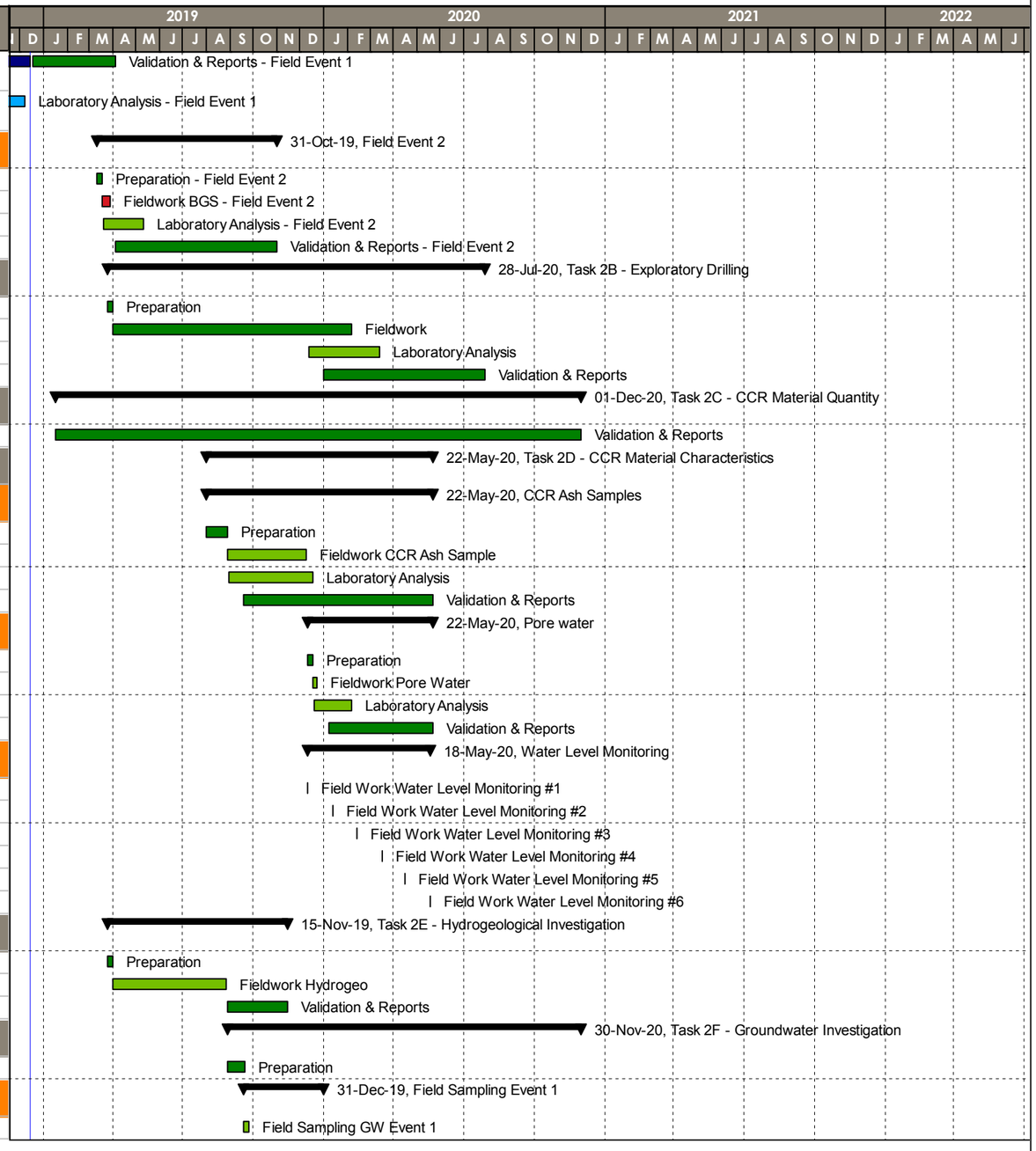


Remaining Level of Effort | Actual Work | Critical Remaining Work
Actual Level of Effort | Remaining Work | Milestone

Data Date:15-Dec-18
Print Date:14-Dec-18

ST612105-003 TDEC Order BRF Phase 2-TDEC Reporting

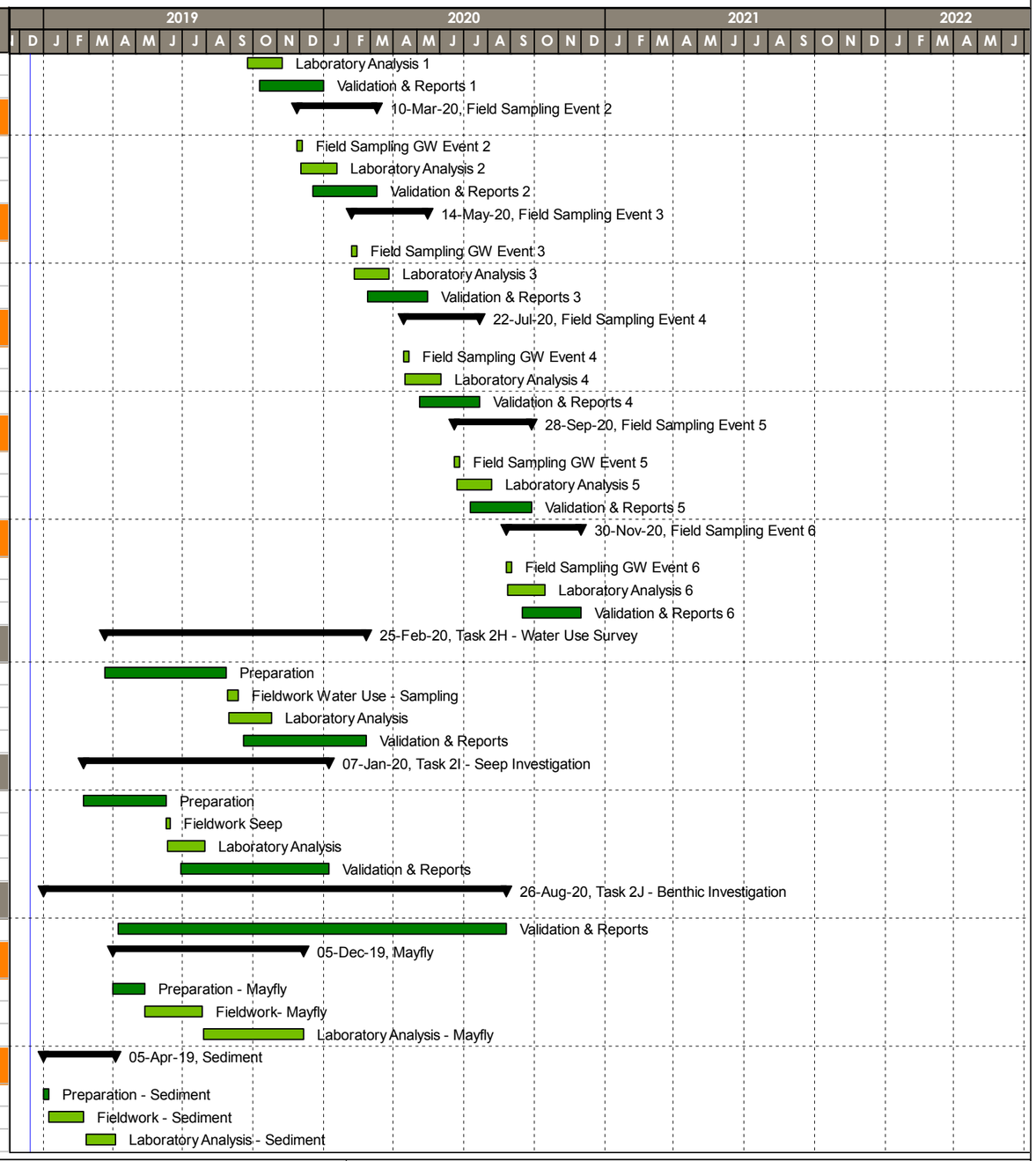
Activity ID	Activity Name	Remaining Duration	Start	Finish
STN-21098	Validation & Reports - Field Event 1	76d	31-Oct-18 A	05-Apr-19
TVA-21020	Laboratory Analysis - Field Event 1	0d	31-Oct-18 A	07-Dec-18 A
Field Event 2		165d	11-Mar-19	31-Oct-19
STN-21196	Preparation - Field Event 2	6d	11-Mar-19	18-Mar-19
STN-21100	Fieldwork BGS - Field Event 2	10d	18-Mar-19*	29-Mar-19
TVA-21110	Laboratory Analysis - Field Event 2	38d	20-Mar-19	10-May-19
STN-21198	Validation & Reports - Field Event 2	146d	05-Apr-19	31-Oct-19
Task 2B - Exploratory Drilling		340d	25-Mar-19	28-Jul-20
STN-22096	Preparation	6d	25-Mar-19	01-Apr-19
STN-22097	Fieldwork	215d	01-Apr-19	06-Feb-20
STN-22040	Laboratory Analysis	63d	12-Dec-19	13-Mar-20
STN-22098	Validation & Reports	146d	31-Dec-19	28-Jul-20
Task 2C - CCR Material Quantity		471d	17-Jan-19	01-Dec-20
STN-23098	Validation & Reports	471d	17-Jan-19	01-Dec-20
Task 2D - CCR Material Characteristics		205d	31-Jul-19	22-May-20
CCR Ash Samples		205d	31-Jul-19	22-May-20
STN-24096	Preparation	21d	31-Jul-19	28-Aug-19
STN-24010	Fieldwork CCR Ash Sample	70d	28-Aug-19	09-Dec-19
TVA-24020	Laboratory Analysis	75d	30-Aug-19	18-Dec-19
STN-24098	Validation & Reports	171d	18-Sep-19	22-May-20
Pore water		115d	10-Dec-19	22-May-20
STN-24094	Preparation	6d	10-Dec-19	17-Dec-19
STN-24110	Fieldwork Pore Water	5d	17-Dec-19	23-Dec-19
TVA-24120	Laboratory Analysis	33d	19-Dec-19	06-Feb-20
STN-24099	Validation & Reports	96d	08-Jan-20	22-May-20
Water Level Monitoring		111d	10-Dec-19	18-May-20
STN-24300	Field Work Water Level Monitoring #1	1d	10-Dec-19	10-Dec-19
STN-24310	Field Work Water Level Monitoring #2	1d	13-Jan-20	13-Jan-20
STN-24320	Field Work Water Level Monitoring #3	1d	13-Feb-20	13-Feb-20
STN-24330	Field Work Water Level Monitoring #4	1d	17-Mar-20	17-Mar-20
STN-24340	Field Work Water Level Monitoring #5	1d	16-Apr-20	16-Apr-20
STN-24350	Field Work Water Level Monitoring #6	1d	18-May-20	18-May-20
Task 2E - Hydrogeological Investigation		165d	25-Mar-19	15-Nov-19
STN-25096	Preparation	6d	25-Mar-19	01-Apr-19
STN-25010	Fieldwork Hydrogeo	105d	01-Apr-19	27-Aug-19
STN-25098	Validation & Reports	55d	28-Aug-19	15-Nov-19
Task 2F - Groundwater Investigation		315d	28-Aug-19	30-Nov-20
STN-26096	Preparation	16d	28-Aug-19	19-Sep-19
Field Sampling Event 1		70d	19-Sep-19	31-Dec-19
STN-26110	Field Sampling GW Event 1	5d	19-Sep-19	25-Sep-19



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

ST612105-003 TDEC Order BRF Phase 2-TDEC Reporting

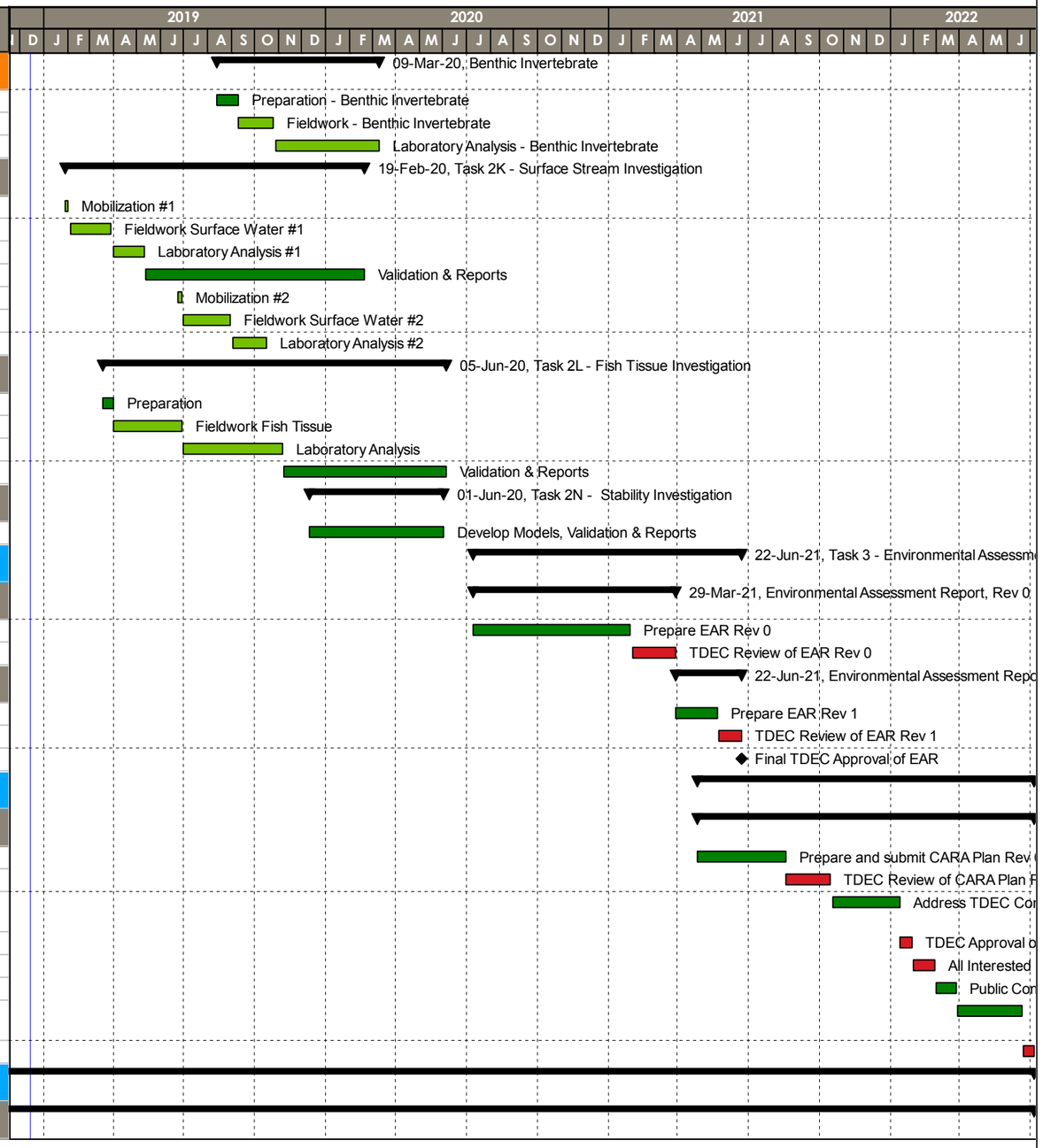
Activity ID	Activity Name	Remaining Duration	Start	Finish
TVA-26120	Laboratory Analysis 1	33d	23-Sep-19	07-Nov-19
STN-26145	Validation & Reports 1	56d	09-Oct-19	31-Dec-19
Field Sampling Event 2		70d	27-Nov-19	10-Mar-20
STN-26210	Field Sampling GW Event 2	5d	27-Nov-19	04-Dec-19
TVA-26220	Laboratory Analysis 2	33d	02-Dec-19	17-Jan-20
STN-26245	Validation & Reports 2	56d	18-Dec-19	10-Mar-20
Field Sampling Event 3		70d	06-Feb-20	14-May-20
STN-26310	Field Sampling GW Event 3	5d	06-Feb-20	12-Feb-20
TVA-26320	Laboratory Analysis 3	33d	10-Feb-20	26-Mar-20
STN-26345	Validation & Reports 3	56d	27-Feb-20	14-May-20
Field Sampling Event 4		70d	14-Apr-20	22-Jul-20
STN-26410	Field Sampling GW Event 4	5d	14-Apr-20	20-Apr-20
TVA-26420	Laboratory Analysis 4	33d	16-Apr-20	02-Jun-20
STN-26445	Validation & Reports 4	56d	04-May-20	22-Jul-20
Field Sampling Event 5		70d	19-Jun-20	28-Sep-20
STN-26510	Field Sampling GW Event 5	5d	19-Jun-20	25-Jun-20
TVA-26520	Laboratory Analysis 5	33d	23-Jun-20	07-Aug-20
STN-26545	Validation & Reports 5	56d	10-Jul-20	28-Sep-20
Field Sampling Event 6		65d	26-Aug-20	30-Nov-20
STN-26610	Field Sampling GW Event 6	5d	26-Aug-20	01-Sep-20
TVA-26620	Laboratory Analysis 6	33d	28-Aug-20	15-Oct-20
STN-26645	Validation & Reports 6	51d	16-Sep-20	30-Nov-20
Task 2H - Water Use Survey		233d	22-Mar-19	25-Feb-20
STN-28096	Preparation	111d	22-Mar-19	27-Aug-19
STN-28130	Fieldwork Water Use - Sampling	10d	28-Aug-19	11-Sep-19
TVA-28140	Laboratory Analysis	38d	30-Aug-19	24-Oct-19
STN-28098	Validation & Reports	108d	18-Sep-19	25-Feb-20
Task 2I - Seep Investigation		220d	22-Feb-19	07-Jan-20
STN-29096	Preparation	76d	22-Feb-19	10-Jun-19
STN-29110	Fieldwork Seep	5d	10-Jun-19	14-Jun-19
TVA-29120	Laboratory Analysis	33d	12-Jun-19	29-Jul-19
STN-29098	Validation & Reports	131d	28-Jun-19	07-Jan-20
Task 2J - Benthic Investigation		418d	31-Dec-18	26-Aug-20
STN-29A098	Validation & Reports	351d	08-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		67d	31-Dec-18	05-Apr-19
STN-29216	Preparation - Sediment	5d	31-Dec-18	07-Jan-19
TVA-29221	Fieldwork - Sediment	33d	07-Jan-19*	22-Feb-19
TVA-29222	Laboratory Analysis - Sediment	30d	25-Feb-19	05-Apr-19



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

ST612105-003 TDEC Order BRF Phase 2-TDEC Reporting

Activity ID	Activity Name	Remaining Duration	Start	Finish
Benthic Invertebrate		142d	13-Aug-19	09-Mar-20
STN-29227	Preparation - Benthic Invertebrate	19d	13-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 2N - Stability Investigation		120d	10-Dec-19	01-Jun-20
STN-29760	Develop Models, Validation & Reports	120d	10-Dec-19	01-Jun-20
Task 3 - Environmental Assessment Report (EAR)		240d	09-Jul-20	22-Jun-21
Environmental Assessment Report, Rev 0		180d	09-Jul-20	29-Mar-21
STN-31096	Prepare EAR Rev 0	140d	09-Jul-20	29-Jan-21
STN-31150	TDEC Review of EAR Rev 0	40d	01-Feb-21	29-Mar-21
Environmental Assessment Report, Rev 1		60d	30-Mar-21	22-Jun-21
STN-32096	Prepare EAR Rev 1	39d	30-Mar-21	21-May-21
STN-32170	TDEC Review of EAR Rev 1	21d	24-May-21	22-Jun-21
STN-32180	Final TDEC Approval of EAR	0d		22-Jun-21
Task 10 - CARA		301d	26-Apr-21	06-Jul-22
Meetings & Deliverables		301d	26-Apr-21	06-Jul-22
STN-98254	Prepare and submit CARA Plan Rev 0 for TDEC Review	81d	26-Apr-21	18-Aug-21
TVA-98255	TDEC Review of CARA Plan Rev 0	40d	19-Aug-21	15-Oct-21
STN-98256	Address TDEC Comments on CARA Plan Rev 0, Prepare and submit Rev 1 to TDEC	60d	18-Oct-21	13-Jan-22
TVA-98295	TDEC Approval of CARA Plan Rev 1	10d	14-Jan-22	28-Jan-22
TVA-98296	All Interested Party Meeting (AIP)	20d	31-Jan-22	28-Feb-22
STN-98296	Public Comment Period	20d	01-Mar-22	28-Mar-22
STN-98298	Address Public Comments on CARA Plan Rev 1 and Prepare CARA Plan Rev 2 for TDEC	60d	29-Mar-22	21-Jun-22
TVA-98345	TDEC Final Approval of CARA Plan Rev 2	10d	22-Jun-22	06-Jul-22
Task 11 - Project Communications & Reporting		892d	06-Nov-18 A	06-Jul-22
Task 11A - TDEC Updates		892d	06-Nov-18 A	06-Jul-22

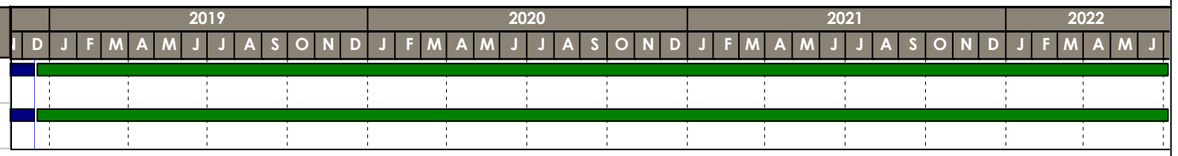


Remaining Level of Effort | Actual Work | Critical Remaining Work
Actual Level of Effort | Remaining Work | Milestone

Data Date:15-Dec-18
Print Date:14-Dec-18

ST612105-003 TDEC Order BRF Phase 2-TDEC Reporting

Activity ID	Activity Name	Remaining Duration	Start	Finish
TVA-96110	TDEC Monthly Progress Reports	892d	06-Nov-18 A	06-Jul-22
TVA-96120	TDEC Progress Update Meetings (Quarterly)	892d	06-Nov-18 A	06-Jul-22



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

Data Date:15-Dec-18
Print Date:14-Dec-18

APPENDIX B
REGULATORY CORRESPONDENCE

Chuck Head, Senior Advisor
Bureau of Environment
TN Department of Environment & Conservation
William R. Snodgrass - TN Tower
312 Rosa L. Parks Ave., 2nd Floor
Nashville, TN 37243
615 532-0998
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Robert J. Martineau, Jr.
Commissioner

Bill Haslam
Governor

September 13, 2016

Mr. Paul Pearman, Project Manager
Tennessee Valley Authority
1101 Market Street
Chattanooga, TN 37402

RE: TVA Bull Run Fossil Plant
Environmental Investigation Plan
Due Date – January 9, 2017

Dear Mr. Pearman:

This letter serves as a follow-up to our meeting with the Tennessee Valley Authority (TVA) on July 13th and 14th 2016 at the TVA Bull Run Fossil Plant (BRF Site). This meeting fulfilled Section VII.A.a. of Commissioner's Order OGC15-0177 (the Order). The TN Department of Environment and Conservation (TDEC) appreciates the time and effort made by your staff and consultants presenting a summary of the geologic, hydrologic, analytical, engineering and historic data for the BRF Site. Our staff easily understood the information presented and greatly appreciated the opportunity to ask questions and to discuss technical issues. The BRF Site has CCR disposal sites adjacent to the Clinch River

Our staff members met following the July 13th and 14th 2016 BRF Site meeting to discuss what we learned about the site and we identified additional information needed from TVA to fully understand the site's current status and the amount and location of all CCR material disposed at the site. Section VII.A.b. of the Order requires TDEC, after the initial TDEC/TVA on-site meeting to provide TVA with a written response identifying additional environmental investigation work and/or additional information needed at each TVA CCR site. TVA is required to submit this information in a proposed Environmental Investigation Plan (EIP).

TDEC identified information needed specifically for the BRF Site or information that TVA shall include in the Environmental Assessment Report (EAR) submitted once Environmental Investigation is complete. Please find the specific BRF Site comments below:

General BRF Comments

1. Bedding Planes dip 30-40 degrees to the southeast. Groundwater will typically flow in the direction of dip. Were the bedding planes considered when TVA selected locations for groundwater monitoring wells? The underlying strata in the vicinity of the BRF property influence the direction of groundwater flow.

   Two fault lines were identified crossing the TVA BRF property. Were the faults considered when TVA selected locations for groundwater monitoring wells? The location of the ground water monitoring wells at the TVA BRF site, including background ground water monitoring wells, shall be selected considering the location of CCR material, bedding planes and faults at the BRF site and how these factors would impact local ground water flow.

2. The off-site water use survey shall be updated to include all usable water wells. This includes ground water used as a drinking water supply as well as sources verified for use by persons other than use as drinking water. All usable water wells shall be sampled to determine if the ground water is impacted by the CCR waste

3. The Groundwater Use Survey identifies multiple residential wells and municipal water intakes within a one-mile radius of the landfill. The water supply points within the one-mile radius shall be sampled to determine if the water is impacted by the CCR waste.

4. The settlement analysis reference on page 84 of the TVA BRF site presentation appears to have been misinterpreted from a previous TDEC questions. Please provide available documents relating to foundation settlement that may have or is calculated to occur as a result of the CCR loading on the natural foundation. This information shall be included in the TVA BRF site Environmental Assessment Report.

5. When submitting the Environmental Assessment Report, TVA shall provide the seismic stability calculations for Phase I of the Dry Fly Ash Stack, the Bottom Ash Disposal Area and the Gypsum Disposal Area 2A.

Dry Ash Stack – IDL 01 000 0080

1. The residuum and upper bedrock hydrogeology and geotechnical properties of the TVA BRF site are properly characterized. However; water-bearing zones in deeper bedrock have not been characterized. Neither the potential for vertical migration of CCR ash-derived contaminants, along deeper structural and stratigraphic interfaces has been assessed nor has the potential for bedrock migration and transport of CCR materials been evaluated. In order to fully understand potential contaminant migration and risks to potential receptors, the vertical gradients and flow patterns need to be established. TVA shall include in the BRF site EIP its plan to collect this information.

2. Eight monitoring wells were installed from 1983 to 1990, and 6 observation wells were installed from 2005 to 2006. TVA shall identify the location of these wells, their current condition and inform TDEC if the wells are currently being used as a part of its ground water monitoring program. Please see the reference to this on page 90 of the TVA BRF site presentation.

3. Please provide the current permitted version for drawing 10W299-11 referenced on page 162 of the TVA BRF site presentation. TVA shall inform the Division of Solid Waste Management (SWM) if it plans to submit a vertical expansion overlaying phases I & II as it stated in its May 11, 2012 letter to Rick Brown. This expansion is also referenced in Volume II of III of the Phase III Expansion permit document for IDL01-0080. This permit will direct the landfill's regulation under the Federal CCR rule and will also provide guidance on future closure plan submittals. TVA shall confirm the remaining landfill capacity and projected landfill life calculations presented in the approved permit documents. TVA shall confirm that site operations have the final approved plans.

4. The document provided to TDEC identified as BRF47-102-229 Slope Stability Analyses 082911 is not the final permitted stability calculations for the Dry Fly Ash Stack. The permitted stability calculations were submitted on April 4, 2012. Please provide the current landfill geometry using the permit documents and provide stability calculations for Phase I of the Dry Fly Ash Stack. This shall be included in the BRF EIP.

5. Justify using a peak ground acceleration of 0.21g in the seismic stability analysis for the Dry Fly Ash Stack.

6. Provide documentation and drawings illustrating the defining the closure boundaries for Phase I of the Dry Fly Ash Stack

Rail Loop

1. No hydrogeologic, geotechnical, or structural stability assessments have been conducted at the Rail Loop site. TVA shall fully characterize the subsurface geophysical characteristics, of this area. TVA shall the impact of CCR material disposal in this area including the potential groundwater or surface water impacts, contaminant fate/transport and structural instability issues.

2. The Draft EIS for TVA Bull Run Fossil Plant Landfill Environmental Review, Project Number 2012-33, refers to a spring at the Rail Loop site. Please locate this feature on a map of the Rail Loop area.

Bottom Ash/Gypsum Ponds - IDL 010000280

1. When the Ash Ponds were originally constructed and the initial CCR Material were placed, the bottom of the ponds was the ground surface with an elevation of approximately 788' Mean Sea Level (MSL)) At that time, the reservoir water level was approximately 768' MSL. The current reservoir level is approximately 795 MSL. While TVA proposes that the natural soils and dykes are composed of low permeability clays that "separate" CCR Material from the reservoir, the reservoir elevation and groundwater elevations in monitoring wells at the site indicate waste is probably submerged in groundwater at the lower levels of the fill. As a part of the TVA BRF EIP, TVA shall propose methodology to determine if CCR material in the ponds is below the reservoir elevation.

2. The Uppermost Aquifer cannot be adequately defined if water level data reflect saturated zones influenced by the ponds, sluice channels, saturated ash, and river elevations. TVA shall propose in the TVA BRF EIP a method to determine (1) if the water level in the

Uppermost Aquifer is/has been influenced by the ponds, sluice channels, saturated ash, and river elevations and (2) if the Uppermost Aquifer has been influenced by these features, the full extent of influence on the Uppermost Aquifer.

3. The groundwater flow and hydraulic interconnection between the waste, dykes, natural soils, and the ground water discharge to the reservoir and/or deeper geologic formations are unknown. Vertical gradients between saturated waste, groundwater in unconsolidated deposits, and groundwater in bedrock have not been determined. The dynamics of groundwater flow through the waste, dykes, pond bottom, underlying soils, and bedrock must be identified. This data shall be used to determine if CCR material has migrated or has the potential to migrate from the unit and escape detection of the existing shallow ground water monitoring network. TVA shall propose in the TVA BRF EIP the method(s) it will use to determine ground water flow and hydraulic interconnection among the CCR material, dykes, natural soils, and the ground water discharge to the reservoir and/or deeper geologic formations

4. Historical groundwater analytical data from existing ground water monitoring wells around the CCR surface impoundments provide numerous statistically significant exceedances of monitored constituents above background levels. Data from sampling these ground water monitoring wells have exceeded the drinking water Maximum Contaminant Limits (MCL). Ground water sample results above the MCLs has been attributed to “naturally occurring” elements, excessive turbidity in groundwater samples, and/or laboratory/analysis-related interferences. TVA states that an advantage of the Closure Plan is “improved groundwater quality”. At this time, there is not sufficient data to determine if the surface impoundments have affected groundwater quality. Further, if the surface impoundments have impacted ground water quality, the extent of impact has not been determined. TDEC does not believe there is evidence to support TVA’s position that closure in place will improve groundwater quality. TVA shall propose in the BRF EIP the methods it will use to determine if ground water quality has been impacted by operation of the TVA BRF Fossil plant and if ground water has been impacted, the extent of the impact. TVA and TDEC will use this information to determine the most appropriate corrective action at the TVA BRF Fossil site. If the facility has caused groundwater degradation that closure in place is purported to alleviate, then TVA must the extent of ground water contamination in the Environmental Assessment Report and/or Corrective Action Plan and, how closure in place will improve the degradation, and to what extent.

5. TVA shall install monitoring wells screened in bedrock, with the well locations based on the BRF site geologic data and location of CCR material. This will provide ground water data that defines properly defines the ground water potentiometric surface and promotes proper ground water monitoring. Well location and typical well construction shall be included in the TVA BRF EIP.

6. TVA shall provide locations and inverts for the French drains installed in the Gypsum Disposal Area 2A.

7. TVA shall determine the amount and location of CCR material in the Gypsum Stack reported on page 160 of the TVA BRF site presentation. The CCR volume and size provided indicates an average depth of CCR material of 10 to and 11 feet. TVA shall include the methods it will use to provide the detailed stratigraphy of Gypsum Disposal Area 2A (from final grade to bedrock) and also provide the stability calculations it will use to determine the

material properties of gypsum and how the material properties of the gypsum are included in the Gypsum Stack stability calculations.

8. TVA shall propose the method it will use to determine the ratio of sluiced fly ash to bottom ash disposed in the Bottom Ash Disposal Area. Section D-D' on page 76 of the TVA BRF site presentation reports that the majority of the CCR depth is sluiced fly ash. TVA shall specify if the CCR closure elevations provided on page 155 of the multisite order intersect (excavate into) the sluiced fly ash. TVA shall provide the method it will use to provide detailed stratigraphy of the Bottom Ash Disposal Area, from the final grade to bed

9. TVA shall provide the method(s) it will use to determine the Stilling Pond volume and a schedule of activities to complete this work in the TVA BRF EIP. The Stilling Pond volume and features identified when performing the Stilling Pond work shall be included in the TVA BRF Environmental Assessment Report. Please provide a schedule for completing the Stilling Pond CCR volume and testing procedures that will be used to determine the Stilling Pond features.

10. TVA shall include in the TVA BRF EIP the testing methods (in situ or remolded) it will use to determine the permeability of clay below the CCR disposal areas. TVA shall also explain why it was not necessary to perform permeability tests below Gypsum Disposal Area 2. Upon review of the information from TVA, TDEC may determine that permeability testing is needed below Gypsum Disposal Area 2.

11. TVA shall clarify determine if the CCR material below the ash disposal line presented on page 19 of the TVA BRF site presentation has been abandoned. TVA shall submit the results of all seep investigations that have been conducted in that area.

12. TVA shall propose the methods to be used to perform stability calculations in the south corner of Gypsum Disposal Area 2A. This area is of interest due to its proximity to the original flow of Bull Run Creek and because clay foundation soils were not reported in this area.

While not a part of the TVA Multisite Order, all permitted facilities that enter Ground Water Assessment must submit a Ground Water Quality Assessment Plan. TVA should submit this plan to SWM on or before October 25, 2016. The plan shall address all pertinent comments/concerns voiced in this letter. This is a requirement of SWM per the Solid Waste Disposal Act, T.C.A. 68-211-101 et. seq. and applicable regulations

In addition to TDEC's BRF site-specific comments setout above, TVA shall also meet a statutory provision that TVA must follow regarding permanent placement of CCR material at the TVA BRF site, as well as all other TVA CCR sites. In 2009, the TN Legislature amended the Solid Waste Disposal Act, specifically T.C.A. 68-211-106(j). The statute states: follows:

"*The commissioner shall not issue a permit under this section for the disposal of coal ash or for the expansion of an existing coal ash disposal facility unless the plans for the disposal facility include a liner and a final cap; however, this subsection (j) shall not apply to the use of coal ash for fill, to any agricultural use, to any engineered uses as a feedstock for the production of a product, to wastewater treatment units or to the disposal of coal ash in connection with any of these uses, as authorized by the department pursuant to this part."*

Given this statutory language, the Commissioner cannot issue a permit for the disposal of coal ash or the expansion of an existing coal ash landfill unless the plans for the landfill/landfill expansion include a liner and a final cap. Further, if anyone plans to use coal ash as fill material, for agricultural purposes, as production feedstock, at wastewater treatment units or for disposal in connection with any of these uses, the Department must first approve the action.

In regards to the TVA BRF site, TVA is required by statute to pursue and receive:

1. A permit if it wishes to dispose of CCR material on-site in an area that does not have a solid waste landfill permit; and
2. TVA must apply for and receive a permit modification from TDEC if it wishes to dispose of CCR material in an existing solid waste landfill that has reached its permitted capacity. If the landfill does not have the capacity to receive all CCR material to be disposed at that landfill, then TVA must apply for and receive a landfill permit modification.

Per T.C.A. 68-211-106(j) although a permit is not required for the certain specified uses of coal ash, these uses must still be "authorized by the department pursuant to this part." In other words, TVA shall not excavate, dredge, or otherwise move CCR material at the TVA BRF site until TDEC has received and approved a plan. TVA must submit for TDEC's review a plan for CCR material management for any activity that movement of CCR material at TVA BRF site other than the disposal of CCR material into properly permitted solid waste landfills in Tennessee or other states. TVA shall not implement a plan for CCR material management, other than disposal at a properly permitted landfill; at any the TVA BRF Fossil Plant site until the plan is approved by TDEC. This includes movement of CCR material from one surface impoundment into another, other than the mechanisms that transport CCR material from one surface impoundment to another as part of an NPDES permitted activity.

Further, if TVA plans to move CCR material from one disposal area to another (other than within an existing permitted landfill with a liner and a plan for final cover) it must submit a proposal for that action and receive approval from the Department before beginning movement of CCR material.

Please find attached to this letter a guidance document which contains a general description of the items that shall be addressed in the Environmental Investigation Plan for each TVA Fossil (active and closed). In addition to the BRF Site specific information listed above.

TVA shall submit the proposed EIP for the TVA BRF site on or before close of business on January 9, 2017.

It is our goal to work with TVA to ensure the environmental investigation of the TVA BRF site is complete, accurate and timely. Please review the Kingston specific questions presented in this letter and Attachment A as you prepare the draft Kingston EIP. If you or staff members have any questions, please contact us.

Sincerely,

Chuck Head

CC:	Shari Meghreblian, Ph. D.	Tisha C. Benton	Susan Smelley.
	E. Joseph Sanders	Britton Dotson	Samuel Hixson
	Patrick J. Flood, P.E.	Glen Pugh	Rob Burnette

Attachment A

General Guidelines for Environmental Investigation Plans

TVA Fossil Plants

TDEC anticipates that the 1st iteration of each TVA Environmental Investigation Plan (EIP) will generate comments and/or questions from TDEC as the review is conducted. TDEC recognizes that each TVA site will have differences due to local geology and plant operation. TDEC believes providing TVA with the guidance for the scope of work for the EIP will significantly limit review time and increase the pace of environmental investigation work at each TVA site. This guidance document is divided into 5 sections based upon different aspects of the TVA Fossil Plants that must be fully environmentally assessed to accurately characterize the site as required in the TN Department of Environment and Conservation (TDEC) and Tennessee Valley Authority Multi-site Order (Order). TDEC believes that successful implementation of the EIP and completion of the corresponding Environmental Assessment Report (EAR) shall provide sufficient information to determine the most appropriate corrective action options to address any environmental and/or public health concerns.

Environmental Investigation Plan Guidance

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:

1. TVA shall provide 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 III Detection Monitoring and Appendix IV Assessment Monitoring found on page 21500 of the Friday, April 17, 2015 Federal Register (Appendix III and IV 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.

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.

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);

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.

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.

   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.

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 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;

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.

C. Groundwater Monitoring and Mapping

The EPA CCR rules specify constituents that should be included for analysis for ground water sampling. The constituents for Ground Water Detection Monitoring are listed in Table Appendix 3 of the EPA CCR regulations and the constituents for Ground Water Assessment Monitoring are listed in Table 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 shall be analyzed for the CCR constituents listed in Tables 3 and 4 of the federal CCR regulations. Items to include in the EIP are:

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.

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

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.

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

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.

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. 7.

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

D. TVA Site Conditions

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;

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.

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.

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

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.

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.

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.

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.

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.

10. TVA shall provide the stability calculations for final permitted design elevations for Landfills that are defined by the Federal Regulations as overfills. If the stability calculations have not been completed, then TVA shall provide stability calculations 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.;

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.

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 non-registered 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.

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).

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.

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 a 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 shall also describe in the EIP how it will assess any impact CCR material and/or dissolved CCR constituents may have on water quality and/or the impact on fish and aquatic life.

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.

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 Appendix 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.

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.

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).

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 Appendix 3 and 4 of the federal CCR regulations.

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.

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.

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.

State of Tennessee
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
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February 9, 2017

Ms. Abigail L. Bowen
Interim Manager
Waste Permits, Compliance and Monitoring
Tennessee Valley Authority
1101 Market Street, BR4a
Chattanooga, Tennessee 37402

RE: IDL010000208 TVA Bull Run Fossil Plant (BRF), Anderson County
Gypsum and Bottom Ash Disposal Area
Groundwater Quality Assessment Plan

Dear Ms. Bowen:

The Division of Solid Waste Management (Division) has received the Groundwater Quality Assessment Plan submitted in response to TDECs comments related to the Coal Combustion Residuals (CCR) Draft Environmental Investigation Plan (EIP). The GWQAP meets Division Rules, is consistent with compliance history at the site, and incorporates 40CFR Part 257 Appendix III and IV monitoring requirements. Any questions or comments can be directed to Patrick Mulligan of the Knoxville Environmental Field Office at 865.594.5582.

Regards,

Patrick Mulligan, P.G.
Environmental Consultant
Division of Solid Waste Management

R. Awasthi

Revendra Awasthi
Field Office Manager
Division of Solid Waste Management

c. DSWM
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Rob Burnette, electronic
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June 22, 2017

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

RE: TDEC Commissioner's Order OGC 15-1077
TVA Coal Fired Fossil Fuel Plants
Environmental Investigation Plans
Conference Dates and EIP Due Dates

Dear Mr. Pearman:

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.

Environmental Investigation Plan Submittals

TDEC and TVA have discussed the format of the Environmental Investigation Plans for the seven TVA Coal Fired Power Plants included in the Commissioner's Order. The sites included in the Commissioner's Order are:

- the TVA Allen Fossil Plant (TVA ALF);
- the TVA Bull Run Fossil Plant (TVA BRF);
- the TVA Cumberland Fossil plant (TVA CUF);
- the TVA Johnsonville Fossil Plant (TVA JoF);
- the TVA John Sevier Fossil Plant (TVA JSF);
- the TVA Kingston Fossil Plant (TVA KIF); and
- the TVA Watts bar Fossil Plant (TVA WBF).

TVA and TDEC met to discuss the format for the Environmental Investigation Plans (EIPs) after the first submission of the TVA CUF EIP. During this discussion, TDEC and TVA determined that the best approach to the investigation of the seven sites was to develop a comprehensive EIP. The EIP should include all activities planned for the initial investigation of each site, maps with historical and current information, identification of soil, ground water and surface water sampling; the methods to be employed to determine ground water elevations, flow rate and velocity, etc. We also discussed including the Standard Operating Procedures, Quality Assurance Project Plans, Sample Collection and Analysis Methods, Procedures for installation of Soil Borings and Monitoring Wells, etc. in the Appendices of the EIP for each site. The primary purpose of the EIP is to provide TDEC and the public with a complete description of the CCR site investigation activities and a schedule for those activates.

TDEC's goal is to work with TVA to ensure the environmental investigation of each TVA site is complete, accurate and timely. We believe working with TVA, following the protocol above, will help TDEC and TVA reach these goals. TVA is required to post each EIP for public notice and comment, once it is approved by TDEC as complete. The greater the detail of the EIP, the better the public will understand how each TVA site will be investigated.

TVA has submitted Revision 1 of the TVA CUF and TVA ALF EIPs to TDEC for review, following the structure described above. TDEC has found this EIP format to be comprehensive and practical. TDEC and TVA plan to meet on June 29, 2017 to discuss the status of the TVA JoF EIP, which has a due date of July 24, 2017. The pre-EIP Submittal meetings have been very helpful in exchange of thoughts, ideas and questions for each site.

Per our conversations, TDEC and TVA have agreed to a schedule for submission of the Revision 1 EIPS for TVA BRF, TVA JSF, TVA KIF and TVA WBF sites. This letter formalizes that schedule. The table below includes the dates for submittal of Revision 1 EIPs.

TVA CCR Environmental Investigation Plan Due Dates

TVA Coal Fired Power Plant	EIP Due Date
TVA Kingston	9/8/2017
TVA Bull Run	10/27/2017
TVA John Sevier	12/15/2017
TVA Watts Bar	2/09/2018

Attached to this letter are environmental investigation comments for the TVA BRF and KIF sites. We will provide comments for the TVA JSF and TVA WBF by July 15, 2017. We look forward to working with TVA in the investigation and remediation of each TVA CCR site. If you have questions or concerns about this letter, please give me a call.

Sincerely,

Chuck Head

CC: Susan Smelley
Pat Flood
Tisha Calabrese Benton
Britton Dotson
Scotty Sorrells
Abigail Bowen
James Clark
Rob Burnette
Joseph E. Sanders

Bull Run (BRF) Environmental Investigation Comments and Questions

General

- Bedding Planes dip 30-40 degrees to the southeast. Groundwater will typically flow in the direction of dip. Was the bedding planes considered when TVA selected locations for groundwater monitoring wells? TVA should demonstrate how the underlying strata near the Bull Run property influence the direction of groundwater flow. TVA's monitoring well locations at all ash disposal areas should be selected based on these findings.

- Two fault lines were identified on crossing the TVA Bull Run property. Were the faults considered when TVA selected locations for groundwater monitoring wells? TVA should demonstrate how the direction of groundwater flow is or could be influenced by the underlying faults at the Bull Run property and show how the well locations were selected. If groundwater is flowing along these fault lines, TVA should place monitoring wells at adequate locations to properly monitor it.

- The off-site water use survey needs to be updated and all potential supply sources verified whether used for human consumption or otherwise.

- The Groundwater Use Survey identifies multiple residential wells and municipal water intakes within one mile of the landfill. The water supply points within the one-mile range must be evaluated and sampled to determine if the water is impacted from CCR waste.

- Settlement analysis reference on page 84 of the multisite order presentation appears to have been misinterpreted from a previous TDEC questions. Please provide available documents relating to foundation settlement that may have or is calculated to occur as a result of the CCR loading on the natural foundation.

- Provide seismic stability calculations for Phase I of the Dry Fly Ash Stack, the Bottom Ash Disposal Area and the Gypsum Disposal Area 2A.

Dry Ash Stack – IDL 01 000 0080

- Residuum and upper bedrock hydrogeology and geotechnical properties appear to be adequately characterized. However, water-bearing zones in deeper bedrock are not characterized. The potential for downward vertical migration of CCR ash-derived contaminants, the potential for their migration along deeper structural and stratigraphic interfaces, and any bedrock migration fate and transport considerations have not been evaluated. To fully understand potential contaminant migration and risks to potential receptors, the vertical gradients and flow patterns need to be established.

- 8 monitoring wells were installed from 1983 to 1990, and 6 observation wells were installed from 2005 to 2006. Where are these wells and are they still being used? Reference page 90 of the multisite order presentation.

- The DSWM SW Rules requires that all permitted facilities that go into assessment submit a Ground Water Quality Assessment Plan. TVA should submit this plan and incorporate all comments/concerns addressed in this review.

- Please provide the current permitted version for drawing 10W299-11 as indicated on page 162 of the multisite order presentation. Please clarify if TVA plans to submit a vertical expansion overlaying phases I & II as indicated in the May 11, 2012 letter to Rick Brown. This expansion is also noted in Volume II of III of the Phase III Expansion permit document for IDL01-0080. This will direct the landfill's regulation under the Federal CCR rule and will also provide guidance on future closure plan submittals. Please confirm volumes and projected landfill life calculations presented in the approved permit documents and that site operations have the final approved plans.

- The document provided to TDEC identified as BRF47_102-229 Slope Stability Analyses Revised 082911 is not the final permitted stability calculations for the Dry Fly Ash Stack. The permitted stability calculations were submitted as on April 4, 2012. Please verify the current landfill geometry with the permitted documents and provide stability calculations for Phase I of the Dry Fly Ash Stack.

- Justify using a peak ground acceleration of 0.21g in the seismic stability analysis for the Dry Fly Ash Stack.

- Provide documentation and drawing illustrating the limits of closure for Phase I for the Dry Fly Ash Stack

Rail Loop

- No hydrogeologic, geotechnical, or structural stability assessments have been conducted at the Rail Loop site. Full subsurface characterization needs to be conducted to understand any potential groundwater or surface water impacts, contaminant fate/transport considerations and structural instability issues there may be.

- The Draft EIS for TVA Bull Run Fossil Plant Landfill Environmental Review, Project Number 2012-33, makes reference to a spring at The Rail Loop site. Please locate this feature on a map in relationship to the CCR limits.

Bottom Ash/Gypsum Ponds - IDL 01 000 0280

- When the Ash Ponds were originally constructed and the initial wastes placed, the pond bottoms were natural soil (elevation approx. 788 MSL) above the reservoir water level elevation (approx. 768 MSL). The current reservoir level is approximately 795 MSL. Despite claims that natural soils and dykes are composed of low permeability clays that affect "separation" of waste from the reservoir, the reservoir elevation and groundwater elevations in monitoring wells at the site indicate waste is likely to be submerged in groundwater at the lower levels of the fill.

- The Uppermost Aquifer cannot be adequately defined if water level data reflect saturated zones influenced by the ponds, sluice channels, saturated ash, and river elevations.

- The nature of groundwater flow and hydraulic interconnection between the waste, dykes, natural soils, and the ultimate discharge to the reservoir or deeper geologic formations are unknown. Vertical gradients between saturated waste, groundwater in unconsolidated deposits, and groundwater in bedrock have not been characterized. The dynamics of groundwater flow through the waste, dykes, pond floor and underlying soils, and bedrock need to be characterized to determine if potential contaminants from the waste fill migrate (or have the potential to migrate) from the unit and not be monitored by the existing shallow groundwater monitoring network.

- Historical groundwater data from sampled monitoring wells around the ponds complex indicates numerous statistically significant exceedances of monitored constituents above background. Likewise, there have been periodic MCL exceedances. These have typically been attributed to “naturally occurring” elements, excessive turbidity in groundwater samples, and/or laboratory/analysis-related interferences. Stated advantages of the Closure Plan include “improved groundwater quality”. It is unclear to the reviewer to what extent the waste ponds have affected groundwater quality, to what extent offsite resources are impacted, and what basis the Owner has for stating that Closure will result in improved groundwater quality. If the facility has caused groundwater degradation that Closure is purported to alleviate, the Owner needs to state to what the extent groundwater has been degraded, how the Closure will improve the degradation, and to what extent.

- TVA must install monitoring wells screened in bedrock and located in appropriate locations to adequately define the potentiometric surface and monitor groundwater.

- The DSWM SW Rules requires that all permitted facilities that go into assessment submit a Ground Water Quality Assessment Plan. TVA should submit this plan and incorporate all comments/concerns addressed in this review.

- Please provide locations and inverts for the French drains installed in the Gypsum Disposal Area 2A.

- Please clarify the Gypsum Stack volume on page 160 of the multisite order presentation. The CCR volume and size provided indicate an average depth of 10 to 11 feet. Section I-I’ on page 78 of the multisite order presentation does not identify gypsum in the disposal units stratigraphy. TVA shall provide details of the stratigraphy of the Gypsum Disposal Area 2A, from the final grade to bedrock. TVA shall provide stability calculations that include the Gypsum’s material properties and account for the Gypsum in the analysis.

- Clarify the ratio of sluiced fly ash to bottom ash for material; contained in the Bottom Ash Disposal Area. Section D-D’ on page 76 of the multisite order presentation indicates a majority of the CCR depth is sluiced fly ash. Would the CCR closure elevations indicated on page 155 of the multisite order intersect (excavate into) the sluiced fly ash? Please provide a detail of the stratigraphy of the Bottom Ash Disposal Area from the final grade to bedrock.

- Please provide a schedule for determining the Stilling Pond CCR volume and the test methods that will be used to determine the types and amounts of CCR materials in the Stilling Pond.

- Identify the test methods to be used (in situ or remolded) to determine the permeability of clay below the CCR disposal areas. Explain why permeability tests were not performed below the Gypsum Disposal Area 2.

- Clarify if the ash disposal line presented on page 19 of the multisite order presentation has been abandoned. TDEC requests that TVA verify the location of seep investigations that have been conducted, the repairs made to the seeps and whether any seeps continue to flow including TVA repaired seeps.

- The stability calculations should evaluate the south corner of Gypsum Disposal Area 2A. This area is of interest due to its proximity to the original flow path of Bull Run Creek and because it is not known if clay foundation soils are present in this area.

TVA Kingston (KIF Environmental Investigation Comments and Questions

TDEC requests that TVA provide responses to the points presented below in the revised EIP for the TVA Kingston site. TDEC has followed the format TVA used with the submittal of the TVA Cumberland Rev. 1 Environmental Investigation Plan.

1. Site Specific Information

- Existing or additional site characterization shall include a discussion of fluctuations in ground water elevations that may be connected to Watts Bar Lake levels, seasonal variations or other factors.
- Existing or additional site characterization shall estimate the amount of CCR material that is below the upper most aquifer for the Stilling Pond, historic Sluice Channel and the "ball field" temporary storage area. The upper most aquifer must be identified to accurately make this determination.
- TVA shall provide a schedule for the placement of any additional borings/monitoring wells proposed at the Kingston site as well as a map identifying the location all borings and monitoring wells that TVA plans to use as a part of its Environmental Investigation (existing and proposed). TVA shall present the reasons for selecting the location of additional boings/monitoring wells at the site. Further, TVA shall install/identify two ground water monitoring wells to serve as background ground water monitoring wells for the site. TVA shall have a TN Licensed Professional Geologist on site to log the installation borings and/or ground water monitoring to install borings and ground water monitoring wells as well as the method of construction for ground water monitoring wells. TVA shall propose a sampling plan to analyze soil, overburden and CCR material generated during on-site drilling for Appendix III and IV CCR constituents.
- TVA shall characterize the site's hydrogeology to better understand the cause of the Red-Water seeps at the East Dike/Engineered Red-Water Wetlands. The investigation should determine if the source might be either infiltration through the Interim Ash Staging Area (ballfield) or groundwater flow from offsite.
- TVA shall gather sufficient information to provide a three dimensional picture of the CCR material disposed in the Stilling Pond, Sluice Trench and "Ballfield" area. TVA shall gather enough information to determine the volume of CCR material disposed in each area.

2. Hydrogeologic Report

- TVA shall collect sufficient data from existing and proposed ground water monitoring wells and from existing and proposed soil borings to allow TVA to determine the following results that will be included in the Environmental Assessment Report:
  - i. A ground water map for the site presenting the ground water elevation
  - ii. Ground water flow rate and direction; and

iii. Location of ground water monitoring wells where the level of CCR constituents exceed the EPA CCR levels provided in Appendices III and IV of the rule;

3. Water Use Survey

- TVA shall conduct a water use survey as required by TDEC for the environmental investigation at other TVA Coal fired power plants. The survey shall include water wells and springs used by for either domestic or business purposes.

4. Ground Water Monitoring

- Due to the 2008 CCR release, there is extensive data for this site including ground water monitoring data. TVA should include a catalog of existing ground water monitoring wells that will be used in determining ground water flow rates, current ground water elevation and direction of ground water flow. TVA shall propose additional ground water monitoring wells, as needed, to accurately identify ground water quality, flow direction, velocity, quality and influence due to release of CCR constituents. TVA shall provide a ground water monitoring schedule that identifies the ground water monitoring wells that will be sampled, sampling methodology, sample collection and transportation, analytical methods used for analyses and the qualifications of the laboratory performing the analyses. All samples shall be analyzed for Appendix III and IV CCR constituents. Disposal units regulated by a landfill permit will need to incorporate the additional constituents through the end of post closure care period.

5. Ground Water - Chemical and Physical Properties

- Ground Water samples analyzed from Monitoring Well KIF-22 exceeded the Drinking Water MCL for Arsenic. TVA suggested the AS levels were higher than TVA Kingston Fossil Plant Environmental Investigation Plan expected due to the influenced of Total Suspended Solids in the ground water samples taken. TVA shall provide a science based explanation of this statement. TVA should explain its position that the Stilling Pond is contributing to the AS levels in Monitoring Well KIF-22.

- TVA shall determine if the level of the ground water at the TVA KIF site is controlled by the level of the Emory River. If the Emory River affects the ground water level, then TVA shall collect data to determine the extent of the impact of the Emory River on the ground water table below the TVA KIF site.

6. Structural and Seismic Stability

- Given the site stabilization work completed as a part of the CERCLA closure of the industrial landfill, additional analyses of the structural and seismic stability of the Stilling Pond is needed for the Stilling Pond once it is dewatered to determine if the Stilling Pond may be closed in place. TDEC has reviewed EPA's comments about the seismic stability of the Stilling Pond. TDEC concurs with EPA's statement "the underlying potential for liquefaction-induced failure of these units remains a concern". The Stilling Pond at KIF is one of the units referenced.

- TVA shall provide a description of the methods it will employ to conduct seismic stability analyses, specifically, embankment liquefaction potential analysis for the Stilling Pond. TVA shall provide a schedule for conducting this analysis.

- It is our understanding that TVA has conducted seismic analyses for the Stilling Pond area and that if the Stilling Pond were closed in place there would be movement of Stilling Pond during a seismic event. TDEC cannot approve closure of the Stilling Pond in place, if the seismic and structural stability of the Stilling Pond does not meet the criteria established in the U.S. Environmental Protection Agency Coal Combustion Residual Rule, even if the Stilling Pond may not be "specifically" subject to those rules.

7. Site Geology

- Due to the 2008 CCR release, there is extensive data for this site including subsurface geology. TVA should include a catalog of existing ground water monitoring wells and soil borings subsurface geological conditions and stability and characteristics of local hydrogeology. TVA shall propose the location and construction of additional ground water monitoring wells and soil borings that will provide data to fully characterize the geology of this site.

- TVA shall collect sufficient data to prepare a three dimensional picture of the subsurface environment from ground surface to bedrock. This shall include the depth of CCR material and native soil, sand and rock, the physical characteristics of these materials and any geologic anomalies discovered during investigation.

Tennessee Valley Authority, 1101 Market Street, BR 4A, Chattanooga, Tennessee 37402

September 19, 2017

Mr. Barnes Johnson, Director
U.S. Environmental Protection Agency (EPA)
Two Potomac Yard
2777 S. Crystal Drive
5th Floor, N-5838
Arlington, Virginia 22202-2733

Dear Mr. Johnson:

TENNESSEE VALLEY AUTHORITY (TVA) - FINAL LETTER - SEISMIC RISK ASSESSMENT - BULL RUN FOSSIL PLANT

On September 19, 2011, the United States Environmental Protection Agency (EPA) performed a coal combustion residual (CCR) site assessment at BRF. A letter from the EPA to TVA on June 13, 2013, requested TVA perform an analysis of the impact of potential liquefaction of materials within and under the bottom ash disposal area, the fly ash pond area and the gypsum disposal area.

TVA and the EPA have been in communication since the initial request. The latest correspondence, dated December 16, 2015, acknowledged that TVA would continue to evaluate the impact of potential liquefaction at the three BRF units. The letter stated that "until determined otherwise, the underlying potential for liquefaction-induced failure of these units remain a concern that should be addressed by taking the necessary actions to ensure that these units will be structurally sound."

TVA has continued taking the necessary actions to determine the structural stability of the bottom ash disposal area, the fly ash pond area and the gypsum disposal area. TVA has performed additional geotechnical investigations and seismic analyses that use the EPA's Federal CCR Rule design criteria, shown in Table 1. The use of this criteria is the industry accepted practice. The analyses evaluated pseudo-static stability and liquefaction stability (post-earthquake analysis) of all three units at critical cross-sections that pose the most risk of instability. The resulting safety factor assessment, shown in Table 2, met and exceeded the EPA's Federal CCR Rule safety factor criteria.

Table 1: Minimum Required Safety Factors

Load Case	Minimum FOS Required
Pseudo-Static	1.00
Liquefaction	1.20

Table 2: Summary of Stability Results

BRF Unit	Pseudo-Static Safety Factor	Liquefaction Safety Factor
Bottom Ash Disposal Area	2.52	1.72
Gypsum Disposal Area	2.60	1.85
Fly Ash Pond Area	2.46	2.21

With these analyses completed, TVA concludes that the initial recommendation from the 2011 site assessment, to evaluate the potential impact of liquefaction-induced failure, has been completed and meets the current safety factor criteria.

The site conditions at the time of analysis are similar to the current planned closure conditions. In closure, geometry is expected to remain similar with minor grading, and pore pressures are expected to lower due to the capping of each unit. Because of the anticipated reduction in pore pressures upon closure, it is understood by TVA that these analyses are conservative, and will represent the closed seismic and potential liquefaction safety factors.

If you have questions or need additional information, please contact Shawn Rudder at (423) 751-7687 or Maggie Gilliland at (423) 751-2808.

Sincerely,

M. Susan Smelley

M. Susan Smelley
Director
Environmental Compliance and Operations

cc: Mr. Patrick J. Flood, P.E.
Director, Division of Solid Waste Management
Tennessee Department of Environment
and Conservation
William R. Snodgrass TN Tower
312 Rosa L. Parks Avenue, 5th Floor
Nashville, Tennessee 37243

State of Tennessee
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
3711 MIDDLEBROOK PIKE
KNOXVILLE, TENNESSEE 37921-6538
Phone (865) 594-6035 Statewide 1-888-891-8332 FAX (865) 594-6105

December 5, 2017

Mr. Shawn Rudder
Tennessee Valley Authority
1101 Market Street, BR4A
Chattanooga, TN 37402

RE: IDL010000080, IDL010000208 - TVA, BRF Dry Ash and Gypsum Landfills,
Anderson County
Groundwater Quality Assessment Plans
Plans Review

Dear Mr. Rudder:

The Groundwater Quality Assessment Plan (GWQAP) for IDL010000080 was received and reviewed by the Division's Knoxville Environmental Field Office staff. This facility has been in Phase II Assessment monitoring since 2010 after its initial entry into the Assessment program. This updated GWQAP was requested by TDEC as part of the Environmental Investigation Plan (EIP) being conducted pursuant to the Commissioner's Order No. OGC15-0177 due to ongoing statistically-elevated concentrations of arsenic in groundwater samples. Similarly, a GWQAP was submitted and reviewed for IDL010000208 in February 2017. Both of the GWQAPs have been forwarded to TDEC's CCR Team for further review as part of the hydrogeologic characterization in the EIP. Thank you for updating the GWQAP.

Comments or questions can be directed to Patrick Mulligan at 865.594.5582.

Sincerely,

Patrick Mulligan, P.G.
Environmental Consultant
Division of Solid Waste Management

Revendra Awasthi
Knoxville Field Office Manager
Division of Solid Waste Management

c. KEFO DSWM File
Wastebin

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Robert J. Martineau, Jr.
Commissioner

Bill Haslam
Governor

January 29, 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 Bull Run 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.

Bull Run CCR site EIP Rev 1 Comments

TVA submitted the EIP Rev 1 for TVA Bull Run Coal Fired Fossil Power Plant (TVA BRF) on October 27, 2017. TDEC has completed its review of EIP Rev 1 and is providing comments listed in the attached **Table 1 TVA Bull Run 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 **March 30, 2018**.

TDEC's goal is to work with TVA to ensure the environmental investigation of the TVA BRF 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	Paula Plont
Revendra Awasthi	Shawn Rudder	Patrick Mulligan
Amos Smith		

TVA Bull Run EIP Rev 1
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
All	All	All	All	All	TVA has agreed to conduct an environmental investigation at the TVA Kingston Fossil Plant 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.
All	All	All	All	All	TVA shall either collect water samples for CCR analyses when it collects samples for NPDES monitoring or collect and analyze water samples from the NPDES discharge point quarterly
NA	Abbreviations	vii	NA	NA	Abbreviations need to be checked to make sure all abbreviations used in EIP are defined. At a minimum include the following: CPT, ICP, MS, RQD, SDG, SPLP, TCLP, TOR, USACE, USGS
All	All	All	All	All	Ground water sampling at the permitted landfills should be taken at the same time as samples taken under the Order. Sample frequencies may not be the same, but it is important that the sample dates coincide for comparable parameters and elevation levels.
General Comment	Surface Water, Benthic, and Fish SAPs	All	All	All	Are the proposed sample sites known to be in representative areas of contamination, and do they account for the worst-case conditions?

TVA Bull Run EIP Rev 1
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
General Comment	Surface Water, Benthic, and Fish SAPs	All	All	All	The Bull Run Environmental Investigation Plan states that data analysis will be done in the Environmental Assessment Report that will be prepared following the sampling outlined in the SAPs. However, some feel for expected data analysis is needed to know if sampling and sample sizes specified in the SAPs are appropriate for the intended data analysis and use. What types of statistical analyses will be done with the data, and what effects endpoints will the data be compared to in order to determine whether environmental harm has occurred due to contaminant concentrations present?
1.1	Purpose	1	1	6	Please revise for consistency with CUF Rev 2. *"The Environmental Assessment Report (EAR), to be submitted at a later date following completion of the environmental investigation identified in the EIP, will provide "an analysis of the extent of soil, surface water, and groundwater 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."*
1.4.1	Site History	3	3	2	First occurrence of DSWM please define in text.
1.4.2	Current Operations and Closure Plans	3	1	4	First occurrence of NPDES please define in text.
1.4.2	Current Operations and Closure Plans	3	1	All	TDEC recognizes that TVA has initiated closure projects for the the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C. These closure actions have occurred prior to complete characterization of the site as part of the EIP process, and, as such, 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.

TVA Bull Run EIP Rev 1
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
2.1	EIP development and structure	Digital Page 15/1079	7	3	Provide a copy of TVA's September 19, 2017 letter to Barnes Johnson, Director EPA, in Appendix B and reference it appropriately in the text. All actions referenced in the letter, including geotechnical investigations and seismic analysis shall be included in the EAR.
2.3	Quality Assurance Project Plan	9	2	4	Please include as an appendix to the EIP the referenced "Data Management Plan".
3.1.1	TDEC General Information Request No. 1	10	All	All	TVA will provide a site map depicting the local geologic formations and faults; current and proposed monitoring well locations; and former pathway of Bull Run Creek/Worthington Branch Creek in relation to all ash disposal areas. TVA will demonstrate the the proposed groundwater monitoring system captures potential preferential pathways for contaminant migration through these features. TVA will install additional monitoring wells as necessary to fully characterize these potential migration pathways.
3.1.1	TDEC General Information Request No. 1	10	2	All	Bedrock geology needs to be discussed for the fly ash stilling pond 2C and railroad loop disposal area.

TVA Bull Run EIP Rev 1
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
3.1.1	TDEC General Information Request No. 1	10	3	3,4	This interpretation must be restricted to movement in the shallow wells. Groundwater in the Chickamauga Limestone below the weathered zone moves through the small solution channels that have developed in that rock. The direction of fluid movement through such cavities is controlled by their three-dimensional geometry and their degree of interconnection with other cavities of lower hydraulic head. That direction may have little or possibly no relationship to the direction of movement inferred from water-table contours, the hydrogeological framework needs to be further characterized for the entire BRF facility specifically answering this conduit flow potential.
3.1.1	TDEC General Information Request No. 1	11	2	All	Since it appears that geologic structure imposes significant control on groundwater flow at the site an evaluation of rock mass permeability needs to be completed to determine directional differences in permeability (i.e., if permeabilities are significantly higher in the northeast-southwest direction, as opposed to perpendicular to bedding).
3.1.1	TDEC General Information Request No. 1	11	2	All	On the northwest boundary of the dry fly ash Phase II and lateral expansion there is an indication in previous reports that there is the potential for solution enhanced joint sets (i.e., conduits) which cause a depression in the top of rock surface. This area of B-14R, B-14 and B-14L also lie on a lineation oriented approximately N62W that has numerous sinkholes to the north of Edgemoor Road. TVA needs to fully characterize groundwater flow along joint sets and the potential for conduit flow. Pilot holes need to be added to sufficiently define this area.
3.1.1	TDEC General Information Request No. 1	11	2	10	Replace "downhold" with downhole
3.1.1	TDEC General Information Request No. 1	11	3	All	What criteria will TVA use to determine if a pilot hole will be converted to a PZ or MW?

TVA Bull Run EIP Rev 1
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
3.1.2	TDEC General Information Request No. 1	12	2	All	In order to characterize the cross-valley strike-slip fault that is located on the southwest edge of the Bottom Fly Ash Pond as well as centrally dissecting the Gypsum Disposal Area 2A and Main Ash Pond TVA needs to determine the location and potential impacts of this fault (i.e., whether this fault serves as a permeability barrier or a pathway for migration laterally or downward). More than one boring is necessary to determine the location and properties of this fault. Surface geophysical techniques may be more suited to delineation of this feature followed by verification through additional borings along the projected lineation.
3.1.5	TDEC General Info Request	23	5	1	If domestic water wells are identified during the Water Use Survey, samples are collected and the sample results indicate the presence of CCR constituents from the TVA BRF site, the domestic water well(s) will be added to the ground water monitoring program or new monitoring wells will be installed near the domestic water wells and become part of the ground water monitoring program
3.2	Dry Ash Stack - IDL011030080	17	All	All	Provide information regarding the potential for a preferential seepage pathway via the stream channel that was present prior to development of the dry ash stack along the northeastern edge of the Phase 1 stack as shown on historical drawing 10W293-1. Borings should be targeted to determine if more pervious stream deposits are present.
3.2	Dry Ash Stack - IDL011030080	17	All	All	Provide information regarding the mitigation of the three sinkholes (i.e., topographic depressions) shown on historical drawing 10W293-1 on the south edge of Phase 1 and determine the potential that they are part of a solution enhanced joint set, bedding plane or other more significant karst area that may serve as a preferential seepage pathway.

TVA Bull Run EIP Rev 1
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
3.2.1	TDEC Dry Ash Stack Information Request No. 1	17	3	1	On the northwest boundary of the dry fly ash Phase II and lateral expansion there is an indication in previous reports that there is the potential for solution enhanced joint sets (i.e., conduits) which caused a depression in the top of rock surface. The area is underlain by sub-unit B of the Chickamauga Formation which is a relatively pure (non-clastic) limestone and known to be karstic. At the site drilling has confirmed the presence of both open and clay filled solution cavities. This area of B-14R, B-14 and B-14L also lie on a lineation oriented approximately N62W that has numerous sinkholes to the north of Edgemoor Road. TVA needs to fully characterize groundwater flow along joint sets and evaluate the potential for conduit flow. Pilot holes need to be added along the northwest boundary to sufficiently characterize this area.
3.2.1	TDEC Dry Ash Stack Information Request No. 1	17	3	1	Three "deep" pilot holes may not provide sufficient spatial coverage to accurately determine overall gradient(s) in the vicinity of the dry fly ash stack. There are no reference points shown on Exhibit 3 along the northwest boundary. Also the influence of impoundments and lined versus unlined portions of the stack on groundwater levels may not be adequately represented with existing and planned monitoring wells. Based on provided data the potentiometric surface indicates water in the dry fly ash stack, which is captured by Worthington Branch but does not characterize bedrock groundwater flow that my not be captured by Worthington Branch (e.g., underflow, conduit flow).
3.3	Railroad Loop	21	All	All	Provide information regarding the potential for preferential seepage pathways via the two pre-construction valleys that may have contained streams and a large topographic depression shown on historical drawing 10W289-1 that were present prior to development of the Railroad loop disposal area. Borings should be targeted to determine if more pervious stream deposits are present.

TVA Bull Run EIP Rev 1
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
3.4.1	TDEC Bottom Ash/Gypsum Ponds Information Request No. 1	23	2	All	The extent and quantity of CCR material beneath the former chemical pond and in the former disposal area is not provided in this EIP. Provide information regarding the amount, saturation level and lateral and vertical extent of CCR material beneath the chemical pond and in the former disposal area surrounding the chemical pond. If the historical information is insufficient then addition borings and piezometers may be required.
3.4.5	TDEC Bottom Ash/Gypsum Ponds Information Request No. 5	27	1	All	A minimum of two monitoring wells need to be added to the north and northwest of the Bottom Ash Disposal Area. Specifically one monitoring well should be located adjacent to the western edge of the chemical treatment pond that was constructed within Disposal Area 1 on top of existing ash in the vicinity of abandoned wells O&R. The second monitoring well should be located near the north-northwestern extent of the former disposal area and chemical pond.
3.4.11	TDEC Bottom Ash/Gypsum Ponds Information	30	3	3	Based on slug tests, Kh values for the silty-clay alluvium were calculated up to 12 ft/day. This is not typical for silt/clay so we are really talking about quite heterogeneous sediments that do include sandy material (potentially important for any migration such that this unit cannot be excluded from deliberations as something unimportant).
3.3.2	TDEC Rail Loop Information Request No.	22	2	All	TVA will provide the documentation used to determine that the mention of the term "spring" was a misstatement. TVA will conduct and document a thorough inspection of the historic "poorly graded wet areas" to determine the presence or absence of a spring or groundwater seepage in the area.
3.4.6	TDEC Bottom Ash/Gypsum Ponds Information Request No.	27	1	2	The text states that "The DSWM approved the Groundwater Quality Assessment Plan [for IDL010000208] on February 9, 2017…." with paraphrased language from the letter. TVA has submitted GWQAPs for both IDL010000208 (Bottom Ash/Gypsum) and IDL010000080 (Dry Ash). TDEC (KEFO) responded to each: IDL010000208 on February 9, 2017 and IDL010000080 on December 5, 2017. Neither letter states that the GWQAP was approved.

TVA Bull Run EIP Rev 1
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
4.1.2	A.2 TDEC Site Information Request No. 2	39	All	All	TVA will conduct a leachability characterization study that includes an evaluation of CCR parameters from pore water and solid material samples (totals and leachable) from locations that would characterize the vertical and lateral distribution of leachability characteristics across the facility.
4.3	Ground Water Monitoring and Mapping	54	3	1	As a part of EIP, TVA shall include a map with the location of all ground water monitoring wells installed to meet the requirements of the EPA CCR regulations. TVA shall identify any of these wells that will be a part of the TVA BRF Ground Water Monitoring Network. All sample results from these wells will be included in the TVA BRF Environmental Assessment Report once the Environmental Investigation is completed.
4.4.13	Site Conditions - Structural Integrity	74	7	1	TDEC understands that specific CCR disposal areas are not subject to the EPA CCR regulations for structural integrity. However, with the exception of the Rail loop Disposal area, all other CCR disposal areas are a part of the original CCR surface impoundment. Given this, the structural integrity of the combined disposal area that are within the boundaries of the original CCR surface impoundment at the TVA BRF facility shall be assessed.
5.0	Environmental Assessment Report	Digital Page 84/1079	1	2 & 3	The EAR will address a list of task required by TDEC in response to TDEC's request during the period from the initial investigation conference through the completion of the EIP activities.
Appendix C	Exhibit 2	127	All	All	Well W09R is not shown on the figure, please revise.
Appendix C	Exhibit 2	127	All	All	On the figure please differentiate which wells are observation wells and which wells are monitoring wells.

TVA Bull Run EIP Rev 1
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix D, 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 E, Section 2.0	Hydrogeologic Investigation SAP	Digital Page 278/1079	1	3	The objective as stated in Section 2 of the Hydrogeologic Investigation SAP should include areas where ash has been managed or placed.
Appendix E, Section 6.2	Groundwater Investigation SAP	16	1	1	If the tubing used to collect the filter blank is not certified clean tubing then a tubing blank would be required.
Appendix E, Section 5.2.1	Hydrogeological Investigation SAP	10	2	6	Drilling and sampling activities will be performed under the direction of a Professional Geologist ~~or~~, licensed in the State of Tennessee, who has sufficient experience to execute the work.
Appendix E, Section 5.2.1	Hydrogeological Investigation SAP	10	3	1	The field geologist will be a TN professional geologist that will oversee the installation of the wells and be responsible for logging the soil in accordance with ASTM standards
Appendix E, Section 5.2.1	Hydrogeological Investigation SAP	10	4	1	The field geologist will be a TN professional geologist that will oversee the installation of the wells and be responsible for logging the soil in accordance with ASTM standards

TVA Bull Run EIP Rev 1
Summary of Comments

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix E, Attachment A	Hydrogeological Investigation SAP		Figure 6		The sand filter pack will extend a minimum of two feet above the screen
Appendix G, Section 3.3.1	Evaluation of Existing Geotechnical Data	10	1	2	TVA will provide a justification for the exclusion of SPT boring and undisturbed sample borings that were excluded from this assessment.
Appendix G, Section 4.1	Evaluation of Existing Geotechnical Data	All	All	All	TVA states that "*Closure design is ongoing, and consists of installing a final cap over the existing geometry of the unit* ". Any closure actions or planning that has occurred prior to complete characterization of the site as part of the EIP process is considered "at risk". Based on the results of the EIP, TVA may be required to take other and further remedial action at the site.
Appendix H	Stability SAP	Digital Page 453/1079	2	4	Summaries for existing geotechnical data should reference Appendix G.
Appendix J, Section 4.0	Sampling Locations	4	1	3	TVA will sample all available groundwater monitoring wells and piezometers onsite to accurately determine groundwater flow and quality as part of the EIP. Additionally, any data collected as part of compliance with federal CCR requirements should be included in the EIP process.
Appendix J, Section 4.1	Groundwater Investigation SAP	4	1	2	On the figure please differentiate which wells are observation wells and which wells are monitoring wells.
Appendix J, Section 4.1	Groundwater Investigation SAP	4	3	2	GS-1 is not shown on Attachment A, Figure 1. Please revise the figure to show the surface water sample point.

TVA Bull Run EIP Rev 1
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Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix J, Section 4.1	Groundwater Investigation SAP	5	2	2	On the figure and here in the text please differentiate which wells are observation wells and which wells are monitoring wells.
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 in the bulletized list.
Appendix J, Table 5	Groundwater Investigation SAP	14	Table 5		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.
Appendix L	Material Characteristics SAP	All	All	All	TVA will conduct a leachability characterization study that includes an evaluation of CCR parameters from pore water and solid material samples (totals and leachable) from locations that would characterize the vertical and lateral distribution of leachability characteristics across the facility. This will include the Rail Road Loop Disposal Area.
Attachment A	Figure 1	302	Map	NA	Does this figure have the location of the monitoring wells that TVA installed to meet the EPA CCR Ground Water Detection Monitoring Program? If not, these wells should be added. If the ground water monitoring wells are included, then they should be specifically identified.
Appendix N	Figure 1	882	All	All	Please provide well abandonment records and rationale in an appendix.
Appendix N	Figure 1	882	All	All	Provide in tabular form available well construction information for monitoring wells shown on Figure 1, including monitored intervals (i.e., screen interval, pump intake depth).

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Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix N	Table 1A	883-90	All	All	Twenty-one of the wells, existing and abandoned, have exceeded the MCL for arsenic. There are a number of historical arsenic detections above the MCL in wells which have since been abandoned. Preliminary concern is locations D, E, K, 44, O, Q, R. These locations do not currently have wells in the near vicinity (or wells proposed in this EIP) that have been sampled since the 90's. Presented data for well H stops in 1997. The exceedances were primarily during November 1991 sampling event. Additional investigations/wells in these locations may be warranted.
Appendix N	Table 1A	893-89	All	All	BRF-D has had numerous exceedances of Cadmium and Lead with intermittent detections above the MCL for Arsenic and Nickel with no results represented beyond 1996. Additional investigations and at least one well in this location appears warranted.
Appendix N	Table 1A	883-90	All	All	Expand cells as appropriate to remove ### (e.g. cells for BRF-D).
Appendix N	Table 1A	895	BRF-F45	NA	Check the result for Selenium on 11/1994. In the table it is presented as <1ug/L; however, it is highlighted as an MCL exceedance.
Appendix N	Table 1A	896	BRF-F45R	All	The reported detection level for Beryllium exceeds the MCL on 8 times (34%) over the 23 events reported. In the future it is imperative that all constituents sampled for (especially those with an MCL) are analyzed at an appropriate detection level to determine if an exceedance of the MCL has occurred.
Appendix N	Table 1A	905	BRF-R	All	BRF-R has had numerous exceedances of Cadmium and Nickel with intermittent detections above the MCL for Arsenic and Lead with no results represented beyond 1997. Additional investigations and at least one well in this location appears warranted.
Appendix N	Table 1A	906	All	All	Please indicate on Figure 1 the locations of BRF-UT0.15, BRF-UT0.38, BRF-WBO.4, BRF-WBO.95, BRF-WB1.2 and BRF-WB1.65.
Appendix N	Table 1B	910	All	All	Was turbidity measured at the time of sample collections, and if so it should be presented in this table?

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Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix N	Table 1C	925	All	All	Based on a cursory review, there appears to be an inconsistent elevation for top of casing (values fro BRF-1 ranged from 830.76 to 830.79. Please explain the discrepancy and provide corrected groundwater elevation depths.
Appendix N	Table 1C	925	All	All	Why are there no well depths listed?
Appendix N	Table 1C	925	All	All	Please explain how there can be a groundwater elevation listed if there is no water level depth provided (e.g. BRF-10-51, BRF-10-52, BRF-20H, BRF-46).
Appendix N	Table 1C	925	All	All	Correct #VALUE cells
Appendix N	All	All	All	All	Please include a summary table for all existing well construction details
Appendix O, Section 4.0	Background Soil SAP	4	1	1	Revise sentence. The proposed locations were selected based on access, current hydrogeologic knowledge, and the sample location criteria set forth by TDEC. The work is planned not completed.
Appendix O, Section 5.2.1.2	Background Soil SAP	8	1	8	The color of the soil shall be determined using the Munsell color chart and shall be described while the soil is still at or near the in-situ moisture condition. Although the Munsell color chart is not specifically called out in ASTM D2488 it is the industry standard. It should be noted if the Munsell Color Charts are not used for soil color descriptions.
Appendix O, Section 5.2.5	Background Soil SAP	13	Table 4		A pH field test kit will be employed to help identify if soil pH is in a range to mobilize CCR contaminants (specifically target sample aliquots and horizon changes).
Appendix P	Benthic SAP	All	All	All	Why is no sediment or macroinvertebrate sampling being conducted in Worthington Branch?
Appendix P	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?

Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix P	Benthic SAP	All	All	All	If mayflies are used, would it be important to be sure you had the same mayfly species at all sites? 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. By what means will mayfly tissue concentrations be normalized for comparison between sites? For example, will the concentrations be based on dry weight, or will a relatively consistent wet weight of biomass be analyzed for each site?
Appendix P	Benthic SAP	All	All	All	What is the purpose and use of developing depurated vs. non-depurated mayfly data?
Appendix P	Benthic SAP	All	All	All	What is the purpose of assessing tissue metals concentrations on non-depurated mayfly nymphs?
Appendix P	Benthic SAP	All	All	All	Would transport of mayflies on ice prior to depuration at a warmer temperature 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?
Appendix P	Benthic SAP	All	All	All	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?
Appendix P	Benthic SAP	All	All	All	Will sediment contaminant concentrations be expressed on a dry weight basis?
Appendix P	Benthic SAP	All	All	All	The sampling is often referred to as quantitative. A ponar sampler will penetrate to different depths based on substrate composition. It is also indicated that benthic sampling could be conducted with “similar self-closing” devices. This could preclude quantitative comparisons. How will identical sample sizes be ensured for appropriate site-to-site comparison?
Appendix P	Benthic SAP	All	All	All	What benthic community metrics do you expect to use for community comparisons between sites?
Appendix P	Benthic SAP	All	All	All	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 assist in interpretation of benthic community composition data?

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Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix P	Benthic SAP	All	All	All	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 sulfide should also be determined to support data interpretation. It may also be useful to include ammonia and dissolved sulfide analysis in the proposed plan to support interpretation of benthic community data.
Appendix Q	Surface Stream SAP	All	All	All	Specific SAP goals are to characterize contaminant concentrations and their potential movement, and page 70 of the EIP mentions assessing potential environmental impacts. What will data analysis consist of with respect to assessing contaminant movement and potential ecological effects?
Appendix Q	Surface Stream SAP	All	All	All	Will statistical comparisons be made between background and other sample locations, and if so are sample sizes sufficient to provide meaningful statistical analysis?
Appendix Q	Surface Stream SAP	All	All	All	Will there be a comparison of chemical concentrations to conditions indicating possible environmental harm, for example water quality standards for receiving stream designated uses in each of the surface waters to be assessed? If so, are contaminant detection levels sufficient to indicate compliance with applicable water quality standards?
Appendix Q	Surface Stream SAP	All	All	All	Total hardness (as CaCO3) and Total Suspended Solids should be added to the analyte list to allow determination of water quality standards for hardness-dependent metals. TSS is needed for conversion of total metals concentrations since the criteria are expressed as dissolved.
Appendix Q	Surface Stream SAP	All	All	All	What is the rationale for basing sample depths on the thermocline as opposed to set depths that are a proportion of the total depth at a site?
Appendix Q	Surface Stream SAP	All	All	All	In what seasons or months are the two sampling events going to be conducted and why?

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Section Number	Section Title	Page	Paragraph	Line	Comment
Appendix Q	Surface Stream SAP	All	All	All	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?
Appendix Q	Surface Stream SAP	All	All	All	The language seems to be inconsistent in Section 5.2.4 where it's stated that 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?
Appendix R	Fish Tissue SAP	All	All	All	Why is no fish sampling being conducted in Worthington Branch?
Appendix R	Fish Tissue SAP	All	All	All	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.
Appendix R	Fish Tissue SAP	All	All	All	Some of the wording in Section 5.2.1.2 is a little confusing with respect to whether each of the five trophic groups will be collected as available from all sites. Is this the goal?
Appendix R	Fish Tissue SAP	All	All	All	It is recommended to analyze individually any larger fish to supplement data obtained from the composite samples.
Appendix R	Fish Tissue SAP	All	All	All	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.

Appendix B – Table 1

Summary of TDEC Comments & TVA Responses

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Comment Number	Section Number	Section Title	Page	Para-graph	Line	BRF EIP Rev. 1 TDEC Comments	TVA Response to BRF EIP Rev. 1 TDEC Comments
1	All	All	All	All	All	TVA has agreed to conduct an environmental investigation at the TVA Kingston Fossil Plant 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 noted.
2	All	All	All	All	All	TVA shall either collect water samples for CCR analyses when it collects samples for NPDES monitoring or collect and analyze water samples from the NPDES discharge point quarterly	TVA shall continue to collect, test and report outfall samples in accordance with the conditions of the NPDES permit. TVA has included NPDES outfall sampling information, as well as detailed constituent information provided in its NPDES permit applications. NPDES compliance data previously submitted to TDEC will be included in the revised EIP as an appendix. If after reviewing the existing data, TDEC desires additional surface water data as part of the investigation, TDEC and TVA can jointly determine a path forward.
3	NA	Abbrevi ations	vii	NA	NA	Abbreviations need to be checked to make sure all abbreviations used in EIP are defined. At a minimum include the following: CPT, ICP, MS, RQD, SDG, SPLP, TCLP, TOR, USACE, USGS	Comment is acknowledged, and the corresponding changes have been made in the documents.
4	All	All	All	All	All	Ground water sampling at the permitted landfills should be taken at the same time as samples taken under the Order. Sample frequencies may not be the same, but it is important that the sample dates coincide for comparable parameters and elevation levels.	Comment is acknowledged. Groundwater sampling events for other programs will be coordinated with the events for the Environmental Investigation (EI) when both sampling events fall within the same timeframe. In addition, groundwater levels will be measured at wells from other programs during each EI groundwater sampling event.
5	General Commen t	Surface Water, Benthic, and Fish SAPs	All	All	All	Are the proposed sample sites known to be in representative areas of contamination, and do they account for the worst-case conditions?	The sediment (including benthic) transects and surface stream transects have been located near areas where historic seeps have been observed. Fish will be collected from the Clinch River and Bull Run immediately adjacent to, and downstream of the facility.
6	General Commen t	Surface Water, Benthic, and Fish SAPs	All	All	All	The Bull Run Environmental Investigation Plan states that data analysis will be done in the Environmental Assessment Report that will be prepared following the sampling outlined in the SAPs. However, some feel for expected data analysis is needed to know if sampling and sample sizes specified in the SAPs are appropriate for the intended data analysis and use. What types of statistical analyses will be done with the data, and what effects endpoints will the data be compared to in order to determine whether environmental harm has occurred due to contaminant concentrations present?	The choice of statistical methods will be appropriate to the analytical data (e.g. percent detected vs. non-detected values, underlying distribution of the data, and variability). Spatial trends will be evaluated visually and quantitatively if the data allow. Analysis of the results from the surface water, benthic, sediment, and fish sampling will be informed by the statistical methods used by Oak Ridge National Laboratory in the studies conducted following the Kingston ash release. Determination of potential harm to the aquatic/terrestrial ecosystem from the presence of CCR constituents from the facility will be based on multiple lines of potential evidence.

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Comment Number	Section Number	Section Title	Page	Para-graph	Line	BRF EIP Rev. 1 TDEC Comments	TVA Response to BRF EIP Rev. 1 TDEC Comments
7	1.1	Purpose	1	1	6	Please revise for consistency with CUF Rev 2. "The Environmental Assessment Report (EAR), to be submitted at a later date following completion of the environmental investigation identified in the EIP, will provide "an analysis of the extent of soil, surface water, and groundwater 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."	Comment is acknowledged, and the corresponding changes have been made in the documents.
8	1.4.1	Site History	3	3	2	First occurrence of DSWM please define in text.	Comment is acknowledged, and the corresponding changes have been made in the documents.
9	1.4.2	Current Operations and Closure Plans	3	1	4	First occurrence of NPDES please define in text.	Comment is acknowledged, and the corresponding changes have been made in the documents.
10	1.4.2	Current Operations and Closure Plans	3	1	All	TDEC recognizes that TVA has initiated closure projects for the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C. These closure actions have occurred prior to complete characterization of the site as part of the EIP process, and, as such, 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 is noted. On February 27, 2018, TVA submitted to TDEC a request for a minor permit modification for the closure plans for the Gypsum Disposal Area 2A and Bottom Ash Disposal Area. As noted in the modification request, closure activities for these areas will not occur until TDEC Order activities run their course. For the Main Ash Pond and the Fly Ash Stilling Pond 2C, TVA is reviewing proposed actions to comply with the CCR Rule and to facilitate plans for future waste water treatment. The text of the EIP has been clarified to be consistent with the current plans for these units.
11	2.1	EIP development and structure	Digital Page 15/1079	7	3	Provide a copy of TVA's September 19, 2017 letter to Barnes Johnson, Director EPA, in Appendix B and reference it appropriately in the text. All actions referenced in the letter, including geotechnical investigations and seismic analysis shall be included in the EAR.	Comment is acknowledged The letter has been referenced in Section 3.1.6 of the EIP and the letter is included in Appendix B.
12	2.3	Quality Assurance Project Plan	9	2	4	Please include as an appendix to the EIP the referenced "Data Management Plan".	Comment is acknowledged, and the corresponding changes have been made in the document.
13	3.1.1	TDEC General Information Request No. 1	10	All	All	TVA will provide a site map depicting the local geologic formations and faults; current and proposed monitoring well locations; and former pathway of Bull Run Creek/Worthington Branch Creek in relation to all ash disposal areas. TVA will demonstrate the the proposed groundwater monitoring system captures potential preferential pathways for contaminant migration through these features. TVA will install additional monitoring wells as necessary to fully characterize these potential migration pathways.	Comment is acknowledged. Existing and proposed monitoring wells and pilot holes are shown on a map depicting local geologic formations and faults including the pathway of Bull Run Creek/Worthington Branch Creek in relation to ash disposal areas. TVA has developed an approach to characterize the hydrogeology around the CCR units. The proposed activities include an investigation of bedrock near these units. This approach is an iterative investigation and is a cooperative effort with TDEC. TVA would prefer to complete the initial phase of the investigation and jointly review the results with TDEC to identify any data gaps. If any data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC. This may include installing additional groundwater monitoring wells to fully characterize the hydrogeology and potential migration pathways.

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Comment Number	Section Number	Section Title	Page	Para-graph	Line	BRF EIP Rev. 1 TDEC Comments	TVA Response to BRF EIP Rev. 1 TDEC Comments
14	3.1.1	TDEC General Information Request No. 1	10	2	All	Bedrock geology needs to be discussed for the fly ash stilling pond 2C and railroad loop disposal area.	Comment is acknowledged. TVA has developed an approach to characterize the hydrogeology around the Fly Ash Stilling Pond 2C and the Railroad Loop Disposal Area. The proposed activities include an investigation of bedrock near these units. After the initial phase of the investigation, a discussion of bedrock geology will be provided in the EAR.
15	3.1.1	TDEC General Information Request No. 1	10	3	3,4	This interpretation must be restricted to movement in the shallow wells. Groundwater in the Chickamauga Limestone below the weathered zone moves through the small solution channels that have developed in that rock. The direction of fluid movement through such cavities is controlled by their three-dimensional geometry and their degree of interconnection with other cavities of lower hydraulic head. That direction may have little or possibly no relationship to the direction of movement inferred from water-table contours, the hydrogeological framework needs to be further characterized for the entire BRF facility specifically answering this conduit flow potential.	Comment is acknowledged. TVA has developed an approach to characterize the hydrogeology at BRF. The proposed pilot borings are intended to investigate bedrock and features within bedrock that influence groundwater flow. This approach is an iterative investigation and is a cooperative effort with TDEC. TVA would prefer to complete the initial phase of the investigation and jointly review the results with TDEC to identify any data gaps. If any data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC. This may include installing additional groundwater monitoring wells to further characterize the hydrogeology.
16	3.1.1	TDEC General Information Request No. 1	11	2	All	Since it appears that geologic structure imposes significant control on groundwater flow at the site an evaluation of rock mass permeability needs to be completed to determine directional differences in permeability (i.e., if permeabilities are significantly higher in the northeast-southwest direction, as opposed to perpendicular to bedding).	TVA has developed an approach to characterize the hydrogeology at BRF. As part of the proposed well and pilot hole drilling program TVA is proposing to utilize downhole geophysics to evaluate the influence of bedrock structure on groundwater conditions in the pilot holes. From this data, it is anticipated that groundwater flow direction and permeability data will be recorded, and results will be submitted in the EAR. This approach is an iterative investigation and is a cooperative effort with TDEC. TVA would prefer to complete the initial phase of the investigation and jointly review the results with TDEC to identify any data gaps. If data gaps are identified with respect to anisotropic hydraulic conductivity, then the need for conducting additional phases of investigation will be discussed with TDEC within the context of monitoring potential releases from CCR units at BRF.
17	3.1.1	TDEC General Information Request No. 1	11	2	All	On the northwest boundary of the dry fly ash Phase II and lateral expansion there is an indication in previous reports that there is the potential for solution enhanced joint sets (i.e., conduits) which cause a depression in the top of rock surface. This area of B-14R, B-14 and B-14L also lie on a lineation oriented approximately N62W that has numerous sinkholes to the north of Edgemoor Road. TVA needs to fully characterize groundwater flow along joint sets and the potential for conduit flow. Pilot holes need to be added to sufficiently define this area.	TVA proposes to add two additional upgradient pilot holes along the northwest boundary of the Dry Fly Ash Stack Phase 2. These will be used to further investigate the hydrogeological conditions upgradient of the Dry Fly Ash Stack and help the understanding of groundwater flow in the DFAS area. As with the other proposed pilot holes, downhole geophysics will be used to investigate groundwater conditions and movement in the bedrock. If joint sets are observed, then TVA will evaluate whether the factures appear to show enlargement due to solution. TVA requests additional information on the mentioned sinkholes north of Edgemoor Road.
18	3.1.1	TDEC General Information Request No. 1	11	2	10	Replace "downhold" with downhole	Comment is acknowledged, and the corresponding changes have been made in the documents.

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Comment Number	Section Number	Section Title	Page	Para-graph	Line	BRF EIP Rev. 1 TDEC Comments	TVA Response to BRF EIP Rev. 1 TDEC Comments
19	3.1.1	TDEC General Information Request No. 1	11	3	All	What criteria will TVA use to determine if a pilot hole will be converted to a PZ or MW?	Whether the pilot hole is completed as a well or piezometer will depend on the findings of the drilling and geophysical program. If there is little to no groundwater or if the pilot hole is close enough to an existing well to not warrant the installation of a monitoring well then it would be turned into a piezometer. In addition, if it is determined that the pilot hole is not in a location that is representative of a groundwater flow path from a CCR unit, then a piezometer will be installed instead of a monitoring well. The use of multi-level vibrating wire piezometers on either side of geological structures can often show groundwater conditions that would not be seen in an open standpipe well. TVA will review the results of the drilling and geophysical program with TDEC to determine the final pilot hole designation (well or piezometer). The corresponding changes have been made in the documents.
20	3.1.2	TDEC General Information Request No. 1	12	2	All	In order to characterize the cross-valley strike-slip fault that is located on the southwest edge of the Bottom Fly Ash Pond as well as centrally dissecting the Gypsum Disposal Area 2A and Main Ash Pond TVA needs to determine the location and potential impacts of this fault (i.e., whether this fault serves as a permeability barrier or a pathway for migration laterally or downward). More than one boring is necessary to determine the location and properties of this fault. Surface geophysical techniques may be more suited to delineation of this feature followed by verification through additional borings along the projected lineation.	Comment is acknowledged. Three pilot holes will be drilled near the estimated location of the unnamed strike-slip fault that is assumed to run near the Bottom Ash Disposal Area to establish the fault properties and ascertain whether it acts as a groundwater conduit or barrier. If additional information is needed, TVA may use surface geophysics, such as seismic and resistivity, to locate the fault and establish its delineation. Once the results have been gathered and interpreted, if deemed necessary, a targeted drilling program will be undertaken to supplement existing data.
21	3.1.5	TDEC General Info Request	23	5	1	If domestic water wells are identified during the Water Use Survey, samples are collected and the sample results indicate the presence of CCR constituents from the TVA BRF site, the domestic water well(s) will be added to the ground water monitoring program or new monitoring wells will be installed near the domestic water wells and become part of the ground water monitoring program	Comment is noted. If water samples collected from domestic water wells identified during the Water Use Survey indicate the presence of CCR constituents from BRF, a groundwater monitoring program will be implemented to monitor the water supplies as part of the CARA Plan.
22	3.2	Dry Ash Stack – IDL01103 0080	17	All	All	Provide information regarding the potential for a preferential seepage pathway via the stream channel that was present prior to development of the dry ash stack along the northeastern edge of the Phase 1 stack as shown on historical drawing 10W293-1. Borings should be targeted to determine if more pervious stream deposits are present.	The Exploratory Drilling SAP and the associated EIP exhibit have been updated to include one additional proposed geotechnical boring, located along the historical alignment of the unnamed tributary of Worthington Branch within Phase 1 of the Dry Fly Ash Stack. There are also existing borings along/near the mapped tributary alignment (see Exhibit 4). Refer to the updated Exploratory Drilling SAP for additional details of the proposed boring. Data from the proposed and existing borings will provide additional information regarding the foundation soils within the historical alignment, support the 3-D model development, and the hydrogeologic understanding of this vicinity. Results will be presented in the EAR.
23	3.2	Dry Ash Stack – IDL01103 0080	17	All	All	Provide information regarding the mitigation of the three sinkholes (i.e., topographic depressions) shown on historical drawing 10W293-1 on the south edge of Phase 1 and determine the potential that they are part of a solution enhanced joint set, bedding plane or other more significant karst area that may serve as a preferential seepage pathway.	The depressions shown on drawing 10W293-1 are not labeled sinkholes. TVA has not located documents that note the occurrence of sinkholes in the area of Phase 1. TVA requests additional information on the mentioned sinkholes.

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24	3.2.1	TDEC Dry Ash Stack Informati on Request No. 1	17	3	1	On the northwest boundary of the dry fly ash Phase II and lateral expansion there is an indication in previous reports that there is the potential for solution enhanced joint sets (i.e., conduits) which caused a depression in the top of rock surface. The area is underlain by sub-unit B of the Chickamauga Formation which is a relatively pure (non-clastic) limestone and known to be karstic. At the site drilling has confirmed the presence of both open and clay filled solution cavities. This area of B-14R, B-14 and B-14L also lie on a lineation oriented approximately N62W that has numerous sinkholes to the north of Edgemoor Road. TVA needs to fully characterize groundwater flow along joint sets and evaluate the potential for conduit flow. Pilot holes need to be added along the northwest boundary to sufficiently characterize this area.	See response to comment 17.
25	3.2.1	TDEC Dry Ash Stack Informati on Request No. 1	17	3	1	Three "deep" pilot holes may not provide sufficient spatial coverage to accurately determine overall gradient(s) in the vicinity of the dry fly ash stack. There are no reference points shown on Exhibit 3 along the northwest boundary. Also the influence of impoundments and lined versus unlined portions of the stack on groundwater levels may not be adequately represented with existing and planned monitoring wells. Based on provided data the potentiometric surface indicates water in the dry fly ash stack, which is captured by Worthington Branch but does not characterize bedrock groundwater flow that my not be captured by Worthington Branch (e.g., underflow, conduit flow).	See response to comment 17. Exhibit 3 has been updated accordingly. The proposed pilot holes are intended to augment understanding of groundwater flow conditions, groundwater quality and water bearing zones in the bedrock underlying the Dry Fly Ash Stack. This approach is an iterative investigation and is a cooperative effort with TDEC. TVA would prefer to complete the initial phase of the investigation and jointly review the results with TDEC to identify data gaps prior to assuming that underflow beneath Worthington Branch exists. 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 to further characterize the hydrogeology.
26	3.3	Railroad Loop	21	All	All	Provide information regarding the potential for preferential seepage pathways via the two pre-construction valleys that may have contained streams and a large topographic depression shown on historical drawing 10W289-1 that were present prior to development of the Railroad loop disposal area. Borings should be targeted to determine if more pervious stream deposits are present.	Exhibit 13 shows several existing borings and foundation soil information within both pre-construction valleys of the Railroad Loop Disposal Area. The existing data will be supplemented with proposed CPTs (Exhibit 21) along the valley alignments. Results will be presented in the EAR.
27	3.4.1	TDEC Bottom Ash/Gyp sum Ponds Informati on Request No. 1	23	2	All	The extent and quantity of CCR material beneath the former chemical pond and in the former disposal area is not provided in this EIP. Provide information regarding the amount, saturation level and lateral and vertical extent of CCR material beneath the chemical pond and in the former disposal area surrounding the chemical pond. If the historical information is insufficient then addition borings and piezometers may be required.	TVA has reviewed as-built closure drawings and construction certification report documentation to evaluate where and how the extent of the CCR limits were determined and closed in the vicinity of the chemical pond and former disposal area. Associated text in Sections 3.4.1 and 4.1.5 has been updated. The Exploratory Drilling SAP and Material Quantity SAP have been updated to add 2 geotechnical borings in the Former Disposal Area, to supplement existing data for CCR thickness. Borings in the Chemical Pond are not feasible, due to a geosynthetic cap and riprap fill in the footprint; the surrounding borings will be used to interpolate the CCR quantity beneath the Chemical Pond.

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28	3.4.5	TDEC Bottom Ash/Gypsum Ponds Information Request No. 5	27	1	All	A minimum of two monitoring wells need to be added to the north and northwest of the Bottom Ash Disposal Area. Specifically one monitoring well should be located adjacent to the western edge of the chemical treatment pond that was constructed within Disposal Area 1 on top of existing ash in the vicinity of abandoned wells O&R. The second monitoring well should be located near the north-northwestern extent of the former disposal area and chemical pond.	Prior to installation of the additional monitoring wells, one pilot hole will be drilled near the former location of closed wells O and R and a second pilot hole will be drilled near the north-northwestern boundary of the Former Disposal Area and Chemical Pond to evaluate hydrogeological conditions. If ash is encountered, the well locations may need to be moved. One shallow monitoring well in the overburden and one deep monitoring well in the bedrock will be installed near the former location of closed wells O and R and one shallow and one deep monitoring well will be installed near the north-northwestern boundary of the Former Disposal Area and Chemical Pond to satisfy this request.
29	3.4.11	TDEC Bottom Ash/Gypsum Ponds Information	30	3	3	Based on slug tests, Kh values for the silty-clay alluvium were calculated up to 12 ft/day. This is not typical for silt/clay so we are really talking about quite heterogeneous sediments that do include sandy material (potentially important for any migration such that this unit cannot be excluded from deliberations as something unimportant).	Comment is acknowledged. TVA will review available slug test data in its hydrogeological characterization of BRF. Apparent discrepancies between visual descriptions of soil types and other available data will be further investigated. TVA's review will include a QA/QC check on existing data.
30	3.3.2	TDEC Bottom Ash/Gypsum Ponds Information Request No. 2	22	2	All	TVA will provide the documentation used to determine that the mention of the term "spring" was a misstatement. TVA will conduct and document a thorough inspection of the historic "poorly graded wet areas" to determine the presence or absence of a spring or groundwater seepage in the area.	Comment is acknowledged, and the corresponding changes have been made in the document.
31	3.4.6	TDEC Bottom Ash/Gypsum Ponds Information Request No. 6	27	1	2	The text states that "The DSWM approved the Groundwater Quality Assessment Plan [for IDL010000208] on February 9, 2017…." with paraphrased language from the letter. TVA has submitted GWQAPs for both IDL010000208 (Bottom Ash/Gypsum) and IDL010000080 (Dry Ash). TDEC (KEFO) responded to each: IDL010000208 on February 9, 2017 and IDL010000080 on December 5, 2017. Neither letter states that the GWQAP was approved.	Comment is acknowledged. In a letter dated February 9, 2017, the DSWM stated that the Groundwater Quality Assessment Plan meets Division Rules, is consistent with compliance history at the site, and incorporates 40 CFR Part 257 Appendix III and IV monitoring requirements. The corresponding changes have been made in the document.
32	4.1.2	A.2 TDEC Site Information Request No. 2	39	All	All	TVA will conduct a leachability characterization study that includes an evaluation of CCR parameters from pore water and solid material samples (totals and leachable) from locations that would characterize the vertical and lateral distribution of leachability characteristics across the facility.	The CCR Material Characteristics SAP has been revised such that during construction and installation of temporary wells for collecting samples from both the phreatic and non-phreatic zones at an active, unclosed unit, grab samples will be taken from each 5-foot core boring, from the top of the unit to its base to characterize the vertical and lateral distribution of leachability characteristics across the unit. These samples will be analyzed for the CCR parameters defined in the EIP, for totals, and leachability after application of the most applicable method based on emerging science in the industry, which could include the Synthetic Precipitation Leaching Procedure (SPLP) method.

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33	4.3	Ground Water Monitoring and Mapping	54	3	1	As a part of EIP, TVA shall include a map with the location of all ground water monitoring wells installed to meet the requirements of the EPA CCR regulations. TVA shall identify any of these wells that will be a part of the TVA BRF Ground Water Monitoring Network. All sample results from these wells will be included in the TVA BRF Environmental Assessment Report once the Environmental Investigation is completed.	Comment is acknowledged. The figure has been updated to identify the CCR Rule groundwater monitoring wells. Groundwater results will be included in the EAR.
34	4.4.13	Site Conditions – Structural Integrity	74	7	1	TDEC understands that specific CCR disposal areas are not subject to the EPA CCR regulations for structural integrity. However, with the exception of the Rail loop Disposal area, all other CCR disposal areas are a part of the original CCR surface impoundment. Given this, the structural integrity of the combined disposal area that are within the boundaries of the original CCR surface impoundment at the TVA BRF facility shall be assessed.	The structural integrity analyses discussed in Section 4.4.13 are intended to include consideration of all former and current CCR disposal areas within the perimeter of the original CCR surface impoundment. The text has been clarified accordingly.
35	5.0	Environmental Assessment Report	Digital Page 84/1079	1	2 & 3	The EAR will address a list of task required by TDEC in response to TDEC's request during the period from the initial investigation conference through the completion of the EIP activities.	Comment is acknowledged.
36	Appendix C	Exhibit 2	127	All	All	Well W09R is not shown on the figure, please revise.	Monitoring well W09R was-installed in September 2017 and the location has been added to the figure.
37	Appendix C	Exhibit 2	127	All	All	On the figure please differentiate which wells are observation wells and which wells are monitoring wells.	Comment is acknowledged. The figure has been updated to show observation and monitoring well locations.
38	Appendix D, 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.	Comment is acknowledged, and the corresponding changes have been made in the documents.
39	Appendix E, Section 2.0	Hydrogeologic Investigation SAP	Digital Page 278/1079	1	3	The objective as stated in Section 2 of the Hydrogeologic Investigation SAP should include areas where ash has been managed or placed.	Comment is noted.
40	Appendix E, Section 6.2	Groundwater Investigation SAP	16	1	1	If the tubing used to collect the filter blank is not certified clean tubing then a tubing blank would be required.	Tubing blanks have been collected at a frequency of 1 per lot for other GW monitoring programs.

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41	Appendix E, Section 5.2.1	Hydrogeological Investigation SAP	10	2	6	Drilling and sampling activities will be performed under the direction of a Professional Geologist or, licensed in the State of Tennessee, who has sufficient experience to execute the work.	Comment is acknowledged, and the corresponding changes have been made in the documents.
42	Appendix E, Section 5.2.1	Hydrogeological Investigation SAP	10	3	1	The field geologist will be a TN professional geologist that will oversee the installation of the wells and be responsible for logging the soil in accordance with ASTM standards	Comment is acknowledged, and the corresponding changes have been made in the documents.
43	Appendix E, Section 5.2.1	Hydrogeological Investigation SAP	10	4	1	The field geologist will be a TN professional geologist that will oversee the installation of the wells and be responsible for logging the soil in accordance with ASTM standards	Comment is acknowledged, and the corresponding changes have been made in the documents.
44	Appendix E, Attachment A	Hydrogeological Investigation SAP		Figure 6		The sand filter pack will extend a minimum of two feet above the screen	Comment is acknowledged, and the corresponding changes have been made in the documents.
45	Appendix G, Section 3.3.1	Evaluation of Existing Geotechnical Data	10	1	2	TVA will provide a justification for the exclusion of SPT boring and undisturbed sample borings that were excluded from this assessment.	The borings in question were not located adjacent to the Railroad Loop Disposal Area footprint; therefore, the borings are not relevant and were excluded from consideration. The text will be clarified accordingly.
46	Appendix G, Section 4.1	Evaluation of Existing Geotechnical Data	All	All	All	TVA states that "Closure design is ongoing, and consists of installing a final cap over the existing geometry of the unit ". Any closure actions or planning that has occurred prior to complete characterization of the site as part of the EIP process is 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 is noted. On February 27, 2018, TVA submitted to TDEC a request for a minor permit modification for the closure plans for the Gypsum Disposal Area 2A and Bottom Ash Disposal Area. As noted in the modification request, closure activities for these areas will not occur until TDEC Order activities run their course.
47	Appendix H	Stability SAP	Digital Page 453/1079	2	4	Summaries for existing geotechnical data should reference Appendix G.	Comment is acknowledged, and the corresponding change has been made in the document.
48	Appendix J, Section 4.0	Sampling Locations	4	1	3	TVA will sample all available groundwater monitoring wells and piezometers onsite to accurately determine groundwater flow and quality as part of the EIP. Additionally, any data collected as part of compliance with federal CCR requirements should be included in the EIP process.	Groundwater level measurements will be collected from monitoring wells and piezometers as part of the EIP. Groundwater quality samples will be collected from monitoring wells. All data collected from monitoring wells from other programs will be used as applicable to the TDEC Order; however, duplicate samples will not be collected for this investigation. Applicable data collected from other programs that meet the QAPP will be utilized in the EAR.

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49	Appendix J, Section 4.1	Ground water Investig ation SAP	4	1	2	On the figure please differentiate which wells are observation wells and which wells are monitoring wells.	See response to comment 37.
50	Appendix J, Section 4.1	Ground water Investig ation SAP	4	3	2	GS-1 is not shown on Attachment A, Figure 1. Please revise the figure to show the surface water sample point.	Comment is acknowledged. The surface water gauging station (GS-1) has been labeled and is shown on Figure 1.
51	Appendix J, Section 4.1	Ground water Investig ation SAP	5	2	2	On the figure and here in the text please differentiate which wells are observation wells and which wells are monitoring wells.	See response to comment 37.
52	Appendix J, Section 5.2.2	Ground water Investig ation SAP, Well Purging	7	2	2	Indicate if specific conductance is measured in mS/cm or µS/cm in the bulletized list.	Comment is acknowledged, and the corresponding changes have been made in the documents.
53	Appendix J, Table 5	Ground water Investig ation SAP	14	Table 5		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.	See response to comment 38.
54	Appendix L	Material Charact eristics SAP	All	All	All	TVA will conduct a leachability characterization study that includes an evaluation of CCR parameters from pore water and solid material samples (totals and leachable) from locations that would characterize the vertical and lateral distribution of leachability characteristics across the facility. This will include the Rail Road Loop Disposal Area	See response to Comment 32 for active, unclosed units. For inactive and/or closed units, the existing groundwater monitoring well network or groundwater wells installed as part of the EIP will monitor the groundwater for CCR constituent contamination. The monitoring protocols will be relied on for the detection, assessment of, and corrective action for any identified CCR parameters identified in the groundwater, and for use in developing any necessary corrective actions.
55	Attachm ent A	Figure 1	302	Map	NA	Does this figure have the location of the monitoring wells that TVA installed to meet the EPA CCR Ground Water Detection Monitoring Program? If not, these wells should be added. If the ground water monitoring wells are included, then they should be specifically identified.	Comment is acknowledged. The figure has been updated to identify the CCR Rule groundwater monitoring wells.

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56	Appendix N	Figure 1	882	All	All	Please provide well abandonment records and rationale in an appendix.	Well closure records and rationale for closing the wells are included in the appendix.
57	Appendix N	Figure 1	882	All	All	Provide in tabular form available well construction information for monitoring wells shown on Figure 1, including monitored intervals (i.e., screen interval, pump intake depth).	A table showing available well construction information including screen interval and pump intake depth is included in the appendix.
58	Appendix N	Table 1A	883-90	All	All	Twenty-one of the wells, existing and abandoned, have exceeded the MCL for arsenic. There are a number of historical arsenic detections above the MCL in wells which have since been abandoned. Preliminary concern is locations D, E, K, 44, O, Q, R. These locations do not currently have wells in the near vicinity (or wells proposed in this EIP) that have been sampled since the 90's. Presented data for well H stops in 1997. The exceedances were primarily during November 1991 sampling event. Additional investigations/wells in these locations may be warranted.	An additional pilot hole and two monitoring wells (one shallow and one deep) will be installed near the locations of closed wells O and R as discussed in the response for comment #28. One pilot hole and one deep monitoring well will be installed near the former locations of closed wells K and Q to satisfy this request. An additional monitoring well is not proposed near the former location of closed well D because this bedrock well was in a location upgradient of the South Railroad Loop and at a greater distance than proposed upgradient and downgradient monitoring wells. In addition, the historical data for wells around the South Railroad Loop, in general, and monitoring well 46, in particular, are lower than the results for well D. Therefore, TVA proposes an iterative approach to evaluate the need to install a replacement well near former location D. TVA would prefer to complete the initial phase of the investigation and jointly review the results with TDEC to identify any data gaps. If any data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC. An additional monitoring well is not proposed near the former location of closed well E because existing well H is in a similar location as well E and will provide current groundwater quality data in this location. An additional monitoring well is not proposed near the location of well 44 since this area is not located on TVA property.
59	Appendix N	Table 1A	893-89	All	All	BRF-D has had numerous exceedances of Cadmium and Lead with intermittent detections above the MCL for Arsenic and Nickel with no results represented beyond 1996. Additional investigations and at least one well in this location appears warranted.	As discussed in comment #58, an additional monitoring well is not proposed near the former location of closed well D because this bedrock well is located in an up-gradient location of the CCR units and constituent concentrations do not appear to be CCR related.
60	Appendix N	Table 1A	883-90	All	All	Expand cells as appropriate to remove ### (e.g. cells for BRF-D).	Comment is acknowledged, and the corresponding change has been made in the table.

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61	Appendix N	Table 1A	895	BRF-F45	NA	Check the result for Selenium on 11/1994. In the table it is presented as <1ug/L; however, it is highlighted as an MCL exceedance.	Comment is acknowledged. The analytical result for selenium is correct and shows a result below the MCL. The highlight has been removed.
62	Appendix N	Table 1A	896	BRF-F45R	All	The reported detection level for Beryllium exceeds the MCL on 8 times (34%) over the 23 events reported. In the future it is imperative that all constituents sampled for (especially those with an MCL) are analyzed at an appropriate detection level to determine if an exceedance of the MCL has occurred.	Comment is acknowledged.
63	Appendix N	Table 1A	905	BRF-R	All	BRF-R has had numerous exceedances of Cadmium and Nickel with intermittent detections above the MCL for Arsenic and Lead with no results represented beyond 1997. Additional investigations and at least one well in this location appears warranted.	As discussed in comment #28, TVA will install one pilot hole and two monitoring wells (one shallow and one deep) near the former location of BRF-R (well R) to satisfy this request.
64	Appendix N	Table 1A	906	All	All	Please indicate on Figure 1 the locations of BRF-UT0.15, BRF-UT0.38, BRF-WBO.4, BRF-WBO.95, BRF-WB1.2 and BRF-WB1.65.	Comment is acknowledged. The samples noted are surface water samples. The surface water sample locations have been added to the figure except for BRF-WBO.95 since this location could not be located in the historical documents.
65	Appendix N	Table 1B	910	All	All	Was turbidity measured at the time of sample collections, and if so it should be presented in this table?	Comment is acknowledged. Available historical turbidity data has been added to the table.
66	Appendix N	Table 1C	925	All	All	Based on a cursory review, there appears to be an inconsistent elevation for top of casing (values fro BRF-1 ranged from 830.76 to 830.79. Please explain the discrepancy and provide corrected groundwater elevation depths.	Historical top of casing and groundwater elevation measurements were obtained from a groundwater database. The differences in measurements at the same location over time could potentially be related to well repairs and re-surveying the location, conversion of units and/or human error. Well measurements for existing wells will be confirmed during the investigation and provided in interim monthly reports and the EAR.
67	Appendix N	Table 1C	925	All	All	Why are there no well depths listed?	Available well depth measurements have been added to the table. Well depth measurements for existing wells will be confirmed during the investigation and provided in interim monthly reports and the EAR.
68	Appendix N	Table 1C	925	All	All	Please explain how there can be a groundwater elevation listed if there is no water level depth provided (e.g. BRF-10-51, BRF-10-52, BRF-20H, BRF-46).	Available groundwater depth measurements have been added to the table. Groundwater depth measurements for existing wells will be confirmed during the investigation and provided in interim monthly reports and the EAR.
69	Appendix N	Table 1C	925	All	All	Correct #VALUE cells	Comment is acknowledged, and the corresponding change has been made in the table.
70	Appendix N	All	All	All	All	Please include a summary table for all existing well construction details	See the response to comment #57.

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71	Appendix O, Section 4.0	Background Soil SAP	4	1	1	Revise sentence. The proposed locations were selected based on access, current hydrogeologic knowledge, and the sample location criteria set forth by TDEC. The work is planned not completed.	Comment is acknowledged, and the corresponding changes have been made in the documents.
72	Appendix O, Section 5.2.1.2	Background Soil SAP	8	1	8	The color of the soil shall be determined using the Munsell color chart and shall be described while the soil is still at or near the in-situ moisture condition. Although the Munsell color chart is not specifically called out in ASTM D2488 it is the industry standard. It should be noted if the Munsell Color Charts are not used for soil color descriptions.	Comment is acknowledged, and the corresponding changes have been made in the documents.
73	Appendix O, Section 5.2.5	Background Soil SAP	13	Table 4		A pH field test kit will be employed to help identify if soil pH is in a range to mobilize CCR contaminants (specifically target sample aliquots and horizon changes).	Comment is acknowledged, and the corresponding change has been made in the document. Background soil samples will be tested using pH field test kits. Ten percent of the samples will have confirmation samples submitted for laboratory analysis of pH.
74	Appendix P	Benthic SAP	All	All	All	Why is no sediment or macroinvertebrate sampling being conducted in Worthington Branch?	Comment is acknowledged, and the corresponding changes have been made in the documents.
75	Appendix P	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.
76	Appendix P	Benthic SAP	All	All	All	If mayflies are used, would it be important to be sure you had the same mayfly species at all sites? 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. By what means will mayfly tissue concentrations be normalized for comparison between sites? For example, will the concentrations be based on dry weight, or will a relatively consistent wet weight of biomass be analyzed for each site?	Mayflies of the genus *Hexagenia* will be used as long as they are recoverable. *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). 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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77	Appendix P	Benthic SAP	All	All	All	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.
78	Appendix P	Benthic SAP	All	All	All	What is the purpose of assessing tissue metals concentrations on non-depurated mayfly nymphs?	Non-depurated mayfly nymphs are a source of potential exposure to organisms (fish, larger macroinvertebrates) that consume the nymphs. The organisms that feed on mayfly nymphs ingest nymph tissues and gut contents containing sediment. Including the gut contents provides a short-term window into the chemical contents of what the mayfly has recently ingested, which may or may not be absorbed into the organism upon digestion.
79	Appendix P	Benthic SAP	All	All	All	Would transport of mayflies on ice prior to depuration at a warmer temperature 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.
80	Appendix P	Benthic SAP	All	All	All	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 AVS/SEM, with TDEC.
81	Appendix P	Benthic SAP	All	All	All	Will sediment contaminant concentrations be expressed on a dry weight basis?	Sediment contaminant concentrations will be expressed on a dry weight basis.
82	Appendix P	Benthic SAP	All	All	All	The sampling is often referred to as quantitative. A ponar sampler will penetrate to different depths based on substrate composition. It is also indicated that benthic sampling could be conducted with "similar self-closing" devices. This could preclude quantitative comparisons. How will identical sample sizes be ensured for appropriate site-to-site comparison?	Identical sample size is not required for comparison of the Reservoir Benthic Index (RBI) metrics outlined in Comment 83 below.

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83	Appendix P	Benthic SAP	All	All	All	What benthic community metrics do you expect to use for community comparisons between sites?	There are seven Reservoir Benthic Index (RBI) metrics 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
84	Appendix P	Benthic SAP	All	All	All	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 assist in interpretation of benthic community composition data?	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 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.
85	Appendix P	Benthic SAP	All	All	All	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 sulfide should also be determined to support data interpretation. It may also be useful to include ammonia and dissolved sulfide analysis in the proposed plan to support interpretation of benthic community data.	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, with TDEC.
86	Appendix Q	Stream SAP	All	All	All	Specific SAP goals are to characterize contaminant concentrations and their potential movement, and page 70 of the EIP mentions assessing potential environmental impacts. What will data analysis consist of with respect to assessing contaminant movement and potential ecological effects?	Surface water and sediment are complementary datasets that characterize pathways of exposure to fish and benthic macroinvertebrates (and humans). Some CCR constituents occur naturally in surface waters, sediments, and biota. The surface water samples are intended to inform: 1) whether or not CCR from (non-NPDES outfall) sources on the facility are moving into the adjacent surface water in the Clinch River, Bull Run, and Worthington Branch; and 2) whether concentrations of CCR adjacent to, and downstream of the facility can be distinguished from background surface water quality.
87	Appendix Q	Stream SAP	All	All	All	Will statistical comparisons be made between background and other sample locations, and if so are sample sizes sufficient to provide meaningful statistical analysis?	Yes, statistical comparisons will be made between background and sample locations. Sample transects are located both upstream and downstream of BRF. With multiple samples per transect being collected, sufficient data will be available to conduct meaningful statistical analysis.
88	Appendix Q	Stream SAP	All	All	All	Will there be a comparison of chemical concentrations to conditions indicating possible environmental harm, for example water quality standards for receiving stream designated uses in each of the surface waters to be assessed? If so, are contaminant detection levels sufficient to indicate compliance with applicable water quality standards?	Concentrations of CCR in all surface water samples (upstream, adjacent, and downstream) will be compared to Tennessee Chapter 0400-40-03 General Water Quality Criteria; EPA National Ambient Water Quality Criteria for Protection of Freshwater Aquatic Life; supplemental proposed criteria for boron and selenium; and any other applicable standards or screening levels.

Appendix B – Table 1

Summary of TDEC Comments & TVA Responses

March 30, 2018

Comment Number	Section Number	Section Title	Page	Para-graph	Line	BRF EIP Rev. 1 TDEC Comments	TVA Response to BRF EIP Rev. 1 TDEC Comments
89	Appendix Q	Stream SAP	All	All	All	Total hardness (as CaCO3) and Total Suspended Solids should be added to the analyte list to allow determination of water quality standards for hardness-dependent metals. TSS is needed for conversion of total metals concentrations since the criteria are expressed as dissolved.	The Surface Stream SAP currently specifies that TSS will be added to the list of constituents for this program. Total hardness will be calculated based on sample analyses and constituent results and presented in the EAR.
90	Appendix Q	Stream SAP	All	All	All	What is the rationale for basing sample depths on the thermocline as opposed to set depths that are a proportion of the total depth at a site?	The thermocline procedure was included based on input during the EIP process. The rationale for basing sample depths on the thermocline, when present, is that when a water body is thermally stratified both the hydrology and chemical characteristics of the water can be significantly different in the epilimnion and hypolimnion, with resulting changes in geochemical and biochemical processes, and in biota. Several of TVA's power plants are located adjacent to areas of reservoirs that can thermally stratify. To accurately characterize water quality in those areas, it is important to design sampling programs that collect representative samples from the different parts of the water body that may be present (the epilimnion and hypolimnion), rather than assuming a well-mixed condition or semi-laminar flow condition that does not exist when thermal stratification is present. When the water body is not stratified, sampling from specified depths is appropriate.
91	Appendix Q	Stream SAP	All	All	All	In what seasons or months are the two sampling events going to be conducted and why?	Targeting spring/summer and fall/winter sampling, but providing allowing field team some flexibility for when these events would occur. Seasonal sampling will allow for capture of temperature and pool level differences.
92	Appendix Q	Stream SAP	All	All	All	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.
93	Appendix Q	Stream SAP	All	All	All	The language seems to be inconsistent in Section 5.2.4 where it's stated that 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?	Comment is acknowledged, and the corresponding changes have been made in the documents.
94	Appendix R	Fish tissue SAP	All	All	All	Why is no fish sampling being conducted in Worthington Branch?	Worthington Branch is a small, shallow tributary to the Clinch River that flows across the southern portion of BRF. TVA has conducted fish community surveys using reservoir fish assemblage index (RFAI) evaluation methods in the Clinch River upstream and downstream of the facility's thermal discharges in fulfilment of National Pollutant Discharge and Elimination System (NPDES) permit requirements. Worthington Branch is not a receiving stream for BRF permitted discharges. With regard to fish tissue sampling for the BRF EIP, 1) Worthington Branch is a small stream that does not support a fish community with trophic levels comparable to the Clinch River and Bull Run (where it joins the Clinch); and 2) Worthington Branch flows into the Clinch River adjacent to the facility within the boundaries of sampling site CRA River Miles 46.1 - 48.1.
95	Appendix R	Fish tissue SAP	All	All	All	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.

Appendix B – Table 1

Summary of TDEC Comments & TVA Responses

March 30, 2018

Comment Number	Section Number	Section Title	Page	Para-graph	Line	BRF EIP Rev. 1 TDEC Comments	TVA Response to BRF EIP Rev. 1 TDEC Comments
96	Appendix R	Fish tissue SAP	All	All	All	Some of the wording in Section 5.2.1.2 is a little confusing with respect to whether each of the five trophic groups will be collected as available from all sites. Is this the goal?	Historical reservoir fish community sampling indicates that members of the five trophic levels are expected to be present in the proposed sampling reaches of the Clinch River and Bull Run. While the intention is to collect individuals from each of the five trophic level species within each sampling reach, the availability of individuals of harvestable size will determine the composition of the samples.
97	Appendix R	Fish tissue SAP	All	All	All	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.
98	Appendix R	Fish tissue SAP	All	All	All	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 notable 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.

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Shari Meghreblian, Ph.D.
Commissioner

Bill Haslam
Governor

May 22, 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 Bull Run 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 Bull Run Coal Fired Fossil Power Plant (TVA BRF) on March 30, 2018. TDEC has completed its review of EIP Rev 2 and is providing comments listed in the attached **Table 1 TVA Bull Run 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 13, 2018**.

TDEC's goal is to work with TVA to ensure the environmental investigation of the TVA BRF 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 Bull Run EIP Rev 2
Summary of Comments

Comment Number	Section Number	Section Title	Page	Paragraph	Line	BRF EIP Rev. 1 TDEC Comments	TVA Response to BRF EIP Rev. 1 TDEC Comments	BRF EIP Rev 2 TDEC Comments
2	All	All	All	All	All	TVA shall either collect water samples for CCR analyses when it collects samples for NPDES monitoring or collect and analyze water samples from the NPDES discharge point quarterly	TVA shall continue to collect, test and report outfall samples in accordance with the conditions of the NPDES permit. TVA has included NPDES outfall sampling information, as well as detailed constituent information provided in its NPDES permit applications. NPDES compliance data previously submitted to TDEC will be included in the revised EIP as an appendix. If after reviewing the existing data, TDEC desires additional surface water data as part of the investigation, TDEC and TVA can jointly determine a path forward.	TVA will confirm that samples collected will be analyzed for all CCR parameters
6	General Comment	Surface Water, Benthic, and Fish SAPs	All	All	All	The Bull Run Environmental Investigation Plan states that data analysis will be done in the Environmental Assessment Report that will be prepared following the sampling outlined in the SAPs. However, some feel for expected data analysis is needed to know if sampling and sample sizes specified in the SAPs are appropriate for the intended data analysis and use. What types of statistical analyses will be done with the data, and what effects endpoints will the data be compared to in order to determine whether environmental harm has occurred due to contaminant concentrations present?	The choice of statistical methods will be appropriate to the analytical data (e.g. percent detected vs. non-detected values, underlying distribution of the data, and variability). Spatial trends will be evaluated visually and quantitatively if the data allow. Analysis of the results from the surface water, benthic, sediment, and fish sampling will be informed by the statistical methods used by Oak Ridge National Laboratory in the studies conducted following the Kingston ash release. Determination of potential harm to the aquatic/terrestrial ecosystem from the presence of CCR constituents from the facility will be based on multiple lines of potential evidence.	What specifically will be included in the Multiple Lines of Evidence to determine possible impacts to biota? Are toxicity data available for the CCR materials and expected receptors, will published EPA benchmarks be used, etc.? Some examples please.
14	3.1.1	TDEC General Information Request No. 1	10	2	All	Bedrock geology needs to be discussed for the fly ash stilling pond 2C and railroad loop disposal area.	Comment is acknowledged. TVA has developed an approach to characterize the hydrogeology around the Fly Ash Stilling Pond 2C and the Railroad Loop Disposal Area. The proposed activities include an investigation of bedrock near these units. After the initial phase of the investigation, a discussion of bedrock geology will be provided in the EAR.	The comment refers to the current EIP text which remains unchanged and only calls out the Bottom Ash Disposal Area, Gypsum Disposal Area and Main Ash Pond as being within the Conasauga Group (including Nolichucky Shale, the Maryville, Rogersville, and Rutledge Formations, Pumpkin Valley Shale) (text refers to it as the Conansauga Formation). The text shall be revised to indicate that the Conasauga Group also underlies the fly ash stilling pond 2C and railroad loop disposal area. Also on Exhibit 2 in order to provide clarity the geologic unit Ccl-should be referred to as the Conasauga Group (including Nolichucky Shale, the Maryville, Rogersville, and Rutledge Formations, Pumpkin Valley Shale).
17	3.1.1	TDEC General Information Request No. 1	11	2	All	On the northwest boundary of the dry fly ash Phase II and lateral expansion there is an indication in previous reports that there is the potential for solution enhanced joint sets (i.e., conduits) which cause a depression in the top of rock surface. This area of B-14R, B- 14 and B-14L also lie on a lineation oriented approximately N62W that has numerous sinkholes to the north of Edgemoor Road. TVA needs to fully characterize groundwater flow along joint sets and the potential for conduit flow. Pilot holes need to be added to sufficiently define this area.	TVA proposes to add two additional upgradient pilot holes along the northwest boundary of the Dry Fly Ash Stack Phase 2. These will be used to further investigate the hydrogeological conditions upgradient of the Dry Fly Ash Stack and help the understanding of groundwater flow in the DFAS area. As with the other proposed pilot holes, downhole geophysics will be used to investigate groundwater conditions and movement in the bedrock. If joint sets are observed, then TVA will evaluate whether the factures appear to show enlargement due to solution. TVA requests additional information on the mentioned sinkholes north of Edgemoor Road.	Using a single boring to target a fracture may not serve to clarify the bedrock profile in this area. TVA should determine if surface geophysical methods may provide the resolution necessary to locate fracture trends and or cutter/pinnacle bedrock morphology within the upper 50 feet of the subsurface in order to target test wells/piezometers. There have been numerous studies on the sinkholes throughout Anderson and Roane counties. Besides first hand knowledge of the area, a website has been created documenting the sinkholes. The address is https://tnlandforms.us/landforms/sinks.php
22	3.2	Dry Ash Stack – IDL011030080	17	All	All	Provide information regarding the potential for a preferential seepage pathway via the stream channel that was present prior to development of the dry ash stack along the northeastern edge of the Phase 1 stack as shown on historical drawing 10W293-1. Borings should be targeted to determine if more pervious stream deposits are present.	The Exploratory Drilling SAP and the associated EIP exhibit have been updated to include one additional proposed geotechnical boring, located along the historical alignment of the unnamed tributary of Worthington Branch within Phase 1 of the Dry Fly Ash Stack. There are also existing borings along/near the mapped tributary alignment (see Exhibit 4). Refer to the updated Exploratory Drilling SAP for additional details of the proposed boring. Data from the proposed and existing borings will provide additional information regarding the foundation soils within the historical alignment, support the 3-D model development, and the hydrogeologic understanding of this vicinity. Results will be presented in the EAR.	The location of B07 as shown on Exhibit 4 is acceptable where located and no doubt will enhance the cross section through the Dry Fly Ash Stack Phase 1. However, the boring does not answer TDEC's request. TVA needs to determine if more pervious stream deposits are present via the stream channel that was present prior to development of the dry ash stack along the northeastern edge of the Phase 1 stack as shown on historical drawing 10W293-1. Existing borings are in the vicinity but do not following or cross the channel.
23	3.2	Dry Ash Stack – IDL011030080	17	All	All	Provide information regarding the mitigation of the three sinkholes (i.e., topographic depressions) shown on historical drawing 10W293-1 on the south edge of Phase 1 and determine the potential that they are part of a solution enhanced joint set, bedding plane or other more significant karst area that may serve as a preferential seepage pathway.	The depressions shown on drawing 10W293-1 are not labeled sinkholes. TVA has not located documents that note the occurrence of sinkholes in the area of Phase 1. TVA requests additional information on the mentioned sinkholes.	Although not labeled sinkholes on historical drawing 10W293-1 they are closed depressions that lack drainage and do not have an alternative explanation. Within a karst terrane closed depressions can provide an important measure of karstification especially when in alignment with other topographic depressions in the area that can be seen on historical topographic maps and reported joint orientations. If TVA cannot provide mitigation details then potentially borings in the area and/or surface geophysical techniques may be required to answer the question.
24	3.2.1	TDEC Dry Ash Stack Information Request No. 1	17	3	1	On the northwest boundary of the dry fly ash Phase II and lateral expansion there is an indication in previous reports that there is the potential for solution enhanced joint sets (i.e., conduits) which caused a depression in the top of rock surface. The area is underlain by sub-unit B of the Chickamauga Formation which is a relatively pure (non-clastic) limestone and known to be karstic. At the site drilling has confirmed the presence of both open and clay filled solution cavities. This area of B-14R, B-14 and B-14L also lie on a lineation oriented approximately N62W that has numerous sinkholes to the north of Edgemoor Road. TVA needs to fully characterize groundwater flow along joint sets and evaluate the potential for conduit flow. Pilot holes need to be added along the northwest boundary to sufficiently characterize this area.	See response to comment 17.	Using a single boring to target a fracture may not serve to clarify the bedrock profile in this area. TVA should determine if surface geophysical methods may provide the resolution necessary to locate fracture trends and or cutter/pinnacle bedrock morphology within the upper 50 feet of the subsurface in order to target test wells/piezometers.
35	5	Environmental Assessment Report	Digital Page 84/1079	1	2 & 3	The EAR will address a list of task required by TDEC in response to TDEC's request during the period from the initial investigation conference through the completion of the EIP activities.	Comment is acknowledged.	The response in incomplete. There were no changes to this section between Revision 1 and Revision 2. TVA should be clear that all TDEC requests will be addressed in the EAR, not only the requests made during the Investigation Conference. TVA shall make the appropriate changes to the document to reflect this request.
39	Appendix E, Section 2.0	Hydrogeologic Investigation SAP	Digital Page 278/1079	1	3	The objective as stated in Section 2 of the Hydrogeologic Investigation SAP should include areas where ash has been managed or placed.	Comment is noted.	The response is incomplete. The objectives have been completely re-written and do not include previous objectives or the requested modification. TVA shall include the previous objectives and requested objectives in this section.
47	Appendix H	Stability SAP	Digital Page 453/1079	2	4	Summaries for existing geotechnical data should reference Appendix G.	Comment is acknowledged, and the corresponding change has been made in the document.	The response is incomplete. Due to additions/subtractions made to Revision 2, Appendix G is now the Water Use SAP. Please correct the reference to the correct Appendix.
54	Appendix L	Material Characteristics SAP	All	All	All	TVA will conduct a leachability characterization study that includes an evaluation of CCR parameters from pore water and solid material samples (totals and leachable) from locations that would characterize the vertical and lateral distribution of leachability characteristics across the facility. This will include the Rail Road Loop Disposal Area	See response to Comment 32 for active, unclosed units. For inactive and/or closed units, the existing groundwater monitoring well network or groundwater wells installed as part of the EIP will monitor the groundwater for CCR constituent contamination. The monitoring protocols will be relied on for the detection, assessment of, and corrective action for any identified CCR parameters identified in the groundwater, and for use in developing any necessary corrective actions.	TVA has not adequately responded to the comment. TVA shall propose the requested study in active and inactive units. TVA has agreed to conduct an environmental investigation at the TVA BRF 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.

TVA Bull Run EIP Rev 2
Summary of Comments

Comment Number	Section Number	Section Title	Page	Paragraph	Line	BRF EIP Rev. 1 TDEC Comments	TVA Response to BRF EIP Rev. 1 TDEC Comments	BRF EIP Rev 2 TDEC Comments
77	Appendix P	Benthic SAP	All	All	All	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.	Please further explain how purging gut contents informs evaluation of possible bioaccumulation. Specifically, TDEC is concerned that it may underestimate by artificially removing contaminants from mayflies prior to analysis.
78	Appendix P	Benthic SAP	All	All	All	What is the purpose of assessing tissue metals concentrations on non-depurated mayfly nymphs?	Non-depurated mayfly nymphs are a source of potential exposure to organisms (fish, larger macroinvertebrates) that consume the nymphs. The organisms that feed on mayfly nymphs ingest nymph tissues and gut contents containing sediment. Including the gut contents provides a short-term window into the chemical contents of what the mayfly has recently ingested, which may or may not be absorbed into the organism upon digestion.	See response for 77.

Appendix B – Table 1

Summary of TDEC Comments & TVA Responses

July 13, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	BRF EIP Rev. 1 TDEC Comments	TVA Response to BRF EIP Rev. 1 TDEC Comments	BRF EIP Rev. 2 TDEC Comments	TVA Response to BRF EIP Rev. 2 TDEC Comments
2	All	All	All	All	All	TVA shall either collect water samples for CCR analyses when it collects samples for NPDES monitoring or collect and analyze water samples from the NPDES discharge point quarterly.	TVA shall continue to collect, test and report outfall samples in accordance with the conditions of the NPDES permit. TVA has included NPDES outfall sampling information, as well as detailed constituent information provided in its NPDES permit applications. NPDES compliance data previously submitted to TDEC will be included in the revised EIP as an appendix. If after reviewing the existing data, TDEC desires additional surface water data as part of the investigation, TDEC and TVA can jointly determine a path forward.	TVA will confirm that samples collected will be analyzed for all CCR parameters.	TVA will collect and analyze effluent water samples from the Fly Ash Stilling Pond 2C discharge point (i.e., Outfall 001) in conjunction with surface stream sampling events during the course of the Environmental Investigation.
6	General Comment	Surface Water, Benthic, and Fish SAPs	All	All	All	The Bull Run Environmental Investigation Plan states that data analysis will be done in the Environmental Assessment Report that will be prepared following the sampling outlined in the SAPs. However, some feel for expected data analysis is needed to know if sampling and sample sizes specified in the SAPs are appropriate for the intended data analysis and use. What types of statistical analyses will be done with the data, and what effects endpoints will the data be compared to in order to determine whether environmental harm has occurred due to contaminant concentrations present?	The choice of statistical methods will be appropriate to the analytical data (e.g. percent detected vs. non-detected values, underlying distribution of the data, and variability). Spatial trends will be evaluated visually and quantitatively if the data allow. Analysis of the results from the surface water, benthic, sediment, and fish sampling will be informed by the statistical methods used by Oak Ridge National Laboratory in the studies conducted following the Kingston ash release. Determination of potential harm to the aquatic/terrestrial ecosystem from the presence of CCR constituents from the facility will be based on multiple lines of potential evidence.	What specifically will be included in the Multiple Lines of Evidence to determine possible impacts to biota? Are toxicity data available for the CCR materials and expected receptors, will published EPA benchmarks be used, etc.? Some examples please.	Multiple lines of evidence to determine possible impacts of CCR on ecological receptors will include: Community structure and population measured as Reservoir Benthic Macroinvertebrate Community Index, and Reservoir Fish Community Assemblage; to determine differences (if any) downstream, adjacent to, and upstream of BRF. Variability in community index scores will be informed by historical biological monitoring conducted by TVA. Comparison of levels of CCR in biological tissues to findings from other studies, including but not limited to follow-up studies from Kingston, a State of Tennessee study on metals concentrations in fish from coal mining areas, and USEPA studies. Comparison of CCR levels in biological tissues, sediment, and surface water to EPA Region 4 ecological screening levels and EPA water quality criteria for protection of aquatic life. Other publicly available toxicity studies and bioassays may inform interpretation of the analytical results from the BRF EI.
14	3.1.1	TDEC General Information Request No. 1	10	2	All	Bedrock geology needs to be discussed for the fly ash stilling pond 2C and railroad loop disposal area.	Comment is acknowledged. TVA has developed an approach to characterize the hydrogeology around the Fly Ash Stilling Pond 2C and the Railroad Loop Disposal Area. The proposed activities include an investigation of bedrock near these units. After the initial phase of the investigation, a discussion of bedrock geology will be provided in the EAR.	The comment refers to the current EIP text which remains unchanged and only calls out the Bottom Ash Disposal Area, Gypsum Disposal Area and Main Ash Pond as being within the Conasauga Group (including Nolichucky Shale, the Maryville, Rogersville, and Rutledge Formations, Pumpkin Valley Shale) (text refers to it as the Conasauga Formation). The text shall be revised to indicate that the Conasauga Group also underlies the fly ash stilling pond 2C and railroad loop disposal area. Also on Exhibit 2 in order to provide clarity the geologic unit Ccl-should be referred to as the Conasauga Group (including Nolichucky Shale, the Maryville, Rogersville, and Rutledge Formations, Pumpkin Valley Shale).	Comment is acknowledged, and the corresponding change has been made in the document.

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July 13, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	BRF EIP Rev. 1 TDEC Comments	TVA Response to BRF EIP Rev. 1 TDEC Comments	BRF EIP Rev. 2 TDEC Comments	TVA Response to BRF EIP Rev. 2 TDEC Comments
17	3.1.1	TDEC General Information Request No. 1	11	2	All	On the northwest boundary of the dry fly ash Phase II and lateral expansion there is an indication in previous reports that there is the potential for solution enhanced joint sets (i.e., conduits) which cause a depression in the top of rock surface. This area of B-14R, B- 14 and B-14L also lie on a lineation oriented approximately N62W that has numerous sinkholes to the north of Edgemoor Road. TVA needs to fully characterize groundwater flow along joint sets and the potential for conduit flow. Pilot holes need to be added to sufficiently define this area.	TVA proposes to add two additional upgradient pilot holes along the northwest boundary of the Dry Fly Ash Stack Phase 2. These will be used to further investigate the hydrogeological conditions upgradient of the Dry Fly Ash Stack and help the understanding of groundwater flow in the DFAS area. As with the other proposed pilot holes, downhole geophysics will be used to investigate groundwater conditions and movement in the bedrock. If joint sets are observed, then TVA will evaluate whether the factures appear to show enlargement due to solution. TVA requests additional information on the mentioned sinkholes north of Edgemoor Road.	Using a single boring to target a fracture may not serve to clarify the bedrock profile in this area. TVA should determine if surface geophysical methods may provide the resolution necessary to locate fracture trends and or cutter/pinnacle bedrock morphology within the upper 50 feet of the subsurface in order to target test wells/piezometers. There have been numerous studies on the sinkholes throughout Anderson and Roane counties. Besides first hand knowledge of the area, a website has been created documenting the sinkholes. The address is https://tnlandforms.us/landforms/sinks.php	Logs and cores from borings around the Dry Fly Ash Stack describe the rock as moderately to slightly fractured with very close to close joints. Surface geophysics would not be expected to have the resolution to identify such closely spaced fractures. The proposed downhole geophysics do have the resolution to identify individual fractures with flowing groundwater. However, previous investigations have indicated that the bedrock surface near the plant is variable. To investigate the potential for cutters and pinnacles, TVA proposes to use electrical resistivity imaging to investigate potential preferential groundwater flow paths prior to locating the two proposed pilot borings. TVA reviewed drawing 10W293-1, information on the link provided by TDEC, aerial photographs, topographic maps and reports from previous investigations. The depressions noted on the drawing are shallow, in the range of 2 to 4 feet deep. No sinkholes are shown on topographic maps or discussed in reports for the original geological investigations for the plant or more recent hydrogeological reports. The report "Hydrogeologic Evaluation of Expanded Dry Fly Ash Disposal Area (TVA, 2006) prepared for the DFAS expansion stated that no sinkholes existed in the pre-plant surface topography. This was attributed to the relatively small dimensions of cavities identified during drilling. A review of information on the link provided by TDEC indicated that no sinkholes are identified at the plant or under the DFAS. In addition, a review of an aerial photograph from 1956 shows that the locations of the depressions had been developed with a building. An area near the location of two of the depressions appears to have been disturbed. Therefore, TVA has not found evidence of sinkholes, but has found an alternative explanation for the depressions. Because the area of the shallow depressions had been disturbed prior to development of the DFAS and an aerial photograph shows indications of ground disturbance, it appears that the depressions were caused by previous uses of the property.
22	3.2	Dry Ash Stack – IDL011030080	17	All	All	Provide information regarding the potential for a preferential seepage pathway via the stream channel that was present prior to development of the dry ash stack along the northeastern edge of the Phase 1 stack as shown on historical drawing 10W293-1. Borings should be targeted to determine if more pervious stream deposits are present.	The Exploratory Drilling SAP and the associated EIP exhibit have been updated to include one additional proposed geotechnical boring, located along the historical alignment of the unnamed tributary of Worthington Branch within Phase 1 of the Dry Fly Ash Stack. There are also existing borings along/near the mapped tributary alignment (see Exhibit 4). Refer to the updated Exploratory Drilling SAP for additional details of the proposed boring.	The location of B07 as shown on Exhibit 4 is acceptable where located and no doubt will enhance the cross section through the Dry Fly Ash Stack Phase 1. However, the boring does not answer TDEC's request. TVA needs to determine if more pervious stream deposits are present via the stream channel that was present prior to development of the dry ash stack along the northeastern edge of the Phase 1 stack as shown	The Exploratory Drilling SAP has been updated to add groups of closely spaced CPT soundings where the pre-construction stream channel is shown to cross the perimeter of the Dry Fly Ash Stack. This approach is consistent with other plants to evaluate the same topic. Due to boring B07 not answering TDEC's original request and the addition of the CPT's, B07 is no

Appendix B – Table 1

Summary of TDEC Comments & TVA Responses

July 13, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	BRF EIP Rev. 1 TDEC Comments	TVA Response to BRF EIP Rev. 1 TDEC Comments	BRF EIP Rev. 2 TDEC Comments	TVA Response to BRF EIP Rev. 2 TDEC Comments
							Data from the proposed and existing borings will provide additional information regarding the foundation soils within the historical alignment, support the 3-D model development, and the hydrogeologic understanding of this vicinity. Results will be presented in the EAR.	on historical drawing 10W293-1. Existing borings are in the vicinity but do not following or cross the channel.	longer proposed within the Exploratory Drilling SAP. Sufficient historical data is available in this vicinity to support other various EIP objectives, including cross section development.
23	3.2	Dry Ash Stack – IDL011030080	17	All	All	Provide information regarding the mitigation of the three sinkholes (i.e., topographic depressions) shown on historical drawing 10W293-1 on the south edge of Phase 1 and determine the potential that they are part of a solution enhanced joint set, bedding plane or other more significant karst area that may serve as a preferential seepage pathway.	The depressions shown on drawing 10W293-1 are not labeled sinkholes. TVA has not located documents that note the occurrence of sinkholes in the area of Phase 1. TVA requests additional information on the mentioned sinkholes.	Although not labeled sinkholes on historical drawing 10W293-1 they are closed depressions that lack drainage and do not have an alternative explanation. Within a karst terrane closed depressions can provide an important measure of karstification especially when in alignment with other topographic depressions in the area that can be seen on historical topographic maps and reported joint orientations. If TVA cannot provide mitigation details then potentially borings in the area and/or surface geophysical techniques may be required to answer the question.	TVA reviewed drawing 10W293-1, information on the link provided by TDEC, aerial photographs, topographic maps and reports from previous investigations. The depressions noted on the drawing are shallow, in the range of 2 to 4 feet deep. No sinkholes are shown on topographic maps or discussed in reports for the original geological investigations for the plant or more recent hydrogeological reports. The report "Hydrogeologic Evaluation of Expanded Dry Fly Ash Disposal Area (TVA, 2006) prepared for the DFAS expansion stated that no sinkholes existed in the pre-plant surface topography. This was attributed to the relatively small dimensions of cavities identified during drilling. A review of information on the link provided by TDEC indicated that no sinkholes are identified at the plant or under the DFAS. In addition, a review of an aerial photograph from 1956 shows that the locations of the depressions had been developed with a building. An area near the location of two of the depressions appears to have been disturbed. Therefore, TVA has not found evidence of sinkholes, but has found an alternative explanation for the depressions. Because the area of the shallow depressions had been disturbed prior to development of the DFAS and an aerial photograph shows indications of ground disturbance, it appears that the depressions were caused by previous uses of the property.
24	3.2.1	TDEC Dry Ash Stack Information Request No. 1	17	3	1	On the northwest boundary of the dry fly ash Phase II and lateral expansion there is an indication in previous reports that there is the potential for solution enhanced joint sets (i.e., conduits) which caused a depression in the top of rock surface. The area is underlain by sub-unit B of the Chickamauga Formation which is a relatively pure (non-clastic) limestone and known to be karstic. At the site drilling has confirmed the presence of both open and clay filled solution cavities. This area of B-14R, B-14 and B-14L also lie on a lineation oriented approximately N62W that has numerous sinkholes to the north of Edgemoor	See response to comment 17.	Using a single boring to target a fracture may not serve to clarify the bedrock profile in this area. TVA should determine if surface geophysical methods may provide the resolution necessary to locate fracture trends and or cutter/pinnacle bedrock morphology within the upper 50 feet of the subsurface in order to target test wells/piezometers.	Logs and cores from borings around the Dry Fly Ash Stack describe the rock as moderately to slightly fractured with very close to close joints. Surface geophysics would not be expected to have the resolution to identify such closely spaced fractures. The proposed downhole geophysics do have the resolution to identify individual fractures with flowing groundwater. However, previous investigations have indicated that the bedrock surface near the plant is variable. To investigate the potential for cutters and pinnacles, TVA proposes to use electrical resistivity imaging to investigate potential

Appendix B – Table 1

Summary of TDEC Comments & TVA Responses

July 13, 2018

Comment Number	Section Number	Section Title	Page	Paragraph	Line	BRF EIP Rev. 1 TDEC Comments	TVA Response to BRF EIP Rev. 1 TDEC Comments	BRF EIP Rev. 2 TDEC Comments	TVA Response to BRF EIP Rev. 2 TDEC Comments
						Road. TVA needs to fully characterize groundwater flow along joint sets and evaluate the potential for conduit flow. Pilot holes need to be added along the northwest boundary to sufficiently characterize this area.			preferential groundwater flow paths prior to locating the two proposed pilot borings.
35	5	Environmental Assessment Report	Digital Page 84/1079	1	2 & 3	The EAR will address a list of task required by TDEC in response to TDEC's request during the period from the initial investigation conference through the completion of the EIP activities.	Comment is acknowledged.	The response in incomplete. There were no changes to this section between Revision 1 and Revision 2. TVA should be clear that all TDEC requests will be addressed in the EAR, not only the requests made during the Investigation Conference. TVA shall make the appropriate changes to the document to reflect this request.	Comment is acknowledged, and the corresponding change has been made in the document.
39	Appendix E, Section 2.0	Hydrogeologic Investigation SAP	Digital Page 278/ 1079	1	3	The objective as stated in Section 2 of the Hydrogeologic Investigation SAP should include areas where ash has been managed or placed.	Comment is noted.	The response is incomplete. The objectives have been completely re-written and do not include previous objectives or the requested modification. TVA shall include the previous objectives and requested objectives in this section.	Comment is acknowledged, and changes have been made in the Hydrogeologic Investigation SAP which is bow Appendix F.
47	Appendix H	Stability SAP	Digital Page 453/ 1079	2	4	Summaries for existing geotechnical data should reference Appendix G.	Comment is acknowledged, and the corresponding change has been made in the document.	The response is incomplete. Due to additions/subtractions made to Revision 2, Appendix G is now the Water Use SAP. Please correct the reference to the correct Appendix.	Comment is acknowledged, and the corresponding change has been made in the document.
54	Appendix L	Material Characteristics SAP	All	All	All	TVA will conduct a leachability characterization study that includes an evaluation of CCR parameters from pore water and solid material samples (totals and leachable) from locations that would characterize the vertical and lateral distribution of leachability characteristics across the facility. This will include the Rail Road Loop Disposal Area	See response to Comment 32 for active, unclosed units. For inactive and/or closed units, the existing groundwater monitoring well network or groundwater wells installed as part of the EIP will monitor the groundwater for CCR constituent contamination. The monitoring protocols will be relied on for the detection, assessment of, and corrective action for any identified CCR parameters identified in the groundwater, and for use in developing any necessary corrective actions.	TVA has not adequately responded to the comment. TVA shall propose the requested study in active and inactive units. TVA has agreed to conduct an environmental investigation at the TVA BRF 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 Exploratory Drilling SAP has been updated to add several temporary wells in the Dry Fly Ash Stack Phases 1 and 2, as well as in the Railroad Loop Disposal Area. The borings for the temporary wells allow for collection of CCR samples and the temporary wells allow for pore water sampling in accordance with the CCR Material Characteristics SAP. The corresponding changes have been made in the document.
77	Appendix P	Benthic SAP	All	All	All	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.	Please further explain how purging gut contents informs evaluation of possible bioaccumulation. Specifically, TDEC is concerned that it may underestimate by artificially removing contaminants from mayflies prior to analysis.	Analyzing both depurated and non-depurated mayflies will allow for direct comparison of results for both. As stated previously, purging the gut contents prior to laboratory analysis will assist in evaluating potential bioaccumulation of CCR metals in mayfly nymph tissues in the absence of metals in the gut contents (which may or may not actually bioaccumulate in the mayfly tissues). Conversely, analysis of non-depurated mayflies will assist in evaluating whether depuration artificially removes contaminants included in the mayfly gut contents that are being ingested by organisms

Comment Number	Section Number	Section Title	Page	Paragraph	Line	BRF EIP Rev. 1 TDEC Comments	TVA Response to BRF EIP Rev. 1 TDEC Comments	BRF EIP Rev. 2 TDEC Comments	TVA Response to BRF EIP Rev. 2 TDEC Comments
							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.		that feed on the mayflies (regardless of whether they actually bioaccumulate in the mayfly tissues). During the transformation from nymph to adult the mayfly gut is emptied and becomes filled with air to increase buoyancy as the adults take to the wing and mate. Mayfly adults do not have mouth parts or functional guts. Thus predators that feed on adult mayflies consume whatever CCR constituents were absorbed into the future adult tissues during the nymphal stage. Analytical results from depurated mayfly nymphs will be directly compared to analytical results for adult mayflies collected in the same area.
78	Appendix P	Benthic SAP	All	All	All	What is the purpose of assessing tissue metals concentrations on non-depurated mayfly nymphs?	Non-depurated mayfly nymphs are a source of potential exposure to organisms (fish, larger macroinvertebrates) that consume the nymphs. The organisms that feed on mayfly nymphs ingest nymph tissues and gut contents containing sediment. Including the gut contents provides a short-term window into the chemical contents of what the mayfly has recently ingested, which may or may not be absorbed into the organism upon digestion.	See response for 77.	See response for 77.

Robert Wilkinson, P.G., CHMM CCR Technical Manager
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Office: (615) 253-0689
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Shari Meghreblian, Ph.D.
Commissioner

Bill Haslam
Governor

August 6, 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 Bull Run Coal Fired Fossil Fuel Plant
Environmental Investigation Plan Revision 3

Dear Ms. Smelley:

Tennessee Valley Authority (TVA) submitted the Environmental Investigation Plan (EIP) Revision 3 for the TVA Bull Run Coal Fired Fossil Power Plant (TVA BRF) on July 13, 2018. The Tennessee Department of Environment and Conservation (TDEC) has completed its review of the submittal and found it to be acceptable.

TDEC added an additional opportunity for public involvement in a letter dated September 28, 2015 from TDEC to the Southern Alliance for Clean Energy (SACE). TDEC intends to schedule an All Interested Parties (AIP) meeting to discuss the TVA BRF EIP Revision 3 within 30 days of this letter. Copies of TVA BRF EIP Revision 3 will be provided to attendees of the AIP meeting prior to the meeting date.

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
Jennifer Dodd
Tisha Calabrese Benton
Caleb Nelson
Britton Dotson
Rob Burnette
Angela Adams
James Clark
Joseph E. Sanders
Bryan Wells
Pat Flood
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Shawn Rudder

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Shari Meghreblian, Ph.D.
Commissioner

Bill Haslam
Governor

August 6, 2018

Amanda Garcia
Southern Environmental Law Center
1033 Demonbreun St, Ste. 205
Nashville, TN 37203

RE: TDEC Commissioner's Order OGC 15-1077
TVA Bull Run Coal Fired Fossil Fuel Plant
All Interested Parties Meeting

Dear Ms. Garcia:

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 requires TVA to perform environmental investigations and to take appropriate corrective action at seven TVA Coal Fossil Power Plants in Tennessee. The Order is specific to Coal Combustion Residual (CCR) material.

On July 13, 2018, TVA submitted the Environmental Investigation Plan (EIP) Revision 3 for the TVA Bull Run Coal Fired Fossil Power Plant (TVA BRF) located near Claxton, TN. TDEC has completed its review of the submittal and found it to be acceptable.

In a letter dated September 28, 2015 from TDEC to the Southern Alliance for Clean Energy (SACE), TDEC added an additional opportunity for public involvement prior to the public notice and comment period stipulated in Section 7 of the Order.

TDEC will hold an All Interested Parties (AIP) meeting to discuss the TVA BRF EIP Revision 3 on September 5, 2018, 2:00 PM EST at the TDEC Oak Ridge Environmental Field Office located at 761 Emory Valley Road, Oak Ridge, TN 37830.

If your organization will be attending the AIP meeting, please respond no later than August 29, 2018. TDEC requests that each organization limit attendees to three personnel. Please provide at least one

valid email address, if you have not already done so, to allow for file sharing of a digital copy of the TVA BRF EIP Revision 3 to review prior to the AIP meeting.

TDEC appreciates your continued interest in this issue and looks forward to meeting with you. 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
TDEC CCR Technical Program Manager

CC:	Shari Meghreblian	Chuck Head	James Clark
	Tisha Calabrese-Benton	Jennifer Dodd	Pat Flood
	Brooke Barrett	Britton Dotson	Rob Burnette
	Jenny Howard	Angela Adams	Joseph E. Sanders
	Bryan Wells	Susan Smelley	Shawn Rudder

BRF Background Soil Borings/ Exploratory Drilling

Location ID	Reason for location Change	Technical Driver	Actions Taken
BRF-BG-05	Ash located in core - no sample collected	To meet a spatial distribution of BGS locations	Relocated boring to include multiple alternates along the edge of Clayton park outside of the beneficial reuse areas
BRF-BG-06	Shallow refusal and backfill in core - no sample collected	To meet a spatial distribution of BGS locations	Relocated boring to include multiple alternates near the Clinch River
BRF-BG-08 through BRF-BG-12	Access to date has been challenging. Area is gated. Vegetation is extremely high and dense. Difficult to navigate or see the surface.	To meet a spatial distribution of BGS locations	Remove locations due to adequate sample quantities
BRF-BG-13	Ash located in core - no sample collected	To meet a spatial distribution of BGS locations	Relocated boring to include multiple alternates near the original location
CPT19 through CPT25	Based on site walkdown, alignment of CPTs is on a slope and would not safely allow CPT rig access.	No change to technical objectives. Advance to top of bedrock and evaluate subsurface conditions in vicinity of historical stream channel.	Shift alignment of CPTs roughly 10 feet south, onto edge of perimeter road. Access will be easier and safer for CPT rig.
CPT54 through CPT74	Based on site walkdown, alignment of CPTs is on a slope and would not safely allow CPT rig access.	No change to technical objectives. Advance to top of bedrock and evaluate subsurface conditions in vicinity of historical stream channel.	Shift alignment of CPTs roughly 10 feet southeast, onto edge of perimeter road. Access will be easier and safer for CPT rig.
CPT75 through CPT81	Based on site walkdown, alignment of CPTs is on a slope and would not safely allow CPT rig access.	No change to technical objectives. Advance to top of bedrock and evaluate subsurface conditions in vicinity of historical stream channel.	Shift alignment of CPTs roughly 5 feet north, onto edge of perimeter road. Access will be easier and safer for CPT rig.
CPT82 through CPT88	Based on site walkdown, alignment of CPTs is on a slope and would not safely allow CPT rig access.	No change to technical objectives. Advance to top of bedrock and evaluate subsurface conditions in vicinity of historical stream channel.	Shift alignment of CPTs roughly 5 feet southwest, onto edge of perimeter road. Access will be easier and safer for CPT rig.
TW03	Based on site walkdown and discussions with BRF construction management staff, original proposed location was in conflict with ongoing construction activities. Drilling in this location would present additional hazards for personnel, and the temporary well would be at increased risk of damage after installation.	No change to technical objectives. Allow installation of temporary well and improve spatial coverage for CCR thickness, water levels, foundation soil type and thickness, top of bedrock elevations, and shallow bedrock characterization for the Main Ash Pond. The temporary well will allow water level readings and pore water sampling in the sluiced ash. Top of hole elevation is comparable to original location. Based on preconstruction contour map, new proposed location is expected to have similar CCR thickness as original location.	Shift location of TW03 alignment roughly 150 feet southeast, towards perimeter of CCR fill. Location will still accomplish technical objectives, while avoiding conflicts and hazards of ongoing construction.

Figure No.

1

Title

Proposed Soil Sampling Locations

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by TKR on 2018-12-12
Technical Review by TG on 2018-12-12

0 700 1,400 2,100 2,800 Feet

1:8,400 (At original document size of 22x34)

Legend

- Alternate Proposed Background Soil Sample Location
- Final Background Soil Sample Location
- Original Proposed Background Soil Sample Location (Revised Location)
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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TVA

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Figure No.

1A

Title

Proposed Background Soil Sample Locations – Dry Fly Ash Stack Area

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by LMB on 2018-12-12
Technical Review by TG on 2018-12-12

0 400 800 1,200 1,600 Feet

1:4,800 (At original document size of 22x34)

Legend

- Alternate Proposed Background Soil Sample Location
- Final Background Soil Sample Location
- Original Proposed Background Soil Sample Location (Revised Location)
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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Figure No.

1B

Title

Proposed Background Soil Sample Locations – Railroad Loop Area

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by LMB on 2018-12-12
Technical Review by TG on 2018-12-12

0 150 300 450 600 Feet

1:1,800 (At original document size of 22x34)

Legend

- Alternate Proposed Background Soil Sample Location
- Final Background Soil Sample Location
- Original Proposed Background Soil Sample Location (Revised Location)
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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Figure No.

1C

Title

Proposed Background Soil Sample Locations – Haw Ridge Area

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346
Prepared by LMB on 2018-12-12
Technical Review by TG on 2018-12-12

0 150 300 450 600 Feet

1:1,800 (At original document size of 22x34)

Legend

- Original Proposed Background Soil Sample Location (Revised Location)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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Figure No.

1

Title

Proposed Geotechnical Borings
Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Fly Ash Stilling Pond 2C & Main Ash Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175568274
Prepared by TKR on 2018-12-07
Technical Review by TG on 2018-12-07

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Proposed Geotechnical Boring
- Proposed Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, and Geotechnical Data) (Screened Interval)
- Original Proposed Boring with Temporary Well (Revised)
- Relocated Proposed Boring with Temporary Well
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

Stantec

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Figure No.

18

Title

Proposed Geotechnical Borings
Dry Fly Ash Stack

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175568274

Prepared by TKR on 2018-11-26
Technical Review by TG on 2018-11-26

0 150 300 450 600 Feet

1:1,800 (At original document size of 22x34)

Legend

- Proposed Cone Penetration Test
- Original Proposed Cone Penetration Test (Revised)
- Relocated Proposed Cone Penetration Test
- Proposed Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, and Geotechnical Data) (Screened Interval)
- Existing Boring
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Historical TVA Drawing 10W293-1 R2 (1993) is shown.
4. CPT borings on 5 feet spacing along historical unnamed tributary alignment.

Stantec

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Figure No.

1

Title

Proposed Cone Penetration Testing - Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Fly Ash Stilling Pond 2C, and Main Ash Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175568274

Prepared by TKR on 2018-11-27
Technical Review by TG on 2018-11-27

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Proposed Cone Penetration Test
- Original Proposed Cone Penetration Test (Revised)
- Relocated Proposed Cone Penetration Test
- Historic Creek Alignment
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Historical TVA Drawing 10N213-14 (1977) is shown.
4. CPT borings on 20 feet spacing at historical Bull Run Creek alignment.
5. CPT borings on 5 feet spacing at historical Worthington Branch alignment.

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Summary of Proposed Updates to BRF EIP Rev 4 Final
General Comments

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response	Proposed Update to BRF 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

Summary of Proposed Updates to BRF 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 BRF EIP Rev 4 Final
1	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
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-0.5.80.50 Soil and Sediment Sampling. Currently referenced TI-08.80.50, should be TI-05.80.50
3	All	NA	NA	SAP 5.2 and 5.2.4	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
4	All	NA	NA	SAP Section 5.1	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"
5	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 BRF EIP Rev 4 Final
CCR Material Characteristics SAP

Item No.	Plant	Date	TDEC Comment	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response/SAP Edit	Proposed Update to BRF 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	All	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	All	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	All	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 BRF 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 BRF 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 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 BRF 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 BRF 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 BRF EIP Rev 4 Final
Seep SAP

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response/SAP Edit	Proposed Update to BRF 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."
3	All	December 3, 2018	NA	General Administrative	Table 5 footnote				NA	NA	Revise "groundwater" to "water" in the Table 5 footnote.
4	All	December 3, 2018	NA	General Administrative	Seep SAP				NA	NA	Revise Table 5 to include the parameter list provided in Table 5 of the KIF and CUF Seep SAPs

Summary of Proposed Updates to CUF EIP Rev 3 Final
Water Use Survey SAP

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response/SAP Edit	Proposed Update to BRF 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 BRF 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 BRF EIP Rev 4 Final
1	All	September 6, 2018	TVA Comment	Section 4.1	Benthic SAP				NA	NA	Per TVA September 2018 email request, designating left and right banks as looking downstream.
2	All	September 6, 2018	TVA Comment	Section 5.2.1.1	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.
3	All	November 7, 2018	TVA Comment	Section 5.2.1.1	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 independant events.
4	All	November 16, 2018	NA	Table 8	Benthic SAP				NA	NA	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 BRF 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 BRF EIP Rev 4 Final
1	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.
2	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.
3	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.
4	ALF	October 3, 2017	59	SS SAP Section 5.2.4	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.	This change has been incorporated into the SAP at Section 5.2.4
5	JOF	October 19, 2017	146	SS SAP Section 5.2.4	All	All	All	All	TDEC recommends 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.	This change has been incorporated into the SAP at Section 5.2.4. Nitric acid may damage water quality sampling equipment. Wiping the sensors, housing, and cable between samples should prevent any cross contamination.
6	BRF	December 13, 2018	NA	SS SAP Section 5.2.4	Collection of Samples	19	3	2-3	NA	NA	Added section to describe sampling within Bull Run and Worthington Branch. Bull Run will be sampled consistently with other perennial surface streams; however, due to the intermittent conditions and limited flow volumes in Worthington Branch, water samples will only be taken mid-column along each transect.
7	BRF	December 13, 2018	NA	SS SAP Section 5.2.4	Assumptions and Limitations	30	3	3-5	NA	NA	Time of year may affect benthic sampling, and if surface stream sampling is conducted concurrently, the statement, "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" applies. If sampling of Benthic and SS are conducted separately, time of year does not apply to water sampling. Caveat added.

Summary of Proposed Updates to CUF EIP Rev 3 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 BRF EIP Rev 4 Final
1	CUF	March 20, 2018	NA	5.2.4	Collection of Samples				NA	TVA/Stantec SAP change	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 fo each other.
2	CUF	April 1, 2018	TVA Comment	5.2.2.3	Chain of Custody Forms	10	1	4	NA	TVA/Stantec SAP change	Delete the sentence "The Investigation Project Manager will staff the project with a field sample manager during sample collection activities." due to change of sampling to be completed by TVA biologists instead of a consultant.
3	All	NA	NA	EIP Section 4.5.7	TDEC Surface Water Impacts Request No. 7	52	3	1	NA	TVA/Stantec SAP change	Update EIP to reflect addition of new biological monitoring reports from TVA and intent to discuss those studies in the EAR

Master Log of Changes to BRF EIP
Quality Assurance Project Plan Revision 2

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response	Proposed Update to BRF EIP Rev 3 Final
1	BRF	NA	NA	2.2.4	Analytical Laboratories	6	Table 2-1	NA	NA	NA	Change PM for both TestAmerica Facilities to Gail Lage
2	BRF	NA	NA	2.2.4	Analytical Laboratories	6	Table 2-1	NA	NA	NA	Update primary TestAmerica facility to Nashville, TN and identify Pittsburgh and St. Louis as support facilities
3	BRF	NA	NA	11.2	Field and Laboratory Quality Control Samples	28	Table 11-1	NA	NA	NA	Clarify field blank frequency to "1 per day of sampling activity per sampling team"
4	BRF	NA	NA	19.1	Precision	49	3	NA	NA	NA	Add language defining RER equation
5	BRF	NA	NA	Attachment D	Table A: TVA - TDEC Order Sample Naming Conventions - Bull Run Fossil Plant	D-2, D-3	NA	NA	NA	NA	Update nomenclature coding for background soil and surface stream investigations.
6	BRF	NA	NA	Attachment E	Investigation-Specific Quality Control Requirements – Background Soil Sampling	E-2	Table E-1	NA	NA	NA	Update container type to 16-oz glass for radiological parameters
7	BRF	NA	NA	Attachment E	Investigation-Specific Quality Control Requirements – Background Soil Sampling	E-2	Table E-1	NA	NA	NA	Remove thermal preservation required for radiological parameters
8	BRF	NA	NA	Attachment E	Investigation-Specific Quality Control Requirements – Background Soil Sampling	E-3	Table E-2	NA	NA	NA	Update RLs to match current laboratory reporting limits
9	BRF	NA	NA	Attachment E	Investigation-Specific Quality Control Requirements – Background Soil Sampling	E-5	Table E-3	NA	NA	NA	Remove surrogate requirement for radiological parameters in solid matrices.
10	BRF	NA	NA	Attachment F	Investigation-Specific Quality Control Requirements – Groundwater	F-2	Table F-1	NA	NA	NA	Remove thermal preservation required for radiological parameters
11	BRF	NA	NA	Attachment F	Investigation-Specific Quality Control Requirements – Groundwater	F-3	Table F-2	NA	NA	NA	Update RLs to match current laboratory reporting limits
12	BRF	NA	NA	Attachment G	Investigation-Specific Quality Control Requirements – Surface Stream	G-2	Table G-1	NA	NA	NA	Remove thermal preservation required for radiological parameters
13	BRF	NA	NA	Attachment G	Investigation-Specific Quality Control Requirements – Surface Stream	G-3	Table G-2	NA	NA	NA	Update RLs to match current laboratory reporting limits

Master Log of Changes to BRF EIP
Quality Assurance Project Plan Revision 2

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response	Proposed Update to BRF EIP Rev 3 Final
14	BRF	NA	NA	Attachment H	Investigation-Specific Quality Control Requirements – Benthic Sampling	H-2	Table H-1	NA	NA	NA	Add requirement for sediment sample containers, volume, and preservation.
15	BRF	NA	NA	Attachment H	Investigation-Specific Quality Control Requirements – Benthic Sampling	H-2	Table H-1	NA	NA	NA	Update requirements for aqueus blanks containers, volume, and preservation.
16	BRF	NA	NA	Attachment H	Investigation-Specific Quality Control Requirements – Benthic Sampling	H-3	Table H-2	NA	NA	NA	Update RLs to match current laboratory reporting limits
17	BRF	NA	NA	Attachment H	Investigation-Specific Quality Control Requirements – Benthic Sampling	NA	new table	NA	NA	NA	Insert table of analyses, methods, and reporting limits fo sediment.
18	BRF	NA	NA	Attachment H	Investigation-Specific Quality Control Requirements – Benthic Sampling	H-3	Table H-2	NA	NA	NA	Removed note that biological samples will be reported on a dry-weight basis; tissue samples will be reported wet-weight.
19	BRF	NA	NA	Attachment H	Investigation-Specific Quality Control Requirements – Benthic Sampling	NA	new table	NA	NA	NA	Insert table of Quantitative QA objectives for sediment.
20	BRF	NA	NA	Attachment I	Investigation-Specific Quality Control Requirements – Fish Tissue Sampling	I-3	Table I-2	NA	NA	NA	Removed note that biological samples will be reported on a dry-weight basis; tissue samples will be reported wet-weight.
21	BRF	NA	NA	Attachment I	Investigation-Specific Quality Control Requirements – Fish Tissue Sampling	I-3	Table K-2	NA	NA	NA	Update RLs to match current laboratory reporting limits
22	BRF	NA	NA	Attachment J	Investigation-Specific Quality Control Requirements – CCR Material	J-2	Table J-1	NA	NA	NA	Update container type to 16-oz glass for radiological parameters for CCR Material.
23	BRF	NA	NA	Attachment J	Investigation-Specific Quality Control Requirements – CCR Material	J-2	Table J-1	NA	NA	NA	Remove thermal preservation required for radiological parameters
24	BRF	NA	NA	Attachment J	Investigation-Specific Quality Control Requirements – CCR Material	J-2	Table J-1	NA	NA	NA	Add requirements for aqueous equipment blank sample containers, volume, and preservation.
25	BRF	NA	NA	Attachment J	Investigation-Specific Quality Control Requirements – CCR Material	J-2	Table J-1	NA	NA	NA	Update requirements for SPLP analyses.
26	BRF	NA	NA	Attachment J	Investigation-Specific Quality Control Requirements – CCR Material	J-2	Table J-1	NA	NA	NA	Remove arsenic speciation as a paremeter for CCR Material, SPLP, and Pore Water.

Master Log of Changes to BRF EIP
Quality Assurance Project Plan Revision 2

Item No.	Plant	Date	TDEC Comment No.	Section No.	Section Title	Page	Paragraph	Line	TDEC Comment	TVA Response	Proposed Update to BRF EIP Rev 3 Final
27	BRF	NA	NA	Attachment J	Investigation-Specific Quality Control Requirements – CCR Material	J-4	Table J-2	NA	NA	NA	Update RLs to match current laboratory reporting limits
28	BRF	NA	NA	Attachment J	Investigation-Specific Quality Control Requirements – CCR Material	J-8	Table J-4	NA	NA	NA	Clarify filtered samples to be collected for metals/mercury only.
29	BRF	NA	NA	Attachment J	Investigation-Specific Quality Control Requirements – CCR Material	J-6	Table J-3	NA	NA	NA	Update RLs to match current laboratory reporting limits
30	BRF	NA	NA	Attachment J	Investigation-Specific Quality Control Requirements – CCR Material	J-10	Table J-5	NA	NA	NA	Remove surrogate requirement for radiological parameters in solid matrices.
31	BRF	NA	NA	Attachment J	Investigation-Specific Quality Control Requirements – CCR Material	J-11	Table J-6	NA	NA	NA	Update Quantitative QA Objectives for SPLP leachates.
32	BRF	NA	NA	Attachment K	Investigation-Specific Quality Control Requirements – Water Use Survey	K-2	Table K-1	NA	NA	NA	Remove thermal preservation required for radiological parameters
33	BRF	NA	NA	Attachment K	Investigation-Specific Quality Control Requirements – Water Use Survey	K-3	Table K-2	NA	NA	NA	Update RLs to match current laboratory reporting limits
34	BRF	NA	NA	Attachment L	Investigation-Specific Quality Control Requirments - Seep Sampling	NA	new attachment	NA	NA	NA	Add Attachment L, Investigation-Specific Quality Control Requirements - Seep Sampling.

APPENDIX C
EXHIBITS

Exhibit No..
1

Title
Bull Run Fossil Plant
Site Map

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

0 700 1,400 2,100 2,800 Feet
1:8,400 (At original document size of 22x34)

Legend

- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)
- Proposed Landfill (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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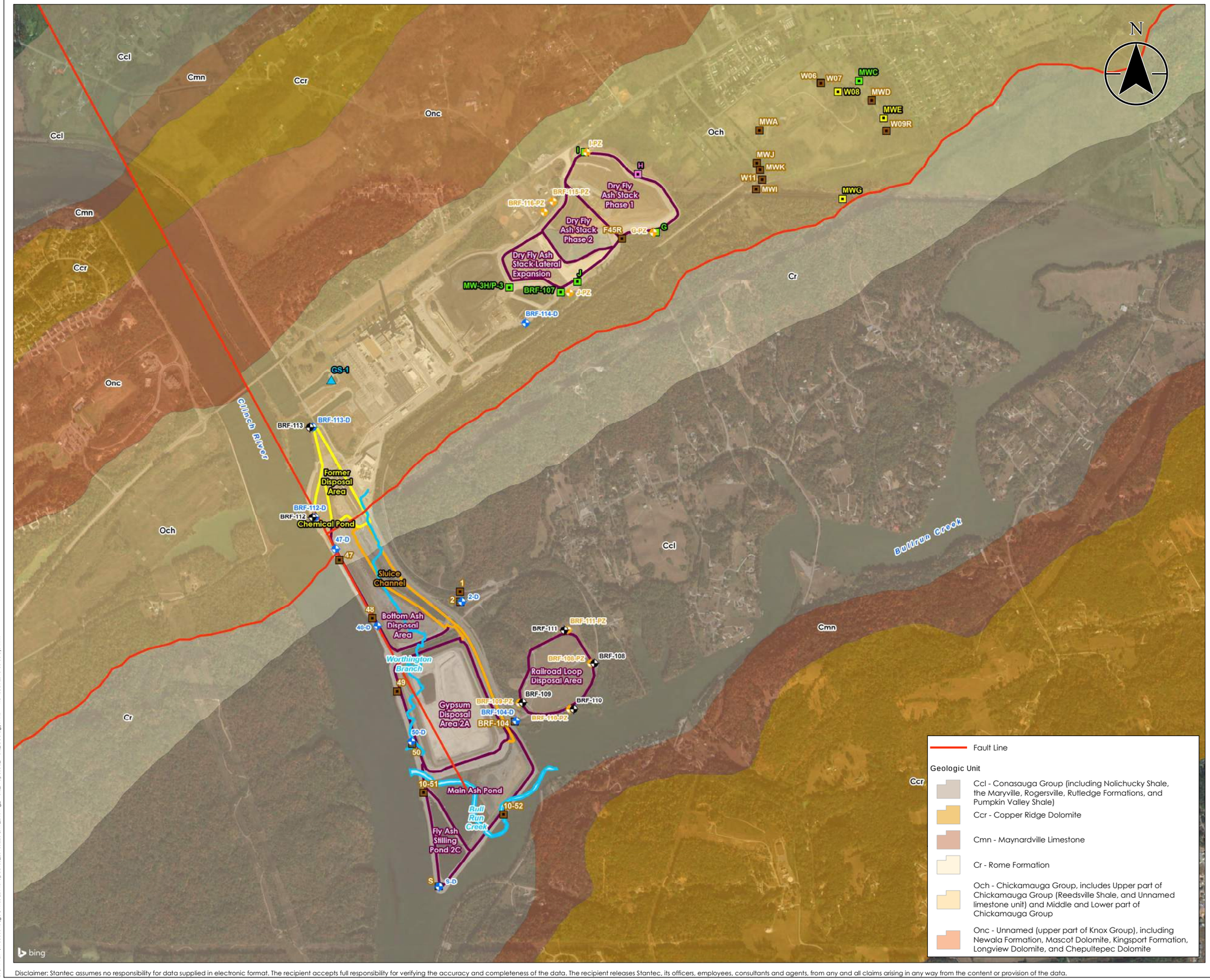

Exhibit No.

2

Title

Site Geology and Existing Monitoring Well and Proposed Monitoring Well, Piezometer and Pilot Hole Locations

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346
Prepared by LMB on 2018-03-06
Technical Review by TG on 2018-03-06

0 700 1,400 2,100 2,800 Feet

1:8,400 (At original document size of 22x34)

Legend

- Proposed Pilot Hole to be Converted to Piezometer
- Proposed Pilot Hole to be Converted to Monitoring Well
- Proposed Monitoring Well

Existing Well

- Existing Monitoring Well (State Compliance)
- Existing Monitoring Well (Other)
- Existing Monitoring Well (State and CCR Rule Compliance)
- Observation Well (State Compliance)
- Surface Water Gauging Station
- Historic Creek Alignment
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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Exhibit No.
3

Title
Proposed Monitoring Well Piezometer, and Pilot Hole Locations

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-03-29
Technical Review by TG on 2018-03-29

0 700 1,400 2,100 2,800 Feet
1:8,400 (At original document size of 22x34)

Legend

- Proposed Pilot Hole to be Converted to Piezometer
- Proposed Pilot Hole to be Converted to Monitoring Well
- Proposed Monitoring Well
- Surface Water Gauging Station
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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Exhibit No.

4

Title

Proposed Geotechnical Borings
Dry Fly Ash Stack

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175568274

Prepared by MB on 2018-12-13
Technical Review by TG on 2018-12-13

0 150 300 450 600 Feet

1:1,800 (At original document size of 22x34)

Legend

- Proposed Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, and Geotechnical Data) (Screened Interval)
- Proposed Cone Penetration Test
- Existing Boring
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Historical TVA Drawing 10W293-1 R2 (1993) is shown.
4. CPT borings on 5 feet spacing along historical unnamed tributary alignment.

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X:\TVA-EPI\175568274_BRF_Phase2\gis\mxd\BRF_Proposed_Geotech_Borings_Dryfly.mxd Revised: 2018-12-13 By: mbourgh

Exhibit No.

5

Title

Existing Monitoring Well and Proposed Monitoring Well, Piezometer and Pilot Hole Locations

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346
Prepared by LMB on 2018-03-06
Technical Review by TG on 2018-03-06

0 700 1,400 2,100 2,800 Feet

1:8,400 (At original document size of 22x34)

Legend

- Proposed Pilot Hole to be Converted to Piezometer
- Proposed Pilot Hole to be Converted to Monitoring Well
- Proposed Monitoring Well

Existing Well

- Existing Monitoring Well (State Compliance)
- Observation Well (State Compliance)
- Existing Monitoring Well (State and CCR Rule Compliance)
- Existing Monitoring Well (Other)
- Surface Water Gauging Station
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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U:\TVA-EIP\175566346\gis\mxds\Exhibit\Updates_20180226\BRF_Existing_Wells_Proposed_Wells.mxd Revised: 2018-03-06 By: lbackman

CCR Unit and Condition	Static Cases		Seismic Cases		
	Long-Term, Global	Long-Term, Veneer[2]	Simp. Displ.[1], Global	Simp. Displ.[1], Veneer[2]	Post-EQ[3], Global
Dry Fly Ash Stack Phase 1 & 2 (Closed Condition)	B, C, D, E, G, H	E, F, H	D	D	D
Dry Fly Ash Stack Lateral Expansion (Future Build-out Condition)	F, CA, CB	CA	CA, CB	CA	CA

[1] Simp. Displ. = Simplified 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 was analyzed.

Blue cells are completed analyses. Yellow cells are proposed analyses.

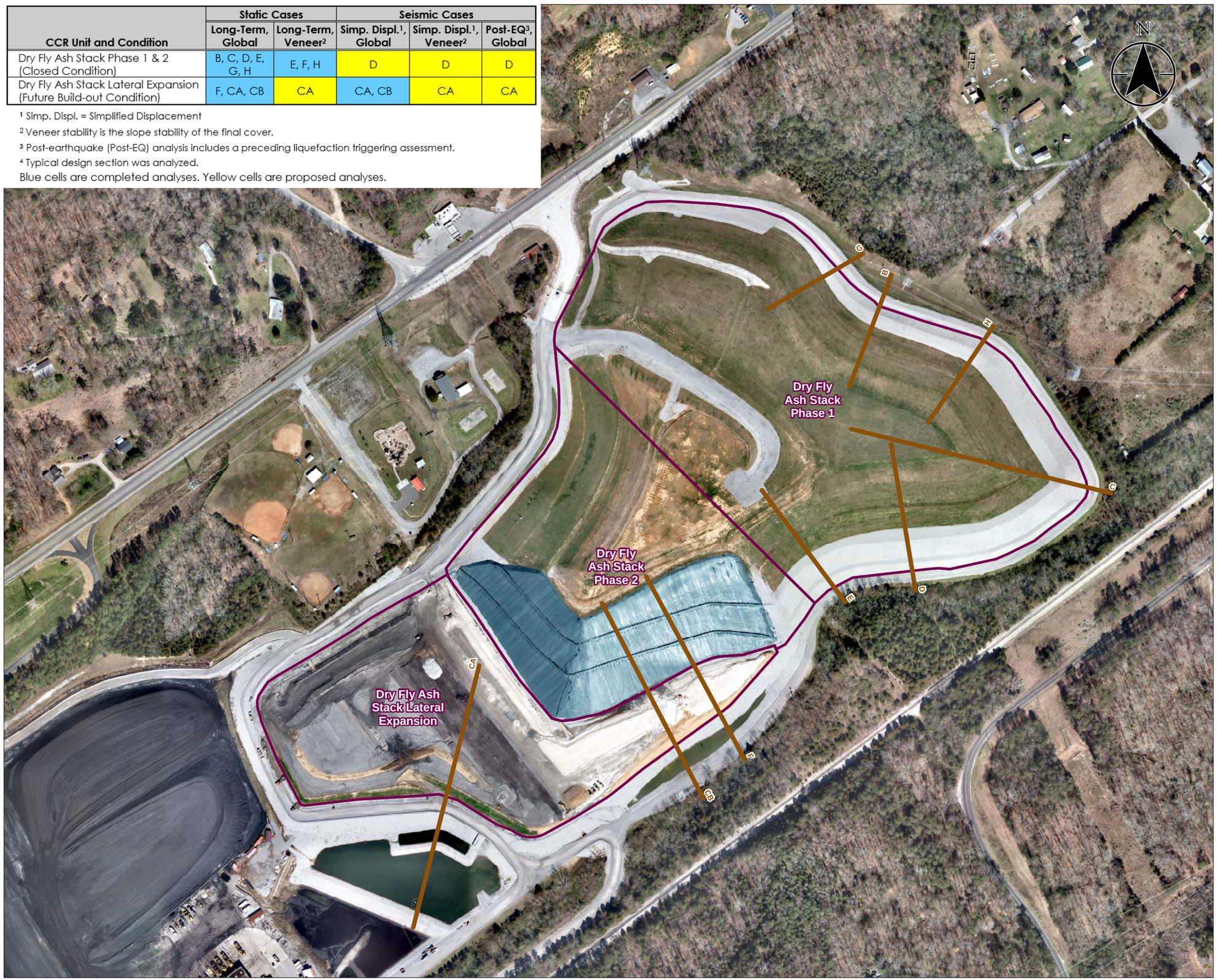

Exhibit No.

6

Title: Completed and Proposed Stability Analyses Dry Fly Ash Stack

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

0 150 300 450 600 Feet

1:1,800 (At original document size of 22x34)

Legend

Stability Cross Section

CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

Stantec

TVA

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U:\TVA-EIP\175566346\gis\mxds\BRF_XS_DryFly_Update.mxd Revised: 2017-10-24 By: mbough

CCR Unit and Condition	Static Cases		Seismic Cases		
	Long-Term, Global	Long-Term, Veneer[2]	Simp. Displ.[1], Global	Simp. Displ.[1], Veneer[2]	Post-EQ[3], Global
Bottom Ash Disposal Area (Closed Condition)	D, F	Typ.[4]	D	Typ.[4]	D
Gypsum Disposal Area 2A (Closed Condition)	F, H, I, J, K, L	Typ.[4]	I	Typ.[4]	I
Main Ash Pond (Closed/Repurposed Condition)	R, S, L, A1, A2, AC	A2, AC	A1	A2	A1
Fly Ash Stilling Pond 2C (Closed/Repurposed Condition)	N, O, AC, AE, AG	AE	AE	AE	AE
Railroad Loop Disposal Area (Closed Condition)	RL	RL	RL	RL	RL

[1] Simp. Displ. = Simplified 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 was analyzed.

Blue cells are completed analyses. Yellow cells are proposed analyses.

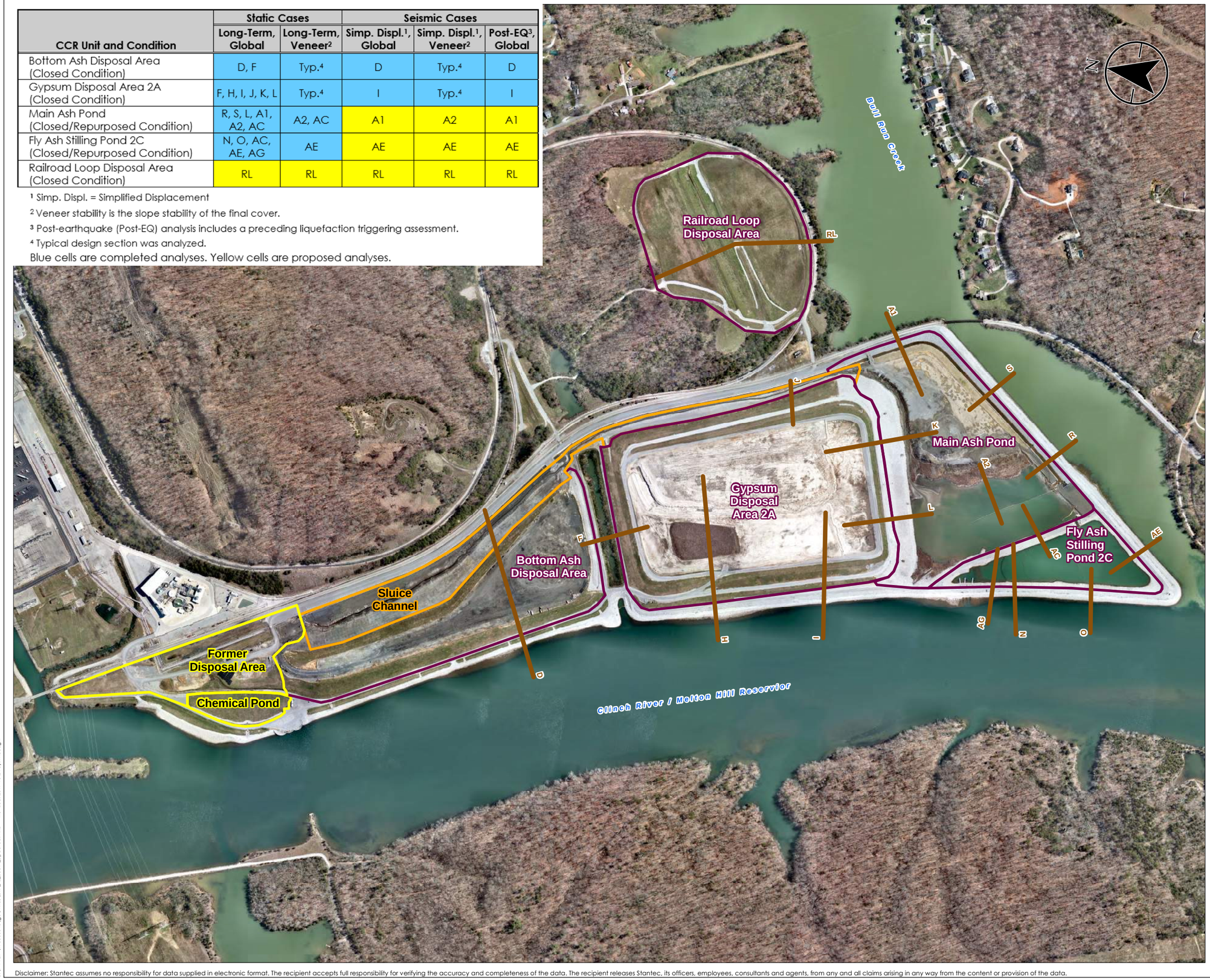

Exhibit No.

7

Title

Completed and Proposed Stability Analyses
Bottom Ash Disposal Area, Gypsum Disposal Area 2A,
Fly Ash Stilling Pond 2C, Railroad Loop & Main Ash Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

0 250 500 750 1,000 Feet

1:3,600 (At original document size of 22x34)

Legend

- Stability Cross Section
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

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J:\TVA-EP\175566346\gis\mxds\BRF_XS_South_updated.mxd Revised: 2017-10-24 By: mbough

Exhibit No.

8

Title

Proposed Geotechnical Borings
Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Fly Ash Stilling Pond 2C & Main Ash Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175568274

Prepared by MB on 2018-12-13
Technical Review by TG on 2018-12-13

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Proposed Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, and Geotechnical Data) (Screened Interval)
- Proposed Geotechnical Boring
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

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U:\TVA-EIP\175568274_BRF_Phase2\gis\mxd\BRF_Proposed_Geotech_Borings_South.mxd Revised: 2018-12-13 By: mbough

Exhibit No.

9

Title

Proposed Cone Penetration Testing - Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Fly Ash Stilling Pond 2C, and Main Ash Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175568274

Prepared by TKR on 2018-12-13
Technical Review by TG on 2018-12-13

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Proposed Cone Penetration Test
- Historic Creek Alignment
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Historical TVA Drawing 10N213-14 (1977) is shown.
4. CPT borings on 20 feet spacing at historical Bull Run Creek alignment.
5. CPT borings on 5 feet spacing at historical Worthington Branch alignment.

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I:\TVA-EP\175568274_BRF_Phase2\gis\mxd\BRF_Proposed_CPT_South.mxd Revised: 2018-12-13 By: mbough

Exhibit No.

10

Title

Existing Borings
Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Fly Ash Stilling Pond 2C, Railroad Loop & Main Ash Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Existing Boring
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

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I:\TVA-EP\175566346\gis\mxds\BRF_Existing_Borings_South.mxd Revised: 2017-10-24 By: mbough

Exhibit No.
11

Title
Existing Borings
Dry Fly Ash Stack

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2017-09-25
Technical Review by TG on 2017-09-25

0 150 300 450 600 Feet
1:1,800 (At original document size of 22x34)

Legend

- Existing Boring
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

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U:\TVA-EIP\175566346\gis\mxds\BRF_Existing_Borings_DryFly.mxd Revised: 2017-09-25 By: mbough

Exhibit No.
12

Title
Uppermost Foundation Soil Data
Dry Fly Ash Stack

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-03-28
Technical Review by TG on 2018-03-28

0 150 300 450 600 Feet
1:1,800 (At original document size of 22x34)

Legend

Bedrock	▣	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Clay	●	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Clayey Fill	▲	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Silt	⬢	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*

CCR Unit Area (Approximate)

Constructed Geologic Buffer (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Borings within Lateral Expansion Area pre-date the construction of the geologic buffer.
4. Borings prior to 1994 pre-date the geologic buffer in the Phase 2 footprint.
5. The Phase 2 footprint includes a constructed geologic buffer, with a specified hydraulic conductivity of less than or equal to 1.0E-06 cm/s, confirmed by construction quality assurance testing.
6. The Lateral Expansion footprint includes a constructed geologic buffer, with a specified hydraulic conductivity of less than or equal to 1.0E-06 cm/s. A compacted clay liner, with a specified hydraulic conductivity of less than or equal to 1.0E-07 cm/s, and a geomembrane overlie the geologic buffer. Hydraulic conductivity requirements were confirmed by construction quality assurance testing.

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I:\TVA-EP\175566346\gis\mxds\BRF Foundation_Soils_DryFly.mxd Revised: 2018-03-28 By: TRink

Exhibit No.
13

Title
Uppermost Foundation Soil Data
Bottom Ash Disposal Area, Gypsum Disposal Area 2A,
Fly Ash Stilling Pond 2C, Railroad Loop & Main Ash Pond

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-03-28
Technical Review by TG on 2018-03-28

0 250 500 750 1,000 Feet
1:3,600 (At original document size of 22x34)

Legend

Bedrock	▣	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Clay	Ⓒ	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Clayey Sand	◉	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Clayey Fill	▲	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Sand	●	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Silt	⬟	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*

CCR Unit Area (Approximate)

Former Disposal Area (Approximate)

Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

Stantec

TVA

P:\BRF Foundation_Soils_South\04.mxd Revised: 2018-03-28 By: mbough

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Exhibit No.

14

Title

Proposed Soil Sampling Locations

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by TKR on 2018-12-14
Technical Review by TG on 2018-12-14

0 700 1,400 2,100 2,800 Feet

1:8,400 (At original document size of 22x34)

Legend

- Alternate Proposed Background Soil Sample Location
- Final Background Soil Sample Location
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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U:\TVA-EIP\175568274_BRF_Phase2\gis\mxd\BRF_Proposed_Soil_Sampling.mxd Revised: 2018-12-14 By: mbough

Exhibit No.

15

Title

Proposed Soil Sampling Locations

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by TKR on 2018-12-14
Technical Review by TG on 2018-12-14

0 700 1,400 2,100 2,800 Feet

1:8,400 (At original document size of 22x34)

Legend

- Alternate Proposed Background Soil Sample Location
- Final Background Soil Sample Location
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)
- Soil Map Unit
- TVA Property Boundary

Map Unit	Map Unit Name	Map Unit	Map Unit Name
Ac	Allegheny-Cotaco complex, occasionally flooded	GnD	Gilpin silt loam, 12 to 20 percent slopes
AlD	Allen loam, 12 to 20 percent slopes	GpE	Gilpin-Petros complex, 20 to 35 percent slopes
AkC	Armuchee silt loam, 5 to 12 percent slopes	GpF	Gilpin-Petros complex, 35 to 70 percent slopes
AkD	Armuchee silt loam, 12 to 20 percent slopes	GrF	Gilpin-Bouldin-Petros complex, 25 to 75 percent slopes, very stony
AkE	Armuchee silt loam, 20 to 35 percent slopes	Hb	Hamblen silt loam, occasionally flooded
AoD2	Armuchee channery silty clay loam, 12 to 20 percent slopes, eroded	JfC	Jefferson loam, 5 to 12 percent slopes
AoE2	Armuchee channery silty clay loam, 20 to 35 percent slopes, eroded	JfD	Jefferson loam, 12 to 20 percent slopes
ApE	Armuchee-Montevallo complex, 25 to 60 percent slopes	JnC	Jefferson gravelly loam, 5 to 12 percent slopes
At	Atkins silt loam, frequently flooded	JnD	Jefferson gravelly loam, 12 to 20 percent slopes
BaF	Berks-Weikert complex, 20 to 75 percent slopes	LoD	Loyston flaggy clay, 12 to 20 percent slopes
BeF	Bethesda-Pits, mine complex, 10 to 80 percent slopes	LoE	Loyston flaggy clay, 20 to 35 percent slopes, rocky
ChB	Clarkrange silt loam, 2 to 5 percent slopes	MnC	Minvale silt loam, 5 to 12 percent slopes
Cd	Cedarbluff loam, 0 to 3 percent slopes, occasionally flooded	MnD	Minvale silt loam, 12 to 20 percent slopes
Ce	Chennieby silt loam, frequently flooded	MoC	Montevallo channery silt loam, 5 to 12 percent slopes
CfD	Colbert-Lyerly-Rock outcrop complex, 5 to 20 percent slopes	MoD	Montevallo channery silt loam, 12 to 20 percent slopes
CgB	Collegedale silt loam, 2 to 5 percent slopes	MoE	Montevallo channery silt loam, 20 to 35 percent slopes
CgC	Collegedale silt loam, 5 to 12 percent slopes	Pe	Pettyjon silt loam
CgD	Collegedale silt loam, 12 to 20 percent slopes	PITS	Pits, quarries
ChC3	Collegedale clay, 5 to 12 percent slopes, severely eroded	Pp	Pope-Philo complex, frequently flooded
ChD3	Collegedale clay, 12 to 20 percent slopes, severely eroded	RcE	Ramsey-Rock outcrop complex, 20 to 50 percent slopes
CkE	Collegedale-Rock outcrop complex, 20 to 35 percent slopes	SfC	Sallacoa silt loam, 5 to 12 percent slopes
Cw	Craigsville-Pope complex, 0 to 4 percent slopes, occasionally flooded	SfD	Sallacoa silt loam, 12 to 20 percent slopes
DAM	Dam	Sk	Shady loam, occasionally flooded
DwC	Dewey silt loam, 5 to 12 percent slopes	SwB	Swafford loam, 2 to 5 percent slopes
DwD	Dewey silt loam, 12 to 20 percent slopes	TbB	Tassio loam, 2 to 5 percent slopes
DwE	Dewey silt loam, 20 to 35 percent slopes	TnC	Townley silt loam, 5 to 12 percent slopes
En	Ennis gravelly silt loam, 1 to 5 percent slopes, occasionally flooded	TnD	Townley silt loam, 12 to 20 percent slopes
EoB	Etowah loam, 2 to 5 percent slopes	UaD	Udorthents, 0 to 25 percent slopes
EoC	Etowah loam, 5 to 12 percent slopes	UeE	Udorthents, refuse substratum, 0 to 35 percent slopes
FoC	Fullerton-Palo complex, 5 to 12 percent slopes	Ur	Urban land
FoD	Fullerton-Palo complex, 12 to 20 percent slopes	W	Water
FoE	Fullerton-Palo complex, 20 to 35 percent slopes	WbD	Waynesboro loam, 15 to 25 percent slopes
GhC	Gilpin silt loam, 5 to 12 percent slopes	WnC	Wernock silt loam, 5 to 12 percent slopes
		Ww	Whitwell loam, 1 to 4 percent slopes, occasionally flooded

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery
3. Soils Data provided by US Department of Agriculture

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U:\TVA-EIP\175566274_BRF_Phase2\gis\mxd\BRF_Proposed_Soil_Sampling_wSoilsOverlay.mxd Revised: 2018-12-14 By: mbough

Exhibit No.
16

Title
Geologic Map

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-10
Technical Review by TG on 2017-10-10

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

Legend

- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery
3. Geologic map corresponds to Geologic Map and Mineral Resources Summary of the Clinton Quadrangle (Swingle 1964)

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I:\TVA-EP\175566346\gis\mxds\BR_Geologic_1944_ClintonQuad.mxd Revised: 2017-10-10 By: trink

Exhibit No.
17

Title
Topographic Map - USGS (1952)

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-10
Technical Review by TG on 2017-10-10

0 600 1,200 1,800 2,400 Feet
1:7,986 (At original document size of 22x34)

Legend

- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery
3. Topographic map corresponds to Clinton Quadrangle Tennessee-Anderson Co. 7.5 Minute Series Topographic Map (USGS 1952)

Stantec

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I:\TVA-EIP\175566346\gis\mxds\BBF Topo 1952_ClintonQuad.mxd Revised: 2017-10-10 By: frink

Exhibit No.

18

Title

Topographic Map: TVA Drawing 10W289-1 Railroad Loop Disposal Area

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-10
Technical Review by TG on 2017-10-10

0 60 120 180 240 Feet

1:720 (At original document size of 22x34)

Legend

CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery
3. TVA Drawing 10W289-1

Stantec

TVA

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U:\TVA-EIP\175566346\gis\mxds\BRF Topo_TVA_10W289-1_RL.mxd Revised: 2017-10-10 By: mbough

Exhibit No.

19

Title

Topographic Map: TVA Drawing 10N213
Bottom Ash DIsposal Area, Gypsum Disposal Area 2A, Main Ash Pond, & Fly Ash Stilling Pond 2C

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. TVA Drawing 10W213-1

Stantec

TVA

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U:\TVA-EBP\175566346\gis\mxds\BRF_Topo_TVA_10W213-1_South.mxd Revised: 2017-10-24 By: mbaugh

Exhibit No.

20

Title

Topographic Map: TVA Drawing 10W293-1
Dry Fly Ash Stack

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-10
Technical Review by TG on 2017-10-10

0 150 300 450 600 Feet

1:1,800 (At original document size of 22x34)

Legend

CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery
3. TVA Drawing 10W293-1

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I:\TVA-EIP\175566346\gis\mxds\BRF_Topo_DVA_10W293-1_DryFly.mxd Revised: 2017-10-10 By: mbough

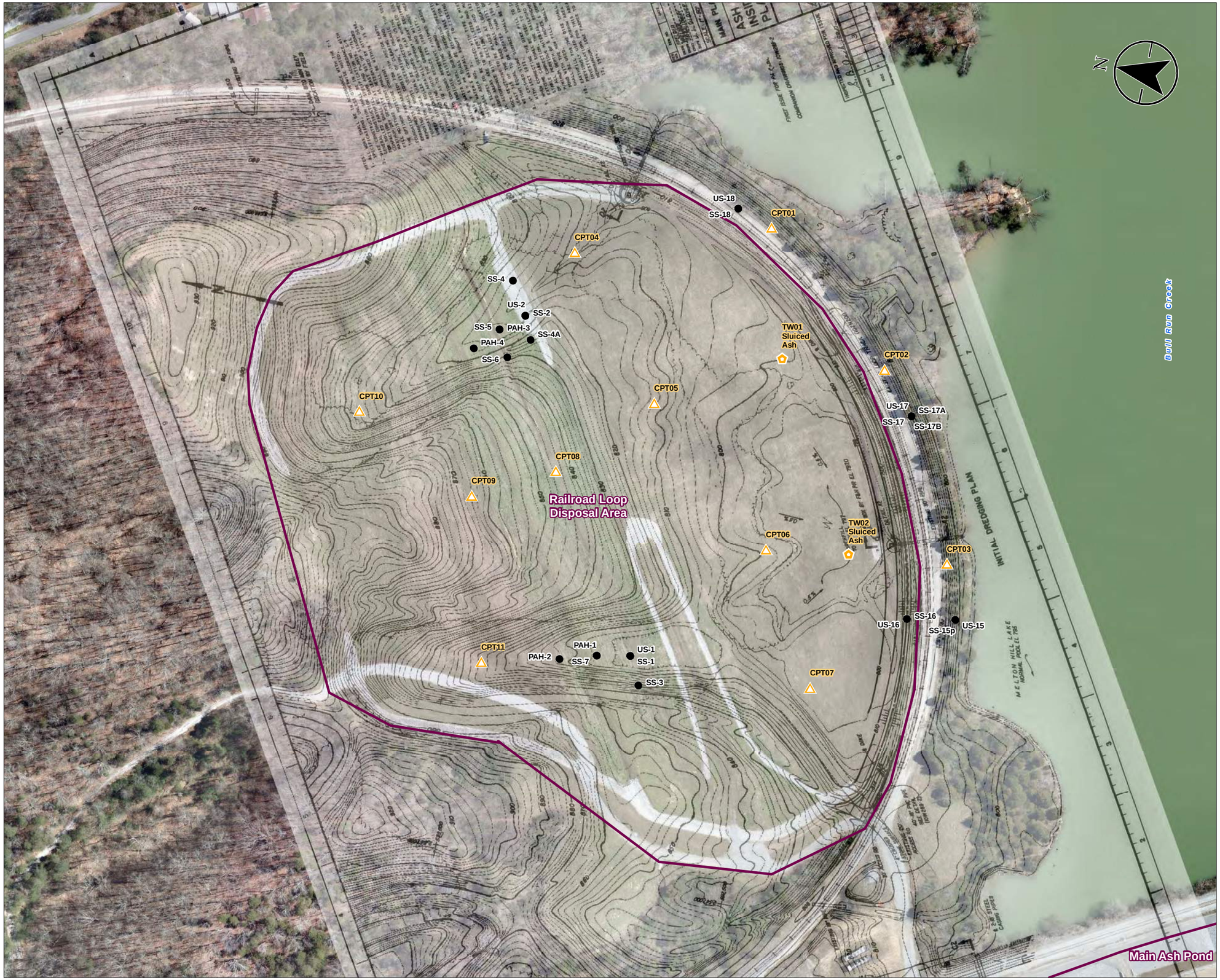

Exhibit No.
21

Title
Proposed Geotechnical Borings
Railroad Loop Disposal Area

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-06-14
Technical Review by TG on 2018-06-14

0 80 160 240 320 Feet
1:960 (At original document size of 22x34)

Legend

- Proposed Cone Penetration Test
- Proposed Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, and Geotechnical Data) (Screened Interval)
- Existing Boring
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Historical TVA Drawing 10W289-1 R0 (1981) is shown.

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U:\TVA-EIP\175566346\gis\mxds\BRF_Proposed_Geotech_Borings_RailLoop.mxd Revised: 2018-06-14 By: mbough

Exhibit No.
22

Title

Existing CCR Thickness Boring Data
Dry Fly Ash Stack

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

0 150 300 450 600 Feet

1:1,800 (At original document size of 22x34)

Legend

- Boring with CCR Thickness Data
- CCR Unit Area (Approximate)
- Constructed Geologic Buffer (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Borings within Lateral Expansion Area pre-date the construction of the geologic buffer. CCR material was removed during construction.

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Exhibit No.

23

Title

Existing CCR Thickness Boring Data
Bottom Ash Disposal Area, Gypsum Disposal Area 2A,
Fly Ash Stilling Pond 2C, Railroad Loop & Main Ash Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-23
Technical Review by TG on 2017-10-23

0 250 500 750 1,000 Feet

1:3,600 (At original document size of 22x34)

Legend

- Boring with CCR Thickness Data
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

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U:\TVA-EIP\175566346\gis\mxds\BRF_CCR_South.mxd Revised: 2017-10-23 By: mbough

Exhibit No.

24

Title

Existing Top of Rock Boring Data
Dry Fly Ash Stack

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by TKR on 2017-09-27
Technical Review by TG on 2017-09-27

0 150 300 450 600 Feet

1:1,800 (At original document size of 22x34)

Legend

- Boring without Rock Core Data [ID, TOR Elevation]
- Boring with Rock Core Data [ID, TOR Elevation, RQD]
- Fault Line
- CCR Unit Area (Approximate)
- Cr - Rome Formation
- Och - Chickamauga Group, includes Upper part of Chickamauga Group (Reedsville Shale, and Unnamed limestone unit) and Middle and Lower part of Chickamauga Group
- Onc - Unnamed (upper part of Knox Group), including Newala Formation, Mascot Dolomite, Kingsport Formation, Longview Dolomite, and Chepultepec Dolomite

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. RQD value corresponds to upper 20 feet of rock core.

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TVA

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I:\TVA-EP\175566346\gis\mxds\BRF_TOR_DryFly.mxd Revised: 2017-09-27 By: mbough

Exhibit No.

25

Title

Existing Top of Rock Elevation Boring Data Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Fly Ash Stilling Pond 2C, Railroad Loop & Stilling Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

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 [ID, TOR Elevation, RQD]
- Fault Line
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)
- Ccl - Nolichucky Shale, and Maryville, Rogersville, and Rutledge Formations, and Pumpkin Valley Shale
- Ccr - Copper Ridge Dolomite
- Cmn - Maynardville Limestone
- Cr - Rome Formation
- Och - Chickamauga Group, includes Upper part of Chickamauga Group (Reedsville Shale, and Unnamed limestone unit) and Middle and Lower part of Chickamauga Group

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. RQD value corresponds to upper 20 feet of rock core.

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U:\TVA-EP\175566346\gis\mxds\BRF_TOR_South.mxd Revised: 2017-10-24 By: mbough

Exhibit No.
26

Title
Sediment Sampling

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-02-21
Technical Review by TG on 2018-02-21

0 1,400 2,800 4,200 5,600 Feet
1:16,800 (At original document size of 22x34)

Legend

- Sediment Sampling Transect
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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J:\TVA-EIP\175566346\gis\mxds\BRF_Sediment_Sampling.mxd Revised: 2018-02-21 By: trink

Exhibit No.
27

Title
Benthic Macroinvertebrates Sampling

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-02-21
Technical Review by TG on 2018-02-21

0 1,400 2,800 4,200 5,600 Feet
1:16,800 (At original document size of 22x34)

Legend

- Transect
- TVA Property Boundary
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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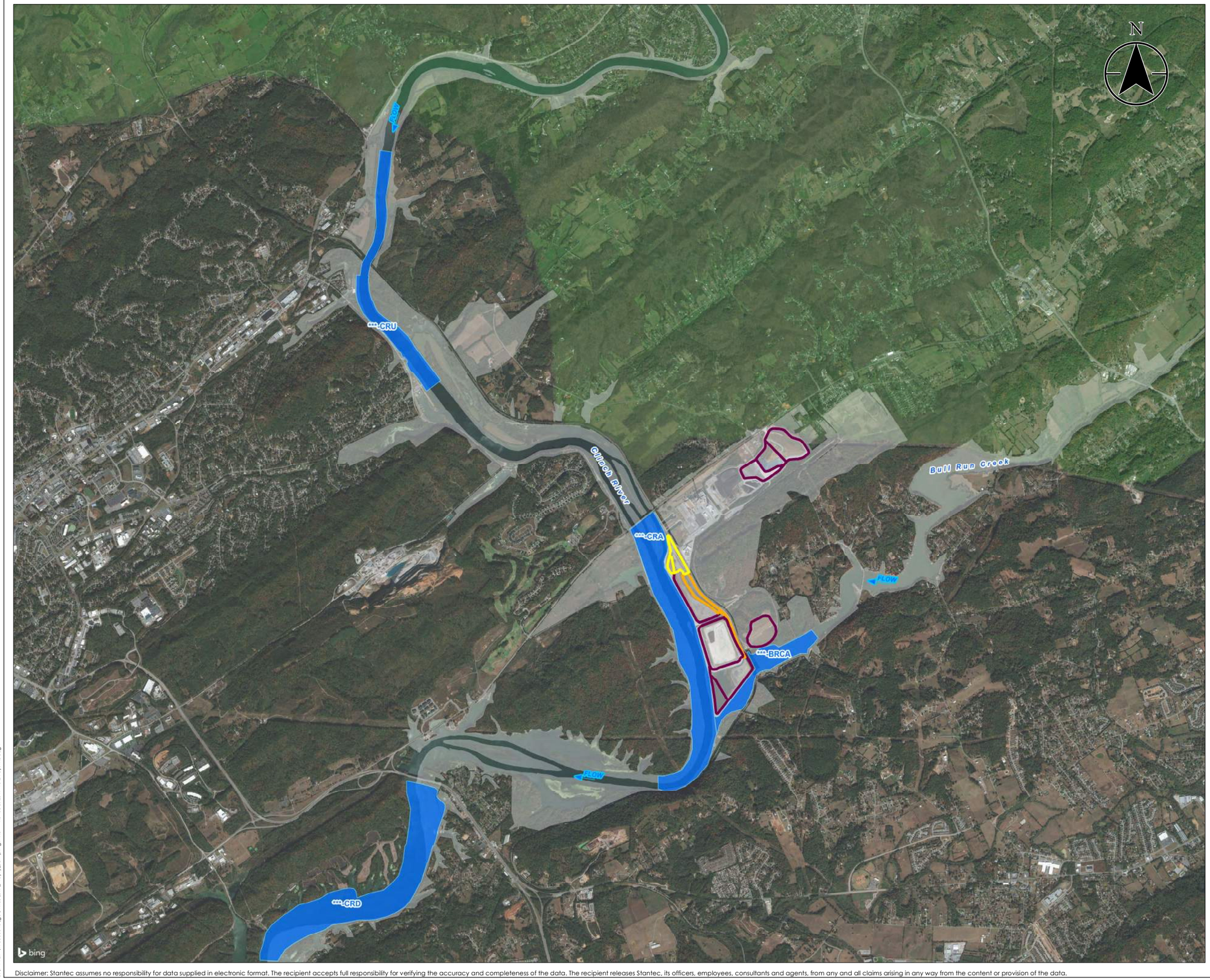

Exhibit No.
28

Title
Mayfly Sampling
Adult Mayflies, Purated Mayfly Nymphs, & Non-Purated Mayfly Nymphs

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

0 1,800 3,600 5,400 7,200 Feet

1:21,600 (At original document size of 22x34)

Legend

- Mayfly Sample Location
- TVA Property Boundary
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

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 Bing Imagery

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TVA

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J:\TVA-EBP\175566346\gis\mxds\BRF_Mayfly_Sampling.mxd Revised: 2017-10-24 By: mbaugh

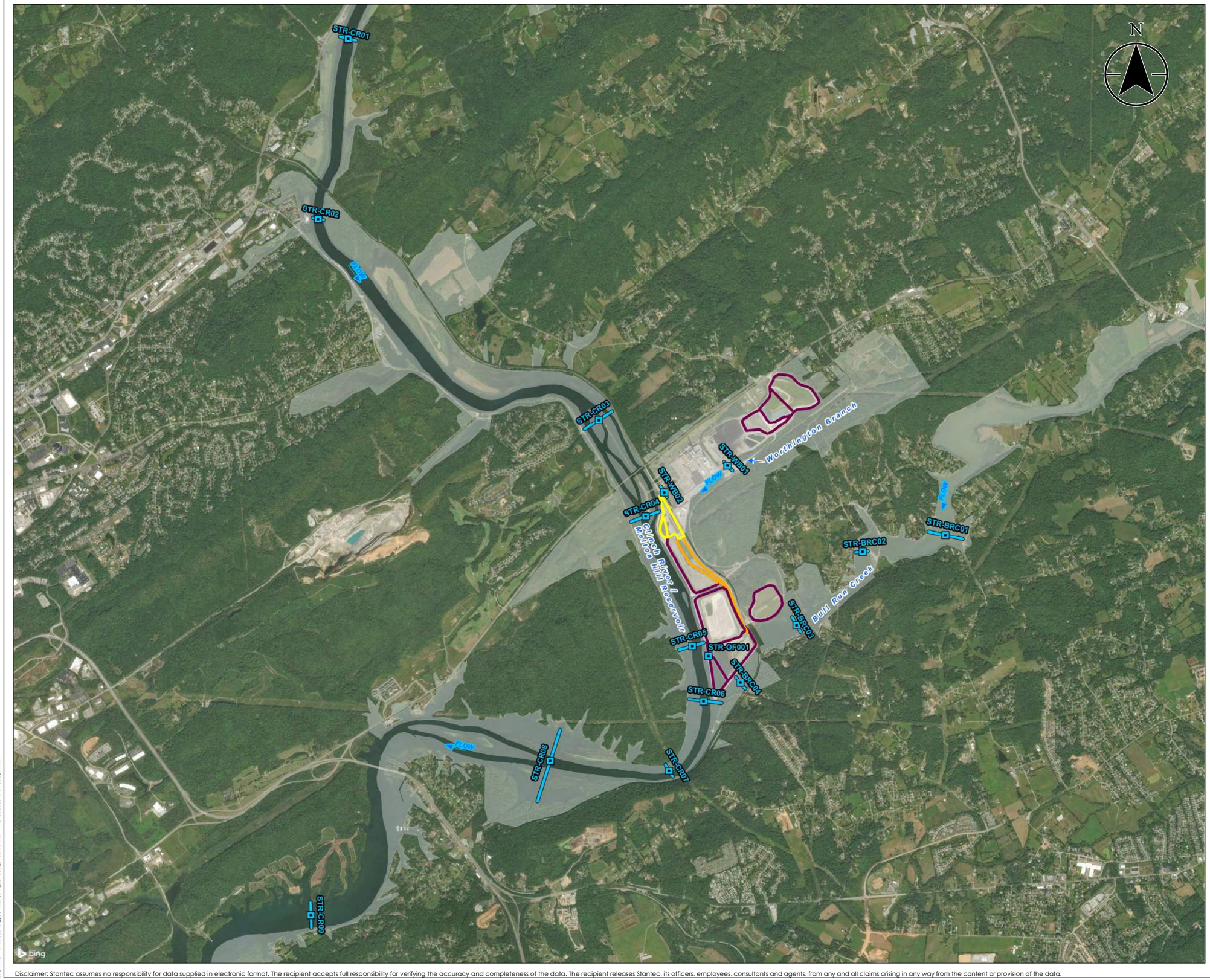

Exhibit No.
29

Title
Surface Stream Sampling

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-07-06
Technical Review by TG on 2018-07-06

0 1,600 3,200 4,800 6,400 Feet
1:19,200 (At original document size of 22x34)

Legend

- Surface Stream Sample Location
- Hydrolab Transect
- TVA Property Boundary
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery
3. If Hydrolab results indicate lateral water quality variations along a transect, samples will be collected at up to four additional locations along the transect.

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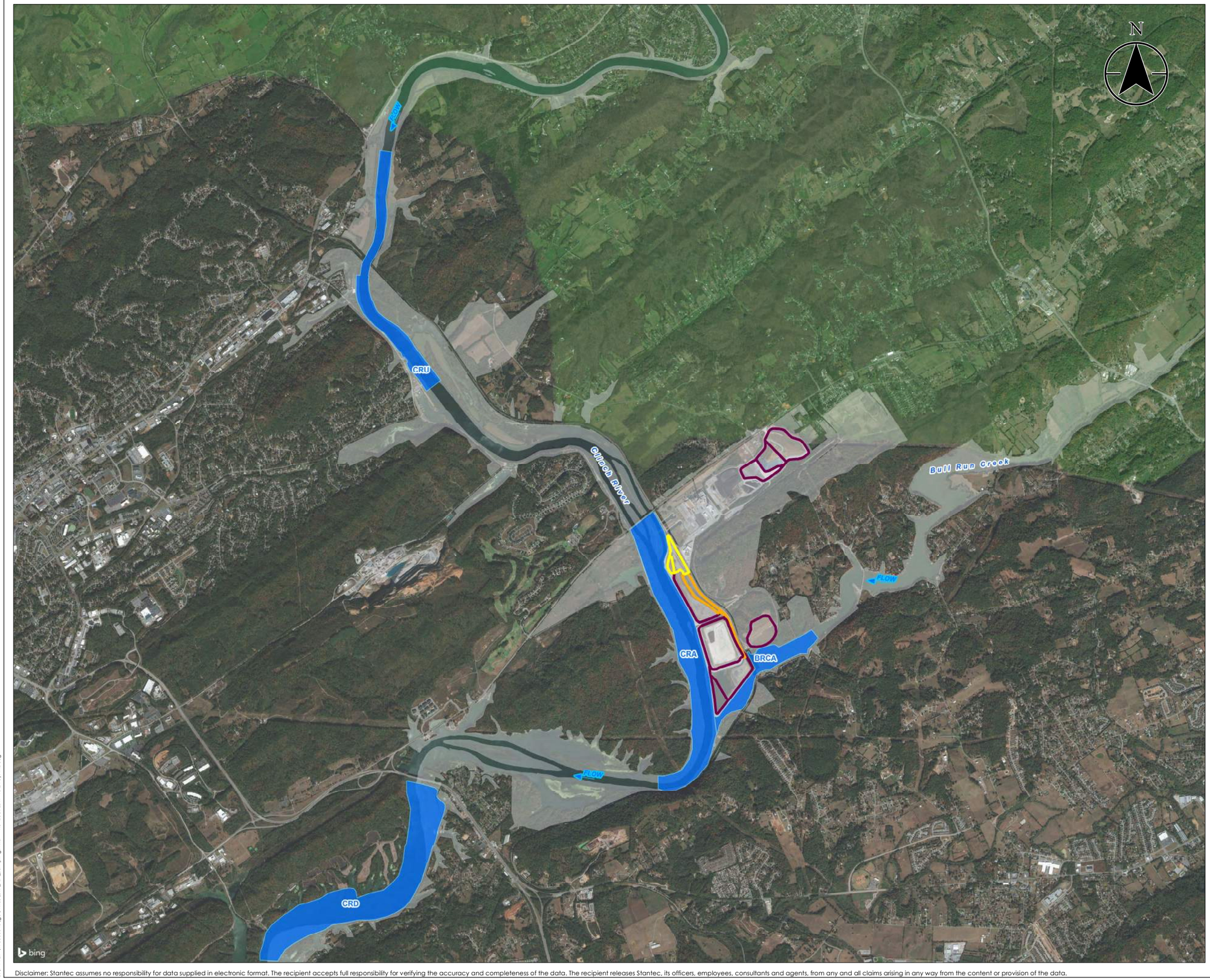

Exhibit No.
30

Title

Fish Sampling

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

0 1,800 3,600 5,400 7,200 Feet

1:21,600 (At original document size of 22x34)

Legend

- Fish Sample Location
- TVA Property Boundary
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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APPENDIX D
QUALITY ASSURANCE PROJECT PLAN

ENVIRONMENTAL® STANDARDS

Setting the Standards for Innovative Environmental Solutions

QUALITY ASSURANCE PROJECT PLAN

FOR THE TENNESSEE VALLEY AUTHORITY

BULL RUN FOSSIL PLANT

ENVIRONMENTAL INVESTIGATION

Revision 3

December 2018

Prepared by:

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Prepared for:

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Chattanooga, TN 34702-2801

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2.0 QUALITY ASSURANCE PROJECT PLAN DESCRIPTION

2.1 Background

The primary goal of this Tennessee Valley Authority (TVA) Bull Run Fossil Plant (BRF) Environmental Investigation Quality Assurance Project Plan (BRF QAPP) is to confirm that the BRF 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 Bull Run Fossil Plant Environmental Investigation Plan*, *Revision 3* (BRF EIP; June 2018) and provides QA procedures and quality control (QC) measures to be applied to associated sampling and monitoring activities. This BRF QAPP will govern the quality aspects of the investigation-specific Sampling and Analysis Plans (SAPs).

This BRF QAPP describes the QA implementation for the BRF 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 BRF 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 BRF QAPP describes the generation and use of environmental data associated with the BRF EIP and is applicable to current sampling and monitoring programs associated with the project. Data generated under the BRF 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

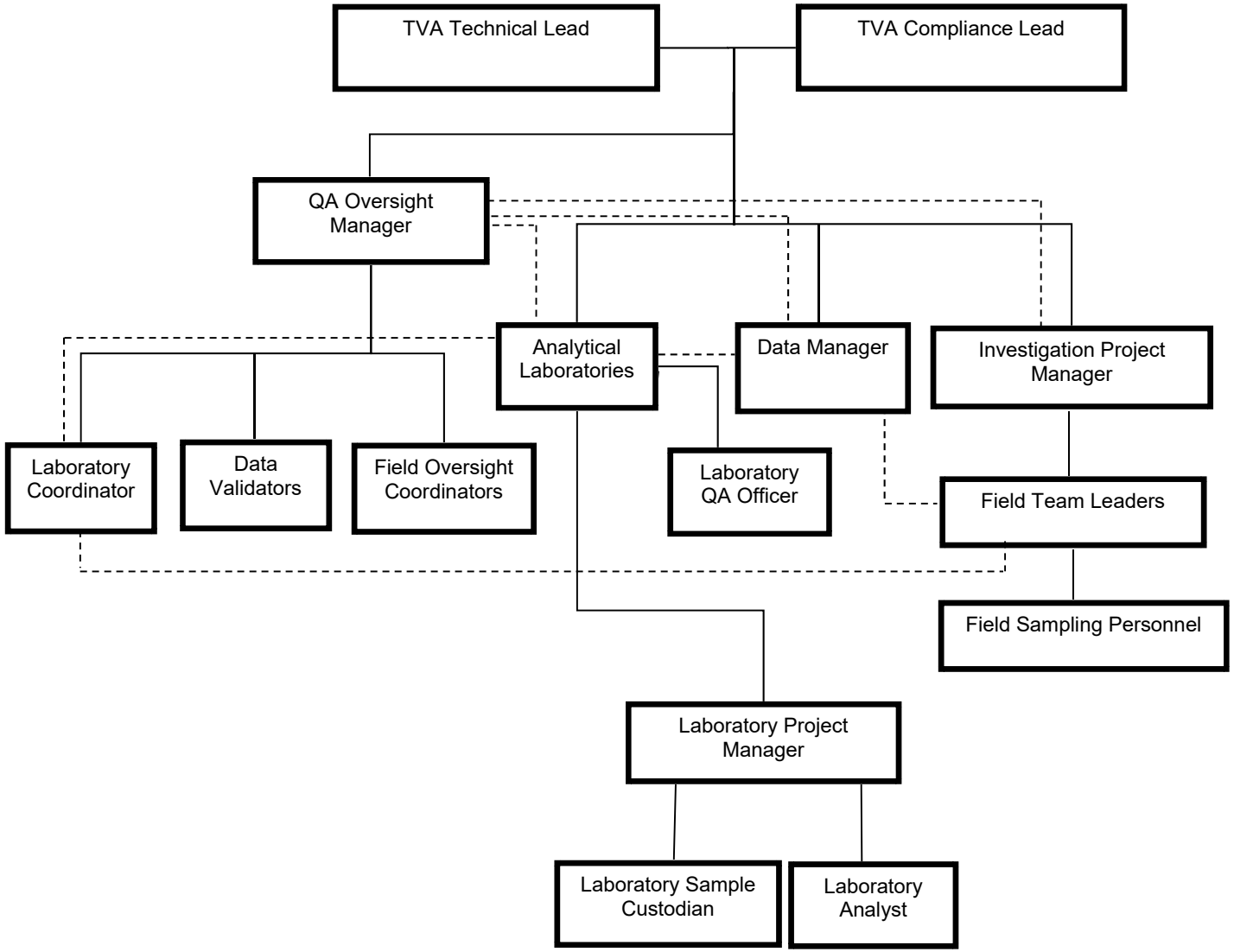
Successful implementation of a QA Program requires clear lines of reporting and authority, along with defined responsibilities for key individuals implementing and administrating the QA Program. This section describes the organizational structure, lines of authority, and responsibilities of key individuals accountable for the implementation and administration of the BRF 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 subset of the overall organizational structure for the project as directly related to implementation of the BRF 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 BRF EIP



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

2.2.1 TVA Compliance Lead

The TVA Compliance Lead is responsible for the coordination and direction of the BRF EIP. The TVA Compliance Lead is ultimately responsible for design and implementation of the BRF 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 BRF EIP strategy.
- Reviewing and approving BRF 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 BRF 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 BRF 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 BRF EIP strategy.
- Developing and reviewing BRF 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 program-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 the 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 personnel, 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 BRF 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 BRF 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 BRF EIP are presented on Table 2-1.

Table 2-1. Analytical Laboratories for BRF EIP

Parameter/ Sample Type	Laboratory	Facility Address	Laboratory Project Manager
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 Ltd.	3052 Beaumont Centre Circle Lexington, KY 40513-1703	Ms. Ryan Jones (ryan.jones@stantec.com)

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 BRF 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 BRF 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 BRF 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 BRF 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 BRF 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 BRF QAPP, program-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 BRF 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 Field Team Leaders, and historical data of known quality used as part of the BRF EIP. The Data Manager is the main point-of-contact for data-related issues. The Data Manager is responsible for ensuring compliance with the BRF 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 Field Team Leader 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, the TDEC issued Commissioner's Order, No. OGC15-0177 (TDEC Order), to the 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 the Bull Run Fossil Plant (BRF) on July 13-14, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at BRF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference. On September 13, 2016, TDEC issued a follow-up letter, which provided specific questions and tasks for TVA to address as part of the EIP. On January 9, 2017 TVA submitted BRF EIP Revision 0.

On June 22, 2017, TDEC issued a letter to TVA regarding the TDEC Order and attached to the letter were environmental investigation plan comments for the TVA BRF site. According to this letter and subsequent discussions between TVA and TDEC, the specific questions and tasks found in the June 22, 2017 TDEC letter were to supersede the original site-specific questions and tasks found in TDEC's September 13, 2016, letter. The General Guidelines for Environmental Investigation Plans provided to TVA as Attachment A in the September 2016 letter remain at TDEC's request. TVA submitted a subsequent revision to the EIP based on site-specific questions and General Guidelines as provided by TDEC. TVA submitted subsequent revisions of the EIP based on review comments provided by TDEC as documented in the TVA BRF EIP Revision Log.

The purpose of the BRF EIP is to characterize the hydrology and geology of the BRF, identify the extent of soil, sediment, surface water, groundwater impact and ecological impact by CCR, and assess the quantities and characteristics of CCR materials currently onsite. 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 BRF.

To support the BRF 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 BRF QAPP. The requirements of the BRF QAPP are applicable to project environmental personnel, support staff, consultants, and subcontractors.

3.1 Purpose and Scope

The BRF QAPP is intended to establish an overall environmental QA framework for the BRF EIP and to provide quantitative quality objectives for analytical data generated under the BRF 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 BRF EIP and provide the appropriate QA procedures and QC measures to be applied to the associated sampling and monitoring activities. The BRF 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 BRF 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 BRF 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 BRF QAPP Distribution and Revision

The BRF 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 BRF 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 BRF QAPP will identify the BRF QAPP 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 BRF 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 Project Manager, 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 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 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 program-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 BRF 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 BRF 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 BRF 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 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 and/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 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 45 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. 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 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 BRF 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 BRF EIP. To maintain uniformity and consistency among analytical laboratories, the EDD format for the transfer of data associated with the BRF 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 BRF 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 BRF 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 BRF EIP. These samples will be subject to a variety of chemical, radiological, and physical analyses to support the objectives outlined in the BRF 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 BRF 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 BRF 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 program-specific 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 SAP 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 SAP. 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 BRF 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 BRF 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 QA Oversight Consultant's 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 Team 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 (or < -10 °C) for frozen samples before and after sample analysis, and the proper disposal of samples. Upon sample receipt, the Laboratory 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 BRF 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 BRF 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 BRF 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 BRF 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 BRF EIP, the collected samples will be tested for the methods, constituents, and reporting limits presented in Attachments E through L of this BRF 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 BRF 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 BRF 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 and biological 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 BRF EIP. Specific quantitative QA objectives for each investigation are presented in Attachments E through L of this BRF 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 program-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 BRF EIP are presented in Attachments E through L of this BRF 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 accuracy and precision may be found in Section 19.0 of the BRF 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 BRF 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 BRF 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[c]	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 laboratory duplicate (LD) 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 Field Team 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 BRF 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 BRF 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 BRF 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 BRF 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 BRF 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 has been 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 project 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 BRF 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 BRF QAPP includes systems and performance audits to ensure that established QA procedures are properly implemented.

The BRF 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 BRF 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 BRF

QAPP will identify the BRF 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 BRF 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, QA Oversight Manager, 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 BRF 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 Department 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 BRF 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 BRF 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 BRF 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 BRF 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 BRF 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 BRF 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 the field team 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.

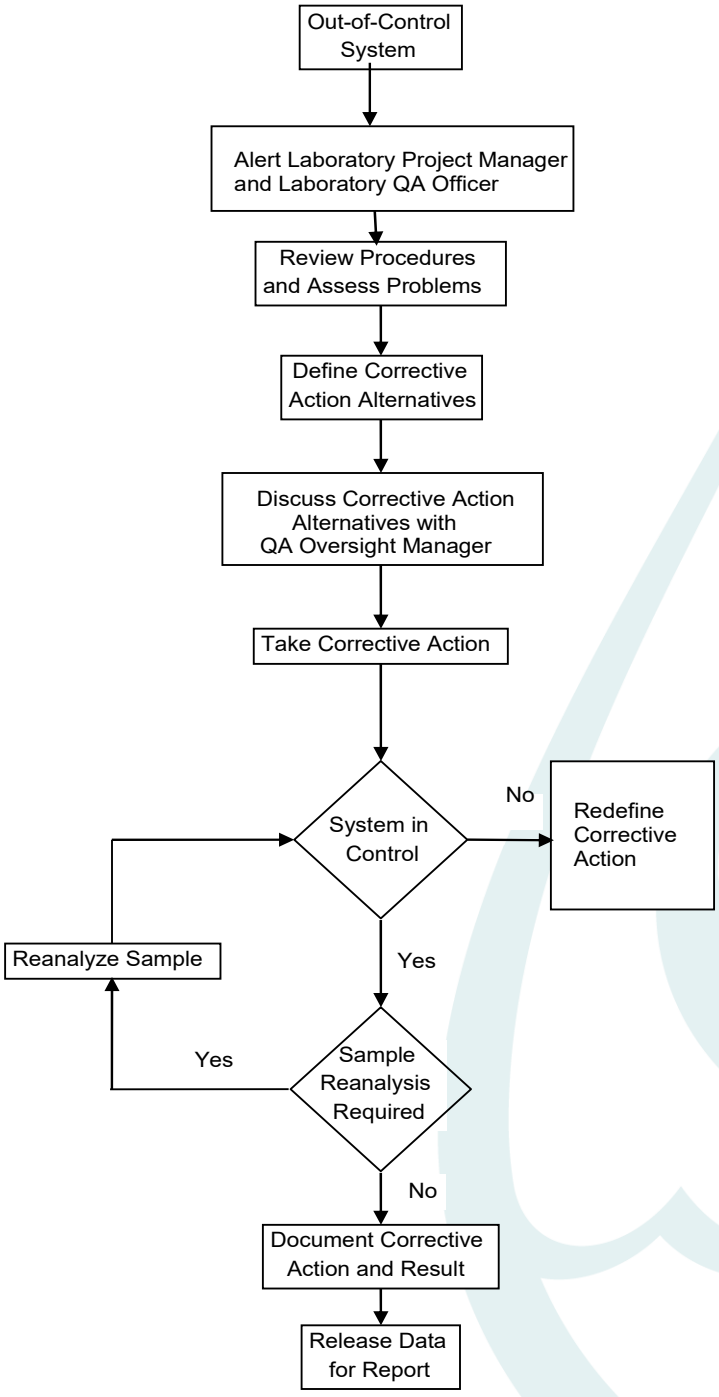
If the assessment reveals that the QC acceptance criteria are not met, the laboratory must immediately evaluate the analytical system and correct the problem. The Laboratory Analyst will notify the Laboratory Project Manager and Laboratory QA Officer of the problem and, if possible, will identify potential 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 BRF 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 to 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 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 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 to TVA and the QA Oversight Consultant as separate documents and will be transmitted in an electronic (.pdf and EDD) and/or hardcopy formats. The QA Oversight Consultant will maintain a database of TVA data for data validation and/or verification. The QA Oversight Consultant 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 results 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 BRF EIP 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 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 the BRF 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 BRF 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 BRF EIP are presented in Attachments E through L of this BRF 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 analyses 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 BRF 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 BRF 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 BRF 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 program-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 BRF 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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US EPA. 40 CFR Part 136, *Final Methods Update Rule*, March 2008.

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 and
- 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 Summaries: 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 activity (MDA). The sample-specific MDA 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 MDA 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)
- measurement 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 MDA 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 MDA observed in the original sample aliquot
- observed activity, uncertainty, and MDA 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 BRF 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**
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-05.80.42	*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*
TVA-GAF-SOP-02	*Sediment 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:

Lab Name:	
Address:	#N/A
Lab PM:	#N/A
Phone/Fax:	#N/A
Lab PM email	#N/A
Applicable Lab Quote #:	

Required Project Information:

Site ID #:			
Project #	#N/A		
Site Address	#N/A		
City	#N/A	State, Zip	#N/A
Site PM Name	#N/A		
Phone/Fax:			
Site PM Email:			

Required Sampler Information:

Sampler			
Sampling Company			
Address:			
City/State		Phone #:	
Reimbursement project?		Non-reimbursement	Mark one
Send EDD to			
CC Hardcopy report to			
CC Hardcopy report to			

TAT: Standard ____ Rush ____ Mark One

ITEM #	SAMPLE ID Samples IDs MUST BE UNIQUE	SAMPLE LOCATION	Sample Depth Depth Unit: Start Depth	Sample Depth End Depth	MATRIX CODE	G=GRAB C=COMP	SAMPLE TYPE	SAMPLE DATE	SAMPLE TIME	#OF CONTAINERS	Comments/Lab Sample I.D.	Analysis: Filtered	Preserve	Analysis
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
Temp in 0C	Samples on Ice?	Sample Intact?	Trip Blank?

SHIPPING METHOD: (mark as appropriate)

UPS COURIER \ FEDEX

US MAIL

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER:

SIGNATURE of SAMPLER:

ATTACHMENT D

SAMPLE NOMENCLATURE

Table A: TVA - TDEC Order Sample Naming Conventions – Bull Run Fossil Plant

Site (Plant) Name	Site Acronym	Sample Type (Matrix)	Matrix Sample Type Acronym	Location	Location ID	Depth Interval (If Applicable)	Quality Assurance/Quality Control Sample Type	QA/QC Sample Type Acronym	Date of Sample	Example
Bull Run Fossil Plant	BRF	Background Soil	BS	Soil Boring Number	BGXX	Feet/Feet	Equipment Rinsate Blank	EBXX	Year/Month/Day	BRF-BS-BGXX-6.0/8.0-20180314 BRF-BS-EBXX-20180314 BRF-BS-FBXX-20180314 BRF-BS-DUPXX-20180314
		Coal Combustion Residual	CCR	Temporary Well Number	TWXX	Feet/Feet	Field Blank	FBXX	Year/Month/Day	BRF-CCR-TWXX-6.0/8.0-20180314 BRF-CCR-EBXX-20180314 BRF-CCR-FBXX-20180314 BRF-CCR-DUPXX-20180314
		Groundwater	GW	Monitoring Well Number	MWXX or Existing Name	Feet Below Top of Casing	Filter Blank	FLBXX	Year/Month/Day	BRF-GW-MWXX-30.0-20180314 BRF-GW-BRF201-20180314 BRF-GW-EBXX-20180314 BRF-GW-FBXX-20180314 BRF-GW-FLBXX-20180314 BRF-GW-DUPXX-20180314
		Pore Water	PW	Temporary Well Number	TWXX	NA	Field Duplicate	DUPXX	Year/Month/Day	BRF-PW-TWXX-20180314 BRF-PW-EBXX-20180314 BRF-PW-FBXX-20180314 BRF-PW-FLBXX-20180314 BRF-PW-DUPXX-20180314
		Seep Soil	SeS	Seep Number	XX	NA	Matrix Spike/Matrix Spike Duplicate *Note applicable sample on COC	MS/MSD	Year/Month/Day	BRF-SeS-XX-20180314 BRF-SeS-EBXX-20180314 BRF-SeS-FBXX-20180314 BRF-SeS-DUPXX-20180314
		Seep Water	SeW	Seep Number	XX	NA			Year/Month/Day	BRF-SeW-XX-20180314 BRF-SeW-EBXX-20180314 BRF-SeW-FBXX-20180314 BRF-SeW-FLBXX-20180314 BRF-SeW-DUPXX-20180314
		Surface Stream **Not Stratified:**	STR	Water Body Acronym Spatial Location Number	CR = Clinch River BRC = Bull Run Creek WB = Worthington Branch	SUR = Water Surface MID = Mid Column BOT = Epibenthic			Year/Month/Day	BRF-STR-CRXX-SUR-20180314 BRF-STR-CRXX-Mid-20180314 BRF-STR-CRXX-BOT-20180314 BRF-STR-BRCXX-SUR-20180314 BRF-STR-BRCXX-Mid-20180314 BRF-STR-BRCXX-BOT-20180314 BRF-STR-WBXX-SUR-20180314 BRF-STR-WBXX-Mid-20180314 BRF-STR-WBXX-BOT-20180314 BRF-STR-EBXX-20180314 BRF-STR-FBXX-20180314 BRF-STR-FLBXX-20180314 BRF-STR-DUPXX-20180314

Site (Plant) Name	Site Acronym	Sample Type (Matrix)	Matrix Sample Type Acronym	Location	Location ID	Depth Interval (If Applicable)	Quality Assurance/Quality Control Sample Type	QA/QC Sample Type Acronym	Date of Sample	Example
		Surface Stream **Stratified:**	STR	Water Body Acronym Spatial Location Number	CR = Clinch River BRC = Bull Run Creek WB = Worthington Branch	SUR = Near Surface ME = Mid-Epillimnion MH = Mid-Hypolimnion BOT = Near Bottom			Year/Month/Day	BRF-STR-CRXX-SUR-20180314 BRF-STR-CRXX-ME-20180314 BRF-STR-CRXX-MH-20180314 BRF-STR-CRXX-BOT-20180314 BRF-STR-BRCXX-SUR-20180314 BRF-STR-BRCXX-ME-20180314 BRF-STR-BRCXX-MH-20180314 BRF-STR-BRCXX-BOT-20180314 BRF-STR-WBXX-SUR-20180314 BRF-STR-WBXX-ME-20180314 BRF-STR-WBXX-MH-20180314 BRF-STR-WBXX-BOT-20180314 BRF-STR-EBXX-20180314 BRF-STR-FBXX-20180314 BRF-STR-FLBXX-20180314 BRF-STR-DUPXX-20180314
		Water Supply	WS	Well ID # or Property Owner Name	State or USGS Well # or Property Owner Name	NA			Year/Month/Day	BRF-WS-TN0001-20180314 BRF-WS-JOHNDOE-20180314 BRF-WS-EBXX-20180314 BRF-WS-FBXX-20180314 BRF-WS-FLBXX-20180314 BRF-WS-DUPXX-20180314
		Macro-invertebrate	MAC	See Table C						
		Adult Mayflies	MFA	See Table B						
		Purated Mayfly Nymphs	MFP	See Table B						
		Non-Purated Mayfly Nymphs	MFN	See Table B						
		Fish	FH	See Table B						
		Sediment	SED	See Table C						

Table B: TVA – TDEC Order Sample Naming Conventions - Bull Run Fossil Plant Fish and Mayfly Nomenclature

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
Bull Run Fossil Plant	BRF	Adult Mayflies	MFA	NA	NA	CRD: Clinch River Downstream Reach (Approximately CRRM 43.1 - 44.1)	NA	Field Duplicate	DUPXX	Year/Month/Day	BRF-MFA-CRD-20180314 BRF-MFA-DUPXX-20180314 BRF-MFA-EBXX-20180314
		Purated Mayfly Nymphs	MFP	NA	NA	CRA: Clinch River Adjacent Reach (Approximately CRRM 46.1 - 48.1)	NA	Equipment Rinsate Blank	EBXX	Year/Month/Day	BRF-MFP-CRA-20180314 BRF-MFP-DUPXX-20180314 BRF-MFP-EBXX-20180314
		Non-Purated Mayfly Nymphs	MFN	NA	NA	CRU: Clinch River Upstream Reach (Approximately CRRM 50.3 - 51.3)	NA	Matrix Spike/Matrix Spike Duplicate *note sample on COC, not proposed on Fish samples	MS/MSD	Year/Month/Day	BRF-MFN-CRU-20180314 BRF-MFN-DUPXX-20180314 BRF-MFN-EBXX-20180314
		Fish	FH	Blue Gill	BG	BRCA: Bull Run Creek Adjacent Reach (Approximately BRCCM 0 - 1.0)	F = Fillet tissue sample O = Ovary tissue sample L = Liver tissue sample			Year/Month/Day	BRF-FH-BG-BRCA-F-20180314 BRF-FH-BG-BRCA-O-20180314 BRF-FH-BG-BRCA-L-20180314 BRF-FH-BG-F-DUPXX-20180314 BRF-FH-BG-F-EBXX-20180314
				Channel Catfish	CC		F = Fillet tissue sample O = Ovary tissue sample L = Liver tissue sample			Year/Month/Day	BRF-FH-CC-CRD-F-20180314 BRF-FH-CC-CRD-O-20180314 BRF-FH-CC-CRD-L-20180314 BRF-FH-CC-F-DUPXX-20180314 BRF-FH-CC-F-EBXX-20180314
				Largemouth Bass	LB		F = Fillet tissue sample O = Ovary tissue sample L = Liver tissue sample			Year/Month/Day	BRF-FH-LB-CRA-F-20180314 BRF-FH-LB-CRA-O-20180314 BRF-FH-LB-CRA-L-20180314 BRF-FH-LB-F-DUPXX-20180314 BRF-FH-LB-F-EBXX-20180314
				Redear Sunfish	RS		F = Fillet tissue sample O = Ovary tissue sample L = Liver tissue sample			Year/Month/Day	BRF-FH-RS-CRU-F-20180314 BRF-FH-RS-CRU-O-20180314 BRF-FH-RS-CRU-L-20180314 BRF-FH-RS-F-DUPXX-20180314 BRF-FH-RS-F-EBXX-20180314
				Shad	SH		WF = Whole Fish			Year/Month/Day	BRF-FH-SH-BRCA-WF-20180314 BRF-FH-SH-WF-DUPXX-20180314 BRF-FH-SH-WF-EBXX-20180314

Table C: TVA - TDEC Order Benthic Sample Naming Conventions - Bull Run Fossil Plant Sediment and Benthic Sample Nomenclature

Site (Plant) Name	Site Acronym	Sample Type (Matrix)	Biota Matrix Code	Location	Location ID	Transect Number	Sample Number	Depth Interval (If Applicable)	Quality Control/Quality Assurance Sample Type	QA/QC Sample Type Acronym	Date of Sample	Example
Bull Run Fossil Plant	BRF	Macroinvertebrate	MAC	Water Body Acronym	CR = Clinch River BRC = Bull Run Creek WB = Worthington Branch	CRXX BRCXX WBXX	BENXX	Feet/Feet	NA	NA	Year/Month/Day	BRF-MAC-CRXX-BENXX-0.0/0.5-20180314 BRF-MAC-BRCXX-BENXX-0.0/0.5-20180314 BRF-MAC-WBXX-BENXX-0.0/0.5-20180314
		Sediment	Sed	Water Body Acronym	CR = Clinch River BRC = Bull Run Creek WB = Worthington Branch	CRXX BRCXX WBXX	CORXX	Feet/Feet	Equipment Rinsate Blank	EBXX	Year/Month/Day	BRF-SED-CRXX-CORXX-0.0/0.5-20180314 BRF-SED-BRCXX-CORXX-0.0/0.5-20180314 BRF-SED-WBXX-CORXX-0.0/0.5-20180314 BRF-SED-CRXX-EBXX-20180314 BRF-SED-CRXX-DUPXX-20180314 BRF-SED-BRCXX-EBXX-20180314 BRF-SED-BRCXX-DUPXX-20180314 BRF-SED-WBXX-EBXX-20180314 BRF-SED-WBXX-DUPXX-20180314
									Field Duplicate	DUPXX		
									Matrix Spike/Matrix Spike Duplicate *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
Soil	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

*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.

Notes:

oz - ounce
g - grams
mL - milliliter
L - liter
HDPE - High Density Polyethylene
NA - Not applicable

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	20	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

GROUNDWATER INVESTIGATION 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
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)	250-mL HDPE	100 mL	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.

Table F-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 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
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
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

Parameter	CAS No.	Method	Reporting Limit	Units
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
µg/L - micrograms per liter
pCi/L - picoCuries per liter
CALC - Parameter determined by calculation.

Table F-3: Quantitative QA Objectives – Groundwater

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
pH	SW-846 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 G

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

SURFACE STREAM SAMPLING

Table G-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	1 L (unfiltered)	Cool to < 6°C	7 days

Notes:

oz - ounce
g - grams
mL - milliliter
L - liter
HDPE - High Density Polyethylene
NA - Not applicable

Table G-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 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	0.5	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
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

Parameter	CAS No.	Method	Reporting Limit	Units
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
µg/L - micrograms per liter
pCi/L - picoCuries per liter
CALC - Parameter determined by calculation.

Table G-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 H

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

BENTHIC SAMPLING

Table H-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 (nymphs and adults)	Metals	4-oz WM jar	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 H-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 H-3: Analytes, Methods, and Reporting Limits – Benthic 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	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
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	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 H-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 H-5: Quantitative QA Objectives – Benthic 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 I

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

FISH TISSUE SAMPLING

Table I-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 I-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 I-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 J

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

CCR MATERIAL CHARACTERISTIC SAMPLING

Table J-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	Cool to < 6°C	180 days
	Mercury				28 days
	Radiological Parameters			Cool to < 6°C	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 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 Cool to < 6°C	180 days
	Total Dissolved Solids (TDS)[2]	250-mL HDPE	100 mL (unfiltered)	Cool to < 6°C	7 days
	Total Organic Carbon	2x 40-mL VOA Vial	40-mL	Cool to ≤ 6°C HCl 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 J-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

Parameter	CAS No.	Method	Reporting Limit [1]	Units
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 – 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
Total Dissolved Solids	TDS	SM2540C	10.0	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

Parameter	CAS No.	Method	Reporting Limit	Units
Vanadium	7440-62-2	SW-846 6020A	1.00	µg/L
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 J-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 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
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

Parameter	CAS No.	Method	Reporting Limit	Units
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
µg/L - micrograms per liter
pCi/L - picoCuries per liter
CALC - Parameter determined by calculation.

Table J-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 J-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
Anions (Chloride, Fluoride, Sulfate)	SW-846 9056A	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

Table J-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 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 K

INVESTIGATION-SPECIFIC QUALITY CONTROL REQUIREMENTS

WATER USE SURVEY SAMPLING

Table K-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
	Total Dissolved Solids (TDS)	250-mL HDPE	100 mL	Cool to < 6°C	7 days
	Alkalinity (Total, Carbonate, and Bicarbonate)	250 mL HDPE	50-mL	Cool to < 6°C	14 days
	pH	NA	NA	NA	15 minutes

Notes:

mL - milliliter
L - liter
HDPE - High Density Polyethylene
NA - Not applicable

Table K-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 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	0.500	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
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

Parameter	CAS No.	Method	Reporting Limit	Units
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 K-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 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
Alkalinity (Total, Carbonate, and Bicarbonate)	SM2320B	NA	< RL	80-120	75-125	20	20	20	RPD < 20% difference < 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
RER - Relative Error
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

Matrix	Parameter(s)	Container Type	Recommended Sample Mass/Volume	Preservation[1]	Holding Time
Seep 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)[2]	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
Seep Soil	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

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.

*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 E
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
Director
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TENNESSEE VALLEY AUTHORITY

MULTI-SITE ORDER ENVIRONMENTAL INVESTIGATIONS

DATA MANAGEMENT PLAN

Revision 1

March 2018

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Revision Log MULTI-SITE ORDER ENVIRONMENTAL INVESTIGATIONS DATA MANAGEMENT PLAN (TVA EI DMP)		
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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.

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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.

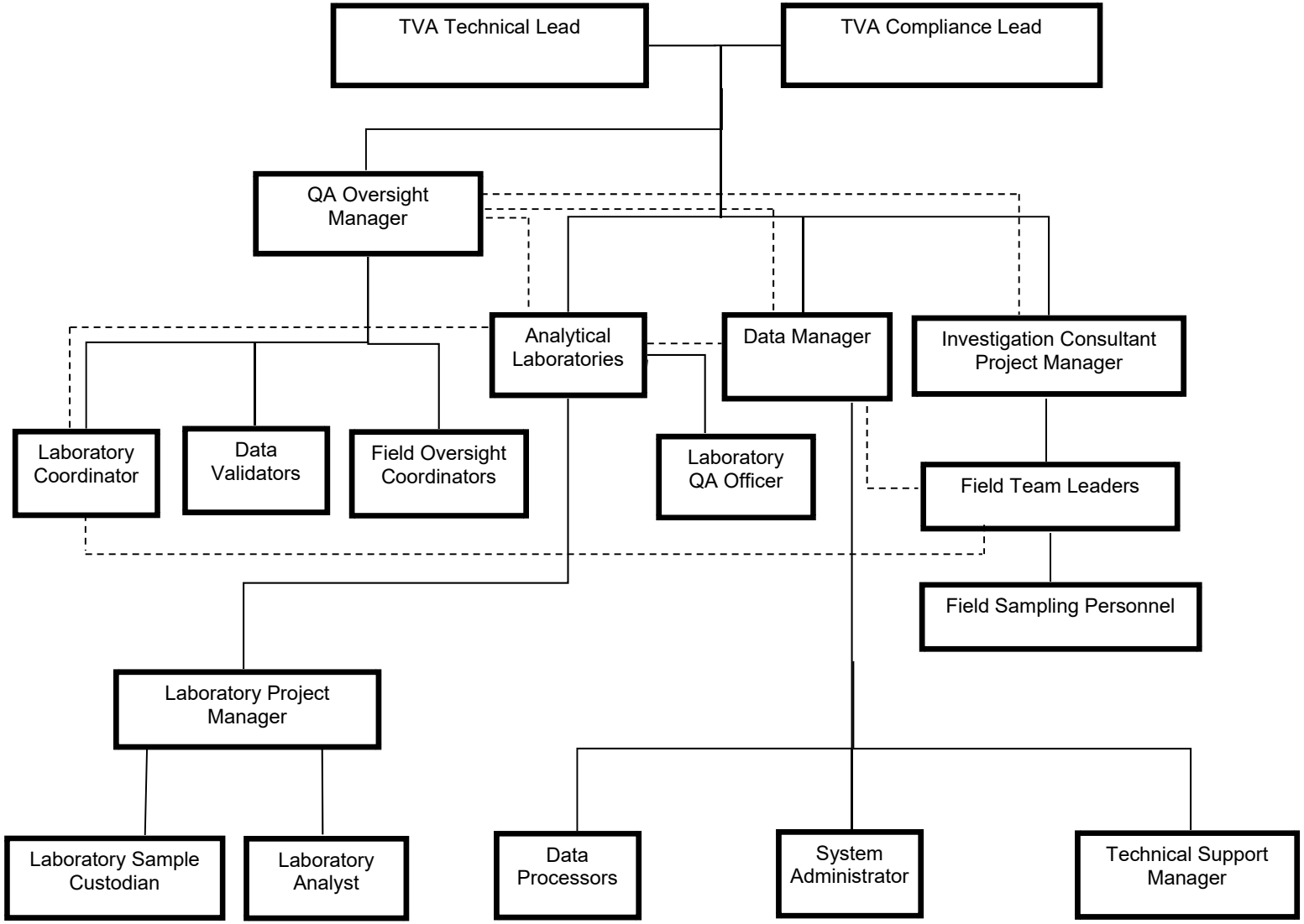
Users of the EQuIS Quality and Data Management System (EQDMS) primarily consist of technical and project staff that are assumed to have a general understanding of the environmental data and the EIs being conducted at each TVA facility. Some users are also required to have an advanced understanding of 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.

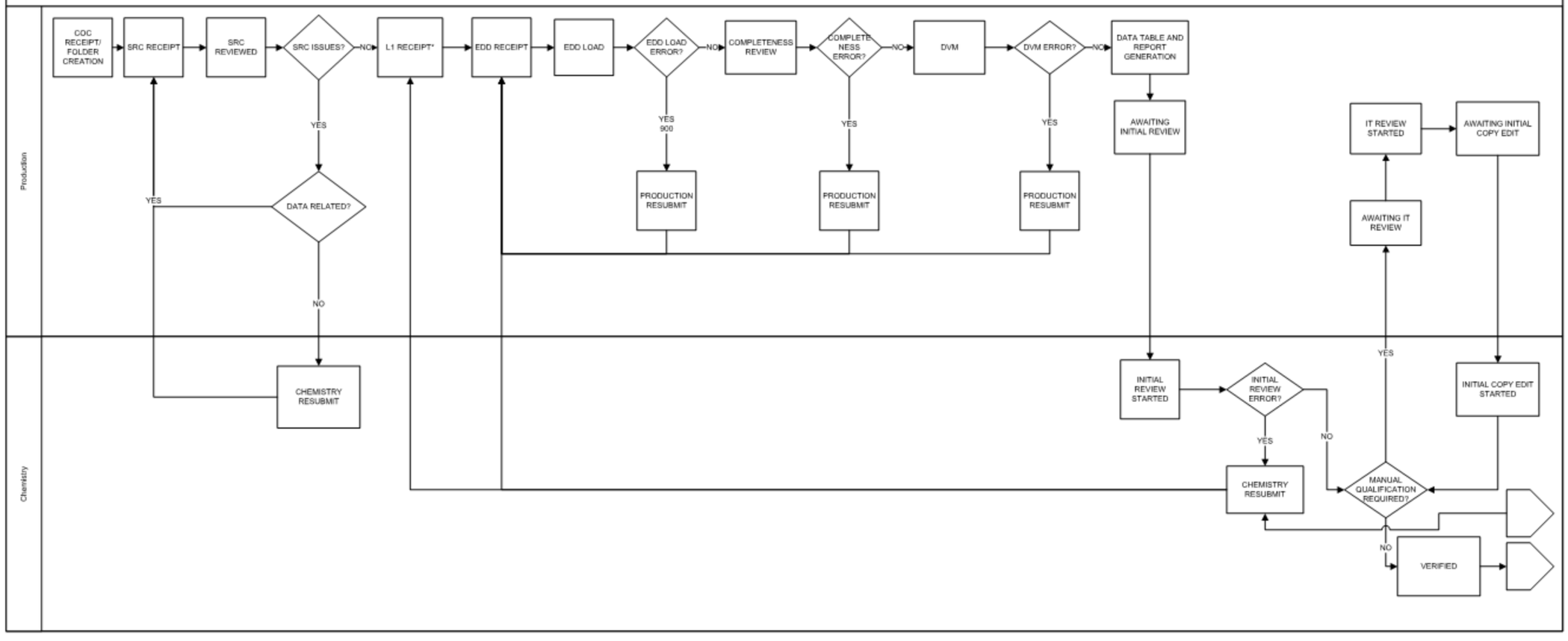
6.0 REFERENCES

- 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



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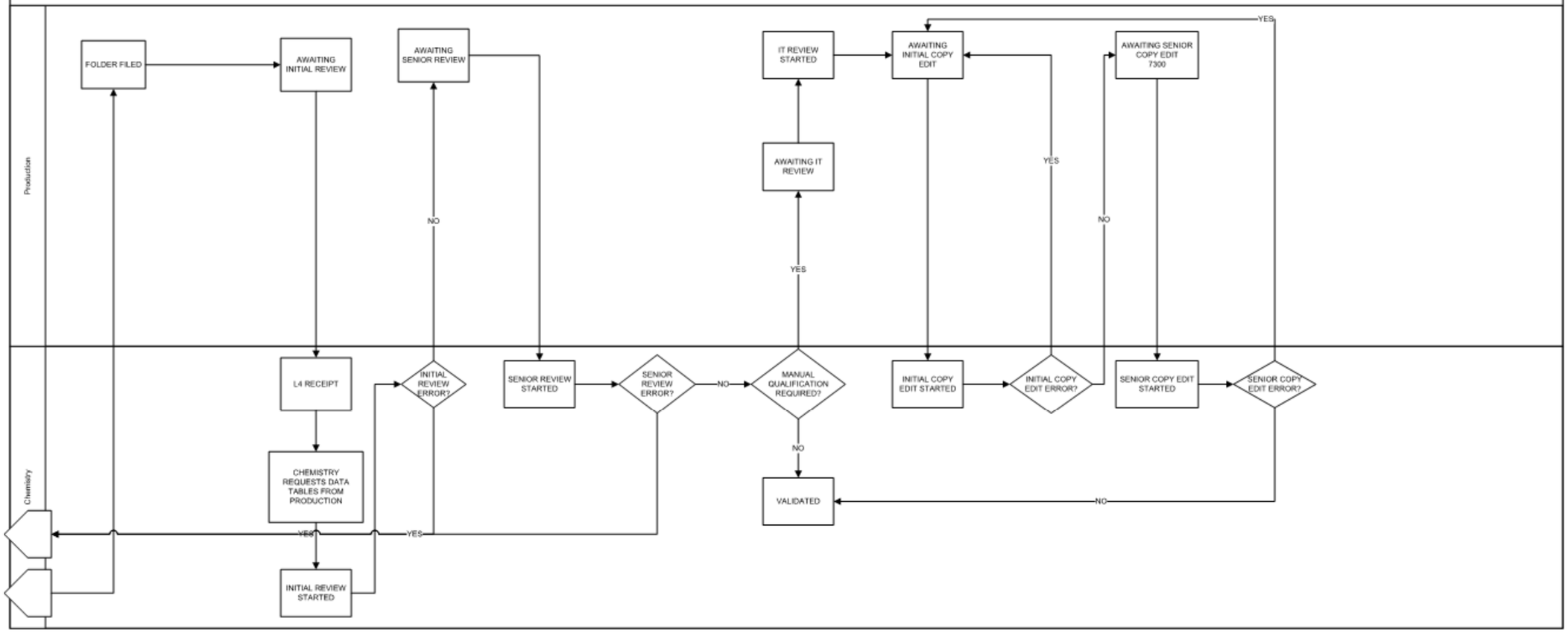
TVA DATA MANAGEMENT PROCESS/VERIFICATION AND VALIDATION (CONT)



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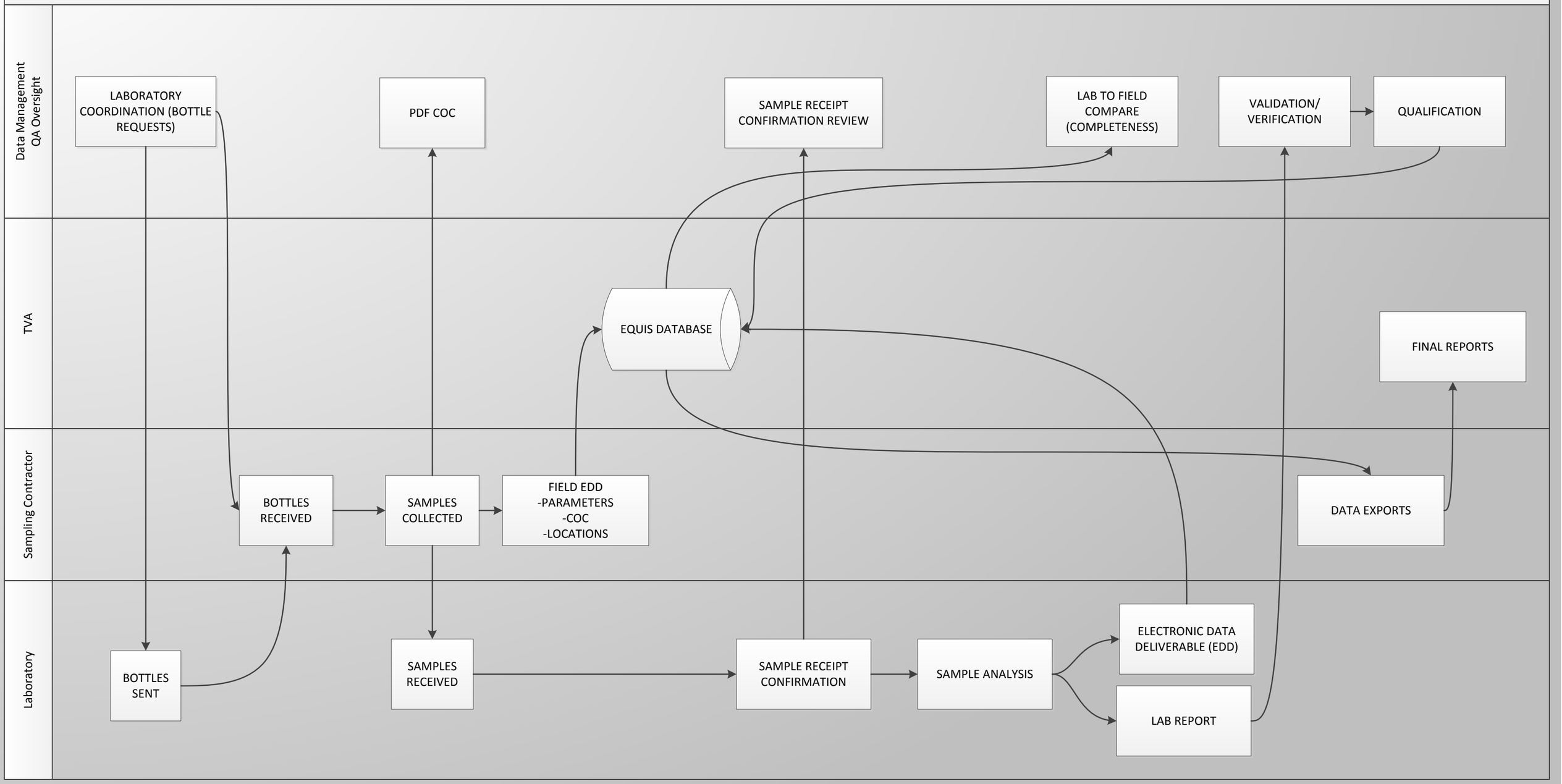
Lab Coordination/Data Management Process



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APPENDIX B

EQUIS EDD SPECIFICATIONS

ENVIRONMENTAL STANDARDS

EQuIS EQEDD Laboratory EDD Specifications

November 2017

ENVIRONMENTAL STANDARDS

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.

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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

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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.

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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

ENVIRONMENTAL STANDARDS

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.

ENVIRONMENTAL STANDARDS

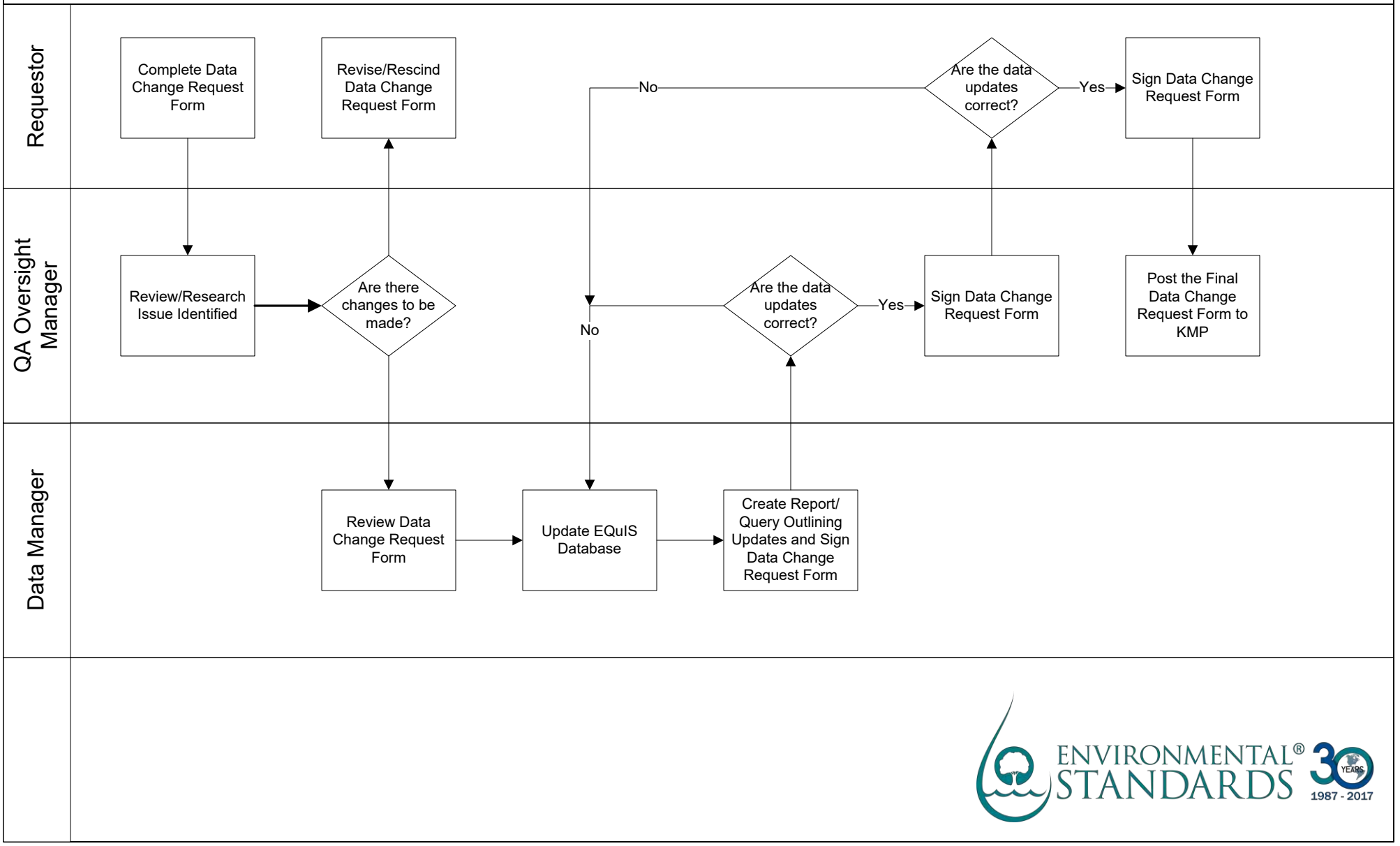
Well Construction

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



ENVIRONMENTAL® STANDARDS 30 YEARS 1987 - 2017

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.

Requestor Information		Data Manager use:
Date:		
Proposed Completion Date:		
Name:		
Company:	Phone:	
E-mail:		
Description of Request: (Below)	File Attached? Y N	
Summary: Proposed Solution:		Date Completed:

Data Manager/QA Oversight Manager

Signature _____ **Date:** _____

Signature _____ **Date:** _____

Data Change Requestor

Signature _____ **Date:** _____

Stakeholders to Notify:

APPENDIX F
HYDROGEOLOGICAL INVESTIGATION SAP

Hydrogeological Investigation Sampling and Analysis Plan Bull Run Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Bull Run Fossil Plant
Clinton, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 17, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	October 27, 2017
2	Addresses January 29, 2018 TDEC Review Comments and Issued for TDEC Review	March 30, 2018
3	Addresses May 22, 2018 TDEC Review Comments and Issued for TDEC Review	July 13, 2018
4	Addresses TDEC Comments, Applicable Programmatic Revisions, and Issued for TDEC Approval	December 17, 2018

HYDROGEOLOGICAL INVESTIGATION
SAMPLING AND ANALYSIS PLAN
BULL RUN FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Hydrogeological Investigation
Sampling and Analysis Plan
Bull Run Fossil Plant
Tennessee Valley Authority
Clinton, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 17, 2018 Revision 4

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: 12/13/18

McClung, Nicholas Anthony — Digitally signed by McClung, Nicholas Anthony Date: 2018.12.07 09:45:48 -05'00'
TVA Investigation Field Lead — Date

Health, Safety, and Environmental (HSE) Manager — Date: 12/13/18

Investigation Project Manager — Date: 12/6/2018

Rock J. Vitale — Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rjvitale@envstd.com, c=US Date: 2018.12.11 12:54:49 -05'00'
QA Oversight Manager — Date

Laboratory Project Manager — Date: 12/6/2018

Charles L. Head
TDEC Senior Advisor — Date

Robert Wilkinson
TDEC CCR Technical Manager — Date

Stantec

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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 Bull Run Fossil Plant (BRF) on July 13-14, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at BRF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference.

On September 13, 2016, TDEC issued 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 January 9, 2017, TVA submitted BRF 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 for measuring groundwater levels, and to provide locations to collect groundwater samples. The plan provides procedures and methods necessary to conduct investigation activities at the BRF plant.

2.0 OBJECTIVES

The objectives of this Hydrogeological Investigation SAP are to characterize groundwater flow and evaluate the potential presence of CCR constituents in groundwater. At BRF there are six CCR units where ash has been managed or placed, and those areas are the Dry Fly Ash Stack Area, the Bottom Ash Disposal Area, the Gypsum Disposal Area 2A, Main Ash Pond, Fly Ash Stilling Pond 2C, and the Railroad Loop Disposal Area. To support the characterization, monitoring wells are proposed to be installed to augment the current observation and monitoring well network (Figure 1) and to provide locations to collect groundwater quality samples for analysis of CCR constituents. A bedrock groundwater characterization investigation will also be performed utilizing surface and downhole geophysics, borings and monitoring wells to investigate the flow patterns and water quality in the bedrock. A Plant-specific Quality Assurance Project Plan (QAPP) will provide the procedures necessary to conduct investigation activities associated with the hydrogeological investigation (Appendix D to the EIP).

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 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 AND PIEZOMETER LOCATIONS

TVA has investigative activities underway at BRF for the CCR Rule, TDEC permitting requirements and capital projects that will provide information that can be used to characterize the hydrogeology of BRF. Some of this work has been conducted, but final reports have not been produced, and the results of those investigations are not yet available to identify final locations to evaluate the need for additional monitoring wells. 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 monitoring wells will also be used to collect groundwater samples to characterize groundwater quality at the Plant. Groundwater sampling frequency and procedures are provided in the Groundwater Investigation SAP.

The BRF site is typical of the Valley and Ridge province and reflects the geologic structure of the area, which consists generally of northeast strike and southeast-dipping strata (Kellberg, 1959). Three different bedrock units underlie the site's overburden, which ranges in thickness from one to two feet in some places near Bull Run Ridge to approximately forty feet near the Clinch River. The Cambrian and Ordovician age bedrock units are, from oldest to youngest: the Rome Formation, Conasauga Group, and the Chickamauga Group. Figure 2 shows a geologic map of BRF. The Rome Formation underlies Bull Run Ridge and is composed of interbedded sandstone, siltstone, shale and locally dolomite. The Conasauga Group underlies the area extending from the southern flank of Bull Run Ridge to the southeast of Bull Run Creek and can be subdivided into six distinct units which are, from top to bottom: Maynardville Limestone, Nolichucky Shale, Maryville Limestone, Rogersville Shale, Rutledge Limestone and Pumpkin Valley Shale. The Chickamauga Group lies between the southern flank of Flint Ridge to the northern flank of Bull Run Ridge and consists of a heterogeneous assemblage of limestones, shaley limestones, calcareous shales, and calcareous siltstones.

Geologic structures on the BRF site include the Copper Creek Thrust Fault near the top of Bull Run Ridge. The strike of the Copper Creek Thrust Fault is generally parallel to that of the bedrock layers and dips to the southeast. The Copper Creek Thrust Fault has also raised up and thrust the older Rome Formation northwestward so that it now overlies the younger, overturned Chickamauga Group. Evidence of other faulting and folding associated with the Copper Creek Thrust Fault has been seen in rock cores drilled at BRF (Kellberg, 1959). The Geologic Map of the Clinton Quadrangle indicates that there is a strike slip fault running northwest - southeast beneath the Clinch River and then under the BRF site near the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, and the Main Ash Pond. This fault has no name and its location on the published geologic maps is only an approximation (Tennessee Department of Conservation, 1964).

TVA will conduct a hydrogeological characterization of the site to further evaluate the groundwater flow conditions beneath the BRF property. Prior groundwater investigations have indicated that groundwater flow is potentially influenced by bedding planes and fractures within the bedrock. As part of this investigation, 18 new pilot holes will be drilled into bedrock and either converted to piezometers or monitoring wells. The pilot holes will be drilled in upgradient and downgradient locations and are proposed to be extended to depths of approximately 60 feet below the overburden/bedrock contact as shown on Figure 1. In addition, six monitoring wells are proposed to be installed in overburden.

Upon completion of drilling and prior to targeted pressure testing (packer tests) to provide a measure of hydraulic conductivity of bedrock, downhole geophysical techniques, including acoustic televiewer, gamma logging, caliper logging, heat pulse flowmeter, and fluid resistivity, will be used to characterize bedrock and groundwater flow within the pilot holes. Other parameters, including specific conductance, dissolved oxygen, pH, and temperature will be collected to evaluate the groundwater conditions beneath the site. These data will allow TVA to evaluate the influence that the fractures and bedding planes encountered in the pilot holes have on groundwater flow. The intervals to be pressure tested will be selected based on observations made from the rock core, such as fracture zones, signs of water movement and weathered zones, drilling observations, and the results of the geophysical and groundwater quality testing.

Nine pilot holes are proposed to be paired with nine existing shallow monitoring wells (I, G, J, 47, 48, 50, S, BRF-104 and 2). The pilot holes near locations 47, 48, 50, S, BRF-104 and 2 will be converted into monitoring wells. The pilot holes near wells I, G and J may be converted into piezometers or monitoring wells, depending on site conditions. If there is little to no groundwater or if viable screen locations are close enough to an existing well screen interval to not warrant the installation of a monitoring well, then it will be turned into a piezometer. In addition, if it is determined that the pilot hole is not in a location that is representative of a groundwater flow path from a CCR unit, then a piezometer will be installed instead of a monitoring well.

Four pilot holes paired with proposed new overburden wells will be installed around the Railroad Loop Disposal Area (BRF-108, BRF-109, BRF-110 and BRF-111). These new monitoring wells will consist of two background wells and two downgradient wells. The pilot holes will be converted into piezometers. Two pilot holes will be drilled along the northwest boundary of the Dry Fly Ash Stack Phase 2 to further investigate the hydrogeological conditions upgradient of the Dry Fly Ash Stack and help the understanding of groundwater flow in this area. These locations will be converted into piezometers because additional upgradient monitoring wells are not needed.

Two pilot holes paired with proposed overburden and bedrock wells will be drilled north and west of the Former Disposal Area and Chemical Pond. One of these pilot holes will be drilled near the former location of closed wells O and R and the second pilot hole will be drilled near the north end of the Former Disposal Area. If ash is encountered in these areas, then the well locations may need to be moved. Both of these pilot holes will be converted into monitoring wells.

One pilot hole will be drilled near the former locations of closed wells Q and K southwest of the Dry Fly Ash Stack Lateral Expansion. This location will be converted into a monitoring well.

The two proposed locations northwest of the Dry Fly Ash Stack will be located after completion of a surface geophysical survey using electrical resistivity imaging (ERI). The goal of the surface geophysics will be to identify potential zones of preferential groundwater flow. Proposed transects for the survey are shown on Figure 3.

As part of TVA's plan to further characterize the groundwater conditions in the bedrock near the Clinch River, it is proposed to attempt to drill pilot holes 47-D, 48-D and BRF-112-D (see Figure 2) through the estimated location of the unnamed strike-slip fault zone that is mapped near the Bottom Ash Disposal Area. Prior to installation of these borings, frequency domain electromagnetics (FDEM) and Electrical Resistivity Imaging (ERI) surface geophysical methods will be utilized in an effort to identify the location of the inferred fault. If the results of this drilling indicate that the fault could be a preferential flow path for groundwater, then further investigation of the fault may be proposed. Proposed transects for the survey are shown on Figure 3.

The screened interval for monitoring wells installed in bedrock will be determined by the findings of the geophysical analysis of the core hole and geological structures mapped in the geological core. Portions of the pilot hole below the screen will be grouted.

The target depths and estimated screened intervals of the proposed wells are presented in Table 1.

Table 1. Proposed Well Construction Details

Well ID	Estimated Total Depth (Feet below Ground Surface)	Estimated Screen Interval (Feet below Ground Surface)	Target Screen Lithology
BRF-108	25	15 - 20	Overburden - Conasauga Group
BRF-108-PZ	85	Dependent on geophysical/ aquifer tests	Bedrock - Conasauga Group
BRF-109	25	15 - 20	Overburden - Conasauga Group
BRF-109-PZ	85	Dependent on geophysical/ aquifer tests	Bedrock - Conasauga Group
BRF-110	25	15 - 20	Overburden - Conasauga Group
BRF-110-PZ	85	Dependent on geophysical/ aquifer tests	Bedrock - Conasauga Group
BRF-111	18	12 - 17	Overburden - Conasauga Group
BRF-111-PZ	75	Dependent on geophysical/ aquifer tests	Bedrock - Conasauga Group
BRF-112	32	32 - 42	Overburden - Chickamauga Group
BRF-112-D	60	Dependent on geophysical/ aquifer tests	Bedrock - Chickamauga Group
BRF-113	32	32 - 42	Overburden - Chickamauga Group
BRF-113-D	60	Dependent on geophysical/ aquifer tests	Bedrock – Chickamauga Group
BRF-114-D	31	Dependent on geophysical/ aquifer tests	Bedrock - Chickamauga Group
BRF-115-PZ	75	Dependent on geophysical/ aquifer tests	Bedrock - Chickamauga Group

Well ID	Estimated Total Depth (Feet below Ground Surface)	Estimated Screen Interval (Feet below Ground Surface)	Target Screen Lithology
BRF-116-PZ	75	Dependent on geophysical/ aquifer tests	Bedrock - Chickamauga Group
G-PZ	65	Dependent on geophysical/ aquifer tests	Bedrock - Chickamauga Group
I-PZ	75	Dependent on geophysical/ aquifer tests	Bedrock - Chickamauga Group
J-PZ	80	Dependent on geophysical/ aquifer tests	Bedrock - Chickamauga Group
2-D	95	Dependent on geophysical/ aquifer tests	Bedrock - Conasauga Group
BRF-104-D	90	Dependent on geophysical/ aquifer tests	Bedrock - Conasauga Group
47-D	100	Dependent on geophysical/ aquifer tests	Bedrock – Rome Formation
48-D	100	Dependent on geophysical/ aquifer tests	Bedrock - Conasauga Group
50-D	100	Dependent on geophysical/ aquifer tests	Bedrock - Conasauga Group
S-D	105	Dependent on geophysical/ aquifer tests	Bedrock - Conasauga Group

Results of investigations to characterize groundwater quality and flow direction will be included and described in the Environmental Assessment Report (EAR). If unexpected unconsolidated or bedrock materials are encountered, then 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 pilot holes or groundwater monitoring wells 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 assist in providing scientifically defensible results.

Monitoring well 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 and Standard Operating Procedures (SOPs), QAPP (Appendix D), SAPs, and HASP.
- Complete required health and safety paperwork and confirm field team members have completed required training.
- Coordinate activities with the drilling subcontractor.
- Clear Access – Proposed geophysical survey transects, pilot hole and monitoring well 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 by TVA 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, including the geophysical surveys, 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/air rotary and coring 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 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 Surface Geophysics

Prior to identifying the locations for the two proposed pilot holes northwest of the Dry Fly Ash Stack and borings targeting the fault along the Clinch River, surface geophysics will be conducted using ERI to identify potential zones of preferential groundwater flow and to investigate the bedrock surface and FDEM to locate the fault. Results of the proposed surface geophysical investigation will be utilized to locate pilot holes. Figure 3 shows the proposed geophysical survey area and transects.

5.2.1.1 Electrical Resistivity Imaging Method

The ERI method provides a rapid and cost-effective means of measuring the electrical resistivity of subsurface materials. The method relies on the principle that different subsurface materials resist the flow of electrical current to varying degrees. A material's resistance to electrical current is measured as the ratio of electrical potential, or voltage (V), to the applied current (I). Resistivity (ρ) is the material property of interest, which is the product of the measured resistance multiplied by an area and divided by length. Resistivity has units of Ohm-meters (Ω-m), or simply the inverse of electrical conductivity. In electrical resistivity surveying, the measured unit is apparent resistivity (ρa) which is the measured resistance with an applied geometric factor based on the configuration of the current and potential electrodes. To extract a resistivity model of the subsurface, apparent resistivity values are modeled with iterative inverse modeling algorithms. The modeled resistivity values for this project will be presented as a two-dimensional cross section from beneath the survey area.

In general, soil and rock act as electrical insulators and are highly resistive. The flow of electrical current is primarily through moisture-filled pore spaces and along grain-surface boundaries. The observed resistivity is controlled by the following: rock composition, porosity, permeability, amount of water within the pore spaces, and the concentration of dissolved solids within the pore fluids. Therefore, resistivity measurements yield useful information for the characterization of the stratigraphy, structure, and composition of the subsurface.

The following physical characteristics of subsurface materials reduce resistivity: increasing water content, increasing groundwater specific conductance, increasing clay content, and decreasing grain size. Resistivity values typically increase across air-filled voids or dry, loose material and decrease across water-filled voids or saturated zones as compared to adjacent soil or rock material. Resistivity values typically increase with an increasing degree of compaction or lithification.

A direct current (DC) electrical resistivity survey is conducted by placing two pairs of electrodes in the ground and connecting them to a power source to create an electrical circuit in the subsurface. An electric current is passed through two of the electrodes (i.e. current electrodes), and the resulting voltage is measured at various locations along the ground surface between a second pair of electrodes (i.e. potential electrodes). Subsurface apparent resistivity values are calculated from the separation and geometry of the electrode positions, the amount of applied current, and the measured voltage across the potential electrodes. There are several types of electrode arrays that can be used to collect electrical resistivity data. Each has characteristic sensitivities to the geometry of subsurface targets (e.g. lateral versus vertical features) and depth of investigation. The most common arrays used in environmental and engineering surface applications include the Wenner, Schlumberger, and dipole-dipole arrays.

5.2.1.2 Electrical Resistivity Imaging Survey Execution

The geophysical surveying will be executed under the oversight of experienced field and office support staff. A team of office support staff will be in regular communication with the field team to support safety, quality, and efficiency of field efforts, and reduce, analyze and present interim results. Daily field logs will be kept to document relevant information including Line Name, File Name, Line Location, Array Type, Electrode Spacing, Battery Voltage, and additional notes if applicable.

The ERI survey will be completed using an Advanced Geosciences, Inc. (AGI) SuperSting R8 earth resistivity meter with an array of up to 112 electrodes. Data will be collected using the dipole-dipole array configuration and a uniform electrode spacing of 5 to 10 feet. Dipole-dipole surveys are suitable for resolving vertical target geometries (such as those that are prevalent in karst terrain). This configuration has been shown to be successful resolving features in limestone environments.

Prior to conducting the ERI survey, AGI's (Advanced Geosciences Inc.) SuperSting Administrator software will be used to simulate a theoretical ERI survey by varying acquisition parameters to evaluate the estimated depth of penetration, data coverage, and data density of each selected set of array parameters. These simulations will be performed to evaluate different possible geometries prior to starting the geophysical field work. The best fit simulation for meeting the project objectives will be saved and an executable command file will be uploaded directly to the SuperSting R8 meter. This command file will be used by the resistivity meter to automatically control data acquisition.

A receiver test will be conducted at the beginning of the project in accordance with the SuperSting Earth Resistivity, IP and SP System with WI-FI instruction manual. The battery voltage will be checked prior to data collection. The battery voltage should be greater than 12 volts for primary data and greater than 11.9 for Roll-Along data (defined below).

A differential GPS, or comparable device, will be used to locate and survey orientations and extents for each proposed geophysical transect. Stainless steel stakes will be placed along a uniform electrode spacing interval from the beginning to the end of each ERI line using survey tapes. The stakes will then be hammered approximately 5 to 8 inches into the ground using a small sledgehammer. Once a stake is securely implanted into the ground it will be attached to a corresponding electrode along the length of the cable, or segment of cable for long arrays. Electrodes will be securely connected to their corresponding electrode stakes using rubber bands or stainless-steel springs. The connection between the electrodes and subsurface creates the necessary electrical coupling needed during ERI surveys. The electrode cables will then be connected to each other and to the resistivity meter and a diagnostic test will be performed to verify proper configuration of the various instrument components and adequate connection between each electrode and subsurface soils.

Data quality is enhanced as connection or contact resistance between two sequential electrodes is minimized. The general goal for an ERI test is to reduce the contact resistance measured between adjacent electrodes to a value below 2,000 Ohms. Where resistances exceed this threshold, metal stakes will be reinstalled or saline water will be added around the stake to increase the coupling between the electrode and subsurface soils. Given particular soil conditions at the electrode location, it is possible for the resistance threshold to be unobtainable. In this situation, the electrode may be removed from the system during in-field operations or during post-acquisition processing of the data.

Data acquisition parameters will be input into the Supersting's command menu. These inputs along with a pre-loaded, site-specific command file, created in AGI's SuperSting Administrator, will be used by the resistivity unit to automatically cycle through the various transmitter and receiver electrode combinations necessary to produce an apparent resistivity pseudo-section. After completing initial data collection, the file will be downloaded to the field laptop computer where initial processing will be used to evaluate the potential for errors to have occurred during data collection prior to advancing the line. The initial dataset will include one 555-foot line with 5-foot spacing, and one 777-foot line with 7-foot spacing, northwest of the Dry Fly Ash Stack. Two 555-foot lines will be included along the Clinch River perpendicular to the alignment of the mapped stick-slip fault. If the transects need to be extended, then, the line will be advanced by picking up the first 28 to 56 electrodes and moving them to the end of the line. This leap frogging process is known as a Roll-Along and can be continued until the end of the ERI transect has been reached. None of the proposed transects (Figure 3) are greater than 777 feet.

At the end of each survey day, the data will be uploaded to a database server where further review and processing will be conducted by an experienced Geophysicist.

5.2.1.3 Frequency Domain Electromagnetic Method

The FDEM method can be used to locate faults and subsurface geological structure. The method is used to characterize differences in the electrical conductivity of subsurface materials utilizing the secondary magnetic field induced in the earth by a time-varying primary magnetic field. A transmitter coil that generates an alternating current induces currents in the subsurface that are proportional to the conductivity of the material through which it passes. The phase and amplitude of an induced magnetic field are measured at various frequencies. A receiver coil detects a secondary electromagnetic field induced by the alternating currents. The ratio of the magnitude of the primary to secondary electromagnetic field, converted to a conductivity, is used to interpret the subsurface materials.

The transmitter and receiver coils are typically aligned in a plane either perpendicular or parallel to the earth's surface. The parallel orientation, with the axis of the coils vertical, is called the vertical dipole (VD) mode. The perpendicular orientation, with the axis of the coils horizontal, is referred to as the horizontal dipole (HD) mode. These modes measure different responses to conductive materials and can be used with various frequencies and coil spacings to provide greater resolution of the subsurface.

The depth of the investigation is related to the distance between transmitter and receiver coils and coil orientation. The depth is inversely proportional to the conductivity and frequency of the alternating current.

The FDEM method measures apparent conductivity. In an ideal horizontally layered earth, the apparent conductivity is the sum of the conductivities of the layers, weighted by their depth and thicknesses. Variations in the conductivity of materials or from an ideal horizontally layered earth invalidate this relationship, which allows anomalies, such as faults, to be identified.

Features such as buried metal objects, metal pipes, buildings, fences, electrical power lines, and communications can interfere with the results of this method. Survey transects should be located as far from these types of features as possible.

5.2.1.4 Frequency Domain Electromagnetic Survey Execution

The FDEM method requires target features to have a conductivity contrast with surrounding materials. When attempting to delineate subsurface features such as faults or fracture zones, the results may only be qualitative. Identification of these features may be limited if there is insufficient conductivity contrast or the features are deeper than the range of the equipment.

Prior to conducting the survey, TVA will record the locations of known sources of potential interference. If sources of interference are encountered during the survey the features will be described and located using GPS.

The FDEM method requires a transmitter coil, a receiver coil, interconnected cables and recording instrumentation. Selection of the instrument depends on the target depth of the investigation. Shallower investigations require greater resolution, which is accomplished by using a smaller coil spacing.

The design of survey transects or grids is dependent on the goal of the survey. Profiles are used to locate faults, linear features and buried objects. Mapping surveys can be used to identify buried layers of materials or conductive groundwater. Sounding surveys are used to explore conductivity changes with depth. Mapping and profiling typically use a fixed coil spacing and frequency and may use both modes of coil orientations. The transect or grid stations should be completely occupied using a single mode before beginning a survey using a different mode.

Sounding surveys use multiple coil spacings, with closer spacing providing information about the shallow subsurface and wider spacing providing information on depth.

A single transect oriented perpendicular to the target linear feature, such as a fault or fracture zone, may be sufficient, depending on the project objectives. However, multiple transects or a survey grid may be needed to map the lateral extent and alignment of linear features or surfaces, such as the soil/bedrock interface. The transects or grids should extend beyond the target area to provide control for background conditions.

Prior to conducting the survey, pilot testing of the method may be appropriate to evaluate the ability of the selected instruments, mode of operation and coil spacing to identify conductivity contrasts. This preliminary testing can also be used to correlate the responses of the survey with known stratigraphy obtained from soil or rock boring logs.

5.2.1.5 Data Analysis

5.2.1.5.1 Electrical Resistivity Imaging Data Processing

ERI data will be processed using the program EarthImager 2D, Version 2.4.2, issued by AGI Inc. Pre-processing of the data involves filtering, correcting elevation, and setting the model convergence parameters (e.g. minimum voltage, maximum repeat error, etc.). The edited data will be subsequently input into the EarthImager 2D inversion routine to produce a two-dimensional resistivity model of the subsurface. Further editing of the data to remove unwanted noise effects will be performed at the end of each model iteration, and the data will be re-modeled until the convergence criteria (e.g. root-mean-square) are met or when subsequent inversions produce minimal change in the final inverted model. The resulting inverted model data will be subsequently exported and then contoured for final presentation.

5.2.1.5.2 Electrical Resistivity Imaging Data Interpretation

The output of the iterative inverse modeling routine is a two-dimensional cross section of subsurface resistivity distribution, commonly referred to as a tomogram. It is important to consider what the tomogram represents and limitations of the inverse model that affect these results. Consideration must be made for model non-uniqueness (e.g. other resistivity distributions that are able to generate the same or comparable convergence criteria), smoothing functions imposed by the inverse model objective function (e.g. penalizing "sharp" model features), and unrealized measurement noise (systematic, structural, or otherwise) which affect the result. Resistivity model interpretation often culminates in a qualitative use of the tomogram, which may be used to direct future work for investigation of anomalies or targets. For the purposes of BRF, the tomograms are ultimately utilized to focus future intrusive work programs to focus on saturated features, since these are the most likely to transmit groundwater. In a tomogram, this will be represented as low resistivity.

The first step in interpretation is calibrating the interpreter of the tomogram to knowns given current site knowledge and data. At BRF, these data include the depth to and the nature of bedrock during drilling, groundwater presence during drilling, and surface geophysics (e.g. ERI) that have been performed at the site. Electrical resistivity values are not directly proportional to hydrogeologic parameters; therefore, it is necessary to adapt elements of the conceptual site model to resistivity values. This is typically done qualitatively. We know from published values that massive limestone features are resistive and fluid-filled voids/cavities are not. These qualitative examples likely represent the extremes in resistivity contrast in subsurface materials at BRF. In between these values, there is a wider range that may represent dry overburden materials, saturated overburden materials, and saturated-weathered rock.

The technical interpretation of the tomograms for use in hydrogeologic investigations integrates known conditions with features of the tomograms. Using other site data in conjunction with the resistivity profiling can aid in the interpretation of high or low resistivity features. These additional data sources can include groundwater elevations, the nature of the aquifer (i.e. confined or unconfined), and previous investigation data at the site whereby boring logs or borehole geophysical logs can be compared to surface resistivity data. As an initial pass, large scale high and low resistivity features are noted in a binary sense as either likely massive rock bodies with little fracturing and/or transmissive features. Low resistivity features are evaluated as potential water-bearing features with transport processes capable of transmitting water at the site. These features are then compared to other locations that are well characterized (e.g. existing boring logs, surface geophysics, borehole geophysics, and/or aquifer testing) to correlate responses of the surface geophysics with other "hard" data. Thereafter, recommendations for investigation can be weighed based on priority of the location and other factors. Data derived from additional investigation activities serves as a ground truth where, in an iterative fashion, the conceptual site model can be reevaluated and reconfigured as necessary.

5.2.1.5.3 Frequency Domain Electromagnetics Data Analysis

Analysis of FDEM data is based on the assumption of a non-magnetic homogenous and horizontally layered earth. If the survey area contains materials that deviate from this ideal model, then the data collected should show anomalous readings that can be used to interpret the type of feature that cause the anomalous data. Data from the surveys are typically plotted and evaluated visually. Certain features cause characteristic readings that can be used to interpret the cause of the anomaly; however, geophysical methods provide non-unique solutions.

5.2.2 Drilling, Logging, and Survey

The monitoring well borings are proposed to be advanced utilizing hollow-stem augering techniques (ASTM D6151-08) until designated boring termination depth or auger refusal, whichever is shallower. In some situations, drilling with a casing advancer may be a suitable alternative to augering.

Upon completion of drilling in overburden for the pilot holes, casing will be installed and seated into competent rock. The purpose of the casing is to separate the bedrock from the overburden. The casing will also be grouted to seal off potential flow pathway between materials. Appropriate drilling methods will be selected to seat the casing and achieve the objective of separating saturated overburden from bedrock. Rock coring tools will be inserted through the casing and coring will be performed in bedrock to the bottom of the hole.

Upon completion of the geophysical and aquifer testing in pilot holes that are proposed to be converted to monitoring wells, air-rotary drilling (ASTM D5782-95) will be used to ream out the pilot holes to a diameter large enough to set monitoring wells.

TVA proposes to perform continuous soil sampling during drilling using hollow stem augers and rock coring to allow for visual logging of the materials encountered at each location. In the case of air-rotary drilling techniques, this can be achieved from the collection of the drill cuttings. 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 (in the overburden only), and other relevant observations. As part of the core drilling, the core will be orientated in the core boxes so that an attempt can be made to compare it with the acoustic televiewer data. Primary core descriptions will include color, weathering, fabric, fractures, bedding planes, joints, hardness, rock name and stratigraphic horizon. The fractures and bedding plane orientation will be measured and the fracture filling (presence or absence) noted, moisture will also be recorded. The rock quality designation (RQD) will also be measured as will the core recovery. Upon completion of the core logging, the core will be stored on site for other relevant observations until the EAR has been accepted by TDEC. Soil color will be logged per the appropriate Munsell 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 P to the EIP).

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).

For the pilot holes that will be converted into wells it will be necessary to ream out the pilot hole to a nominal 8-inch diameter to accommodate a 4-inch well casing and a 2-inch annulus around it. The drilling 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.

5.2.2.1 Pressure Testing

Upon completion of drilling and down hole geophysical testing, 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 down hole 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.

5.2.2.2 Downhole Geophysics

At each pilot hole location, TVA proposes to perform the following suite of geophysical analyses 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 specific conductance 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 presence of different water-bearing zones. 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.

5.2.3 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 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.

5.2.4 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 systems (GIS) or global positioning system (GPS) documentation). Additional information regarding field documentation is provided below and included in the QAPP and TVA 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. Boring log forms will be used to document lithologic conditions and field observations at each boring location. Monitoring well diagrams will be prepared for each well.

Field documentation will also be prepared for development of each monitoring well.

5.2.4.3 Chain-of-Custody Forms

Chain-of-custody (COC) forms are not applicable to this SAP. Refer to the Groundwater Investigation SAP (Appendix H to the EIP) for groundwater sampling and monitoring procedures.

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 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.

5.2.5.2 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.

5.2.6 Core Drilling and Logging

The core samples will provide continuous information that can be visually examined to characterize the rock strata type and structure and will be used to compare to the geophysical test work results. The core drilling and sampling will follow ASTM D2113 "Practice for Rock Core Drilling and Sampling of Rock for Site Investigation", and the RDQ measurements will follow ASTM D6032 "Test Method for Determining Rock Quality Designation (RQD) of Rock Core."

5.2.7 Preservation and Handling

5.2.7.1 Rock Core and SPT 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 storage facility. 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.

5.2.7.2 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

5.2.7.3 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.

5.2.8 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.

5.2.9 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, Liquinox® or other appropriate non-phosphatic detergent, and deionized water 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.

5.2.10 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 piezometers 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 piezometers 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 piezometers 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 temporaryplug 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.

The piezometers will be installed per the TVA TI ENV-TI-05.80.25 (Monitoring Well and Piezometer Installation and Development Technical Instructions), using the same general procedures for monitoring wells. The transducer location will be located based on the results of the geophysical and aquifer tests so that they can represent the hydraulic head at the determined point in the aquifer.

The transducer will be set on a riser pipe in a short-screened interval in a predetermined sand zone based on the geophysical and aquifer test data above (and below). Then, the borehole will be backfilled with a bentonite grout to the surface. At the surface the riser pipe will be fitted with a vented cap.

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 4. A drawing of the wellhead construction is shown on Figure 5.

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 or rock.

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.

5.4.1 Sampling Pump Calibration

Dedicated sampling pumps will be calibrated when installed in order to facilitate purging prior to sample collection. Prior to energizing the dedicated pump, the initial depth-to-water level as specified by TVA TI ENV-TI-05.80.44, *Groundwater Level and Well-Depth Measurement* will be measured using a clean, properly decontaminated water-level indicator (and interface probe, if applicable). After the depth-to-water level has been recorded, the well will be purged. Stabilized flow rate, drawdown, and time will be recorded in the field logbook and field data sheet.

After an acceptable drawdown has been established and maintained, the designated indicator field parameters will be monitored. These indicator parameters include pH, oxidation-reduction potential (ORP), dissolved oxygen, specific conductance, temperature, and turbidity. ORP and temperature will be measured and recorded but will not be evaluated to determine stabilization as described below.

Purging will continue until field measurements of indicator parameters stabilize during three consecutive readings, taken at 3- to 5-minute intervals per the stabilization criteria listed below:

- Turbidity - below 5 NTUs or ±10% for values above 5 NTUs
- pH - ±0.1 (Standard units)
- Specific Conductance - ±3% microSiemens per centimeter (µS/cm)
- Dissolved Oxygen - ±10% for > 0.5 milligrams per Liter (mg/L) or <0.5 mg/L

If critical indicator field parameters have not stabilized after two hours of documented purging, purging will be discontinued and TVA will be notified before a groundwater sample is collected. Efforts used to stabilize the parameters (such as modified pumping rates) will be documented in the field logbook and field data sheet by field personnel.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The QAPP 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 and piezometers.

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 and piezometer installation, geophysical testing 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 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	20 Days	Following EIP Approval
Conduct Field Activities	130 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;
- 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 and pilot hole locations can be safely accessed;
- Saturated conditions exist at each proposed location;
- Positional navigation and recording will be completed using a handheld differential GPS;
- Topographic data for the areas to be studied are readily available (in electronic format) from TVA and will be supplemented by surveying data provided by TVA where needed;
- The ERI survey will be completed along up to 2,442 feet of transects on properties owned by TVA; and
- No geophysical surveying will be conducted in areas deemed potentially hazardous to personal safety.

9.0 REFERENCES

Kellberg, J. M. (1959). "Preliminary Geologic Investigations, Knoxville Area Steam Plant, Edgemoor and Kirkstall Sites" Report No. 39-3#1. March.

Tennessee Department of Conservation, Division of Geology (1964) Geologic map of the Clinton Quadrangle.

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.

ATTACHMENT A
FIGURES

Figure No.

1

Title

Existing Monitoring Well and Proposed Monitoring Well, Piezometer and Pilot Hole Locations

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by LMB on 2018-03-06
Technical Review by TG on 2018-03-06

0 700 1,400 2,100 2,800 Feet

1:8,400 (At original document size of 22x34)

Legend

- Proposed Pilot Hole to be Converted to Piezometer
- Proposed Pilot Hole to be Converted to Monitoring Well
- Proposed Monitoring Well

Existing Well

- Existing Monitoring Well (State Compliance)
- Observation Well (State Compliance)
- Existing Monitoring Well (State and CCR Rule Compliance)
- Existing Monitoring Well (Other)
- Surface Water Gauging Station
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

Stantec

TVA

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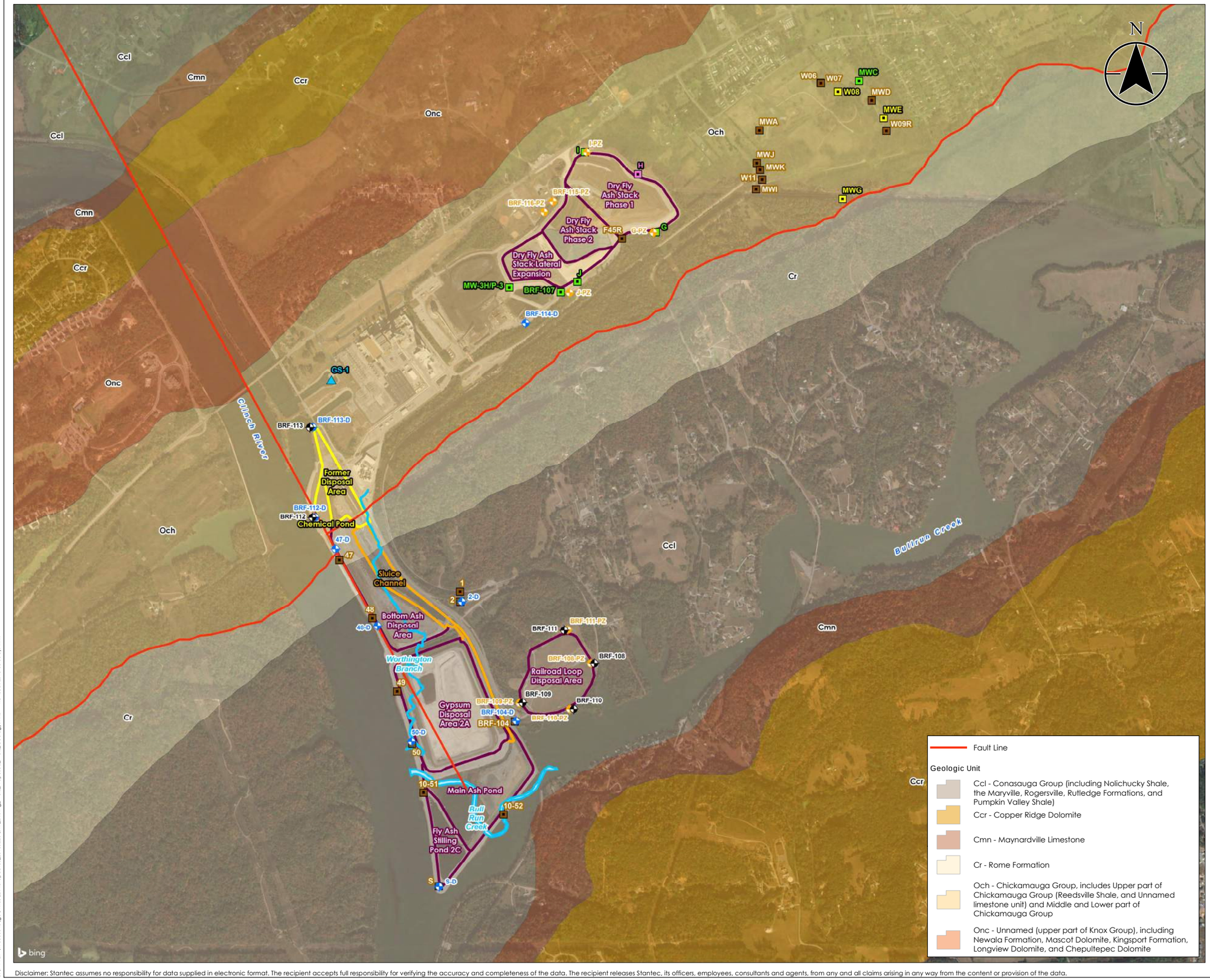

Fault Line

Geologic Unit

- Ccl - Conasauga Group (including Nolichucky Shale, the Maryville, Rogersville, Rutledge Formations, and Pumpkin Valley Shale)
- Ccr - Copper Ridge Dolomite
- Cmn - Maynardville Limestone
- Cr - Rome Formation
- Och - Chickamauga Group, includes Upper part of Chickamauga Group (Reedsville Shale, and Unnamed limestone unit) and Middle and Lower part of Chickamauga Group
- Onc - Unnamed (upper part of Knox Group), including Newala Formation, Mascot Dolomite, Kingsport Formation, Longview Dolomite, and Chepultepec Dolomite

Figure No.

2

Title

Site Geology and Existing Monitoring Well and Proposed Monitoring Well, Piezometer and Pilot Hole Locations

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346
Prepared by LMB on 2018-03-06
Technical Review by TG on 2018-03-06

0 700 1,400 2,100 2,800 Feet

1:8,400 (At original document size of 22x34)

Legend

- Proposed Pilot Hole to be Converted to Piezometer
- Proposed Pilot Hole to be Converted to Monitoring Well
- Proposed Monitoring Well

Existing Well

- Existing Monitoring Well (State Compliance)
- Existing Monitoring Well (Other)
- Existing Monitoring Well (State and CCR Rule Compliance)
- Observation Well (State Compliance)
- Surface Water Gauging Station
- Historic Creek Alignment
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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Figure No.

3

Title

Proposed Surface Geophysics Survey Locations

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346
Prepared by LMB on 2018-07-10
Technical Review by TG on 2018-07-10

0 700 1,400 2,100 2,800 Feet

1:8,400 (At original document size of 22x34)

Legend

- Proposed Pilot Hole to be Converted to Piezometer
- Proposed Pilot Hole to be Converted to Monitoring Well
- Proposed Monitoring Well

Existing Well

- Existing Monitoring Well (State Compliance)
- Existing Monitoring Well (Other)
- Existing Monitoring Well (State and CCR Rule Compliance)
- Observation Well (State Compliance)
- Surface Water Gauging Station
- Historic Creek Alignment
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)
- Proposed Electrical Resistivity Imaging (ERI)
- Proposed Frequency Domain Electromagnectics Survey Area (FDEM)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

Fault Line

Geologic Unit

- Ccl - Nolichucky Shale, and Maryville, Rogersville, and Rutledge Formations, and Pumpkin Valley Shale
- Ccr - Copper Ridge Dolomite
- Cmn - Maynardville Limestone
- Cr - Rome Formation
- Och - Chickamauga Group, includes Upper part of Chickamauga Group (Reedsville Shale, and Unnamed limestone unit) and Middle and Lower part of Chickamauga Group
- Onc - Unnamed (upper part of Knox Group), including Newala Formation, Mascot Dolomite, Kingsport Formation, Longview Dolomite, and Chepultepec Dolomite

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.

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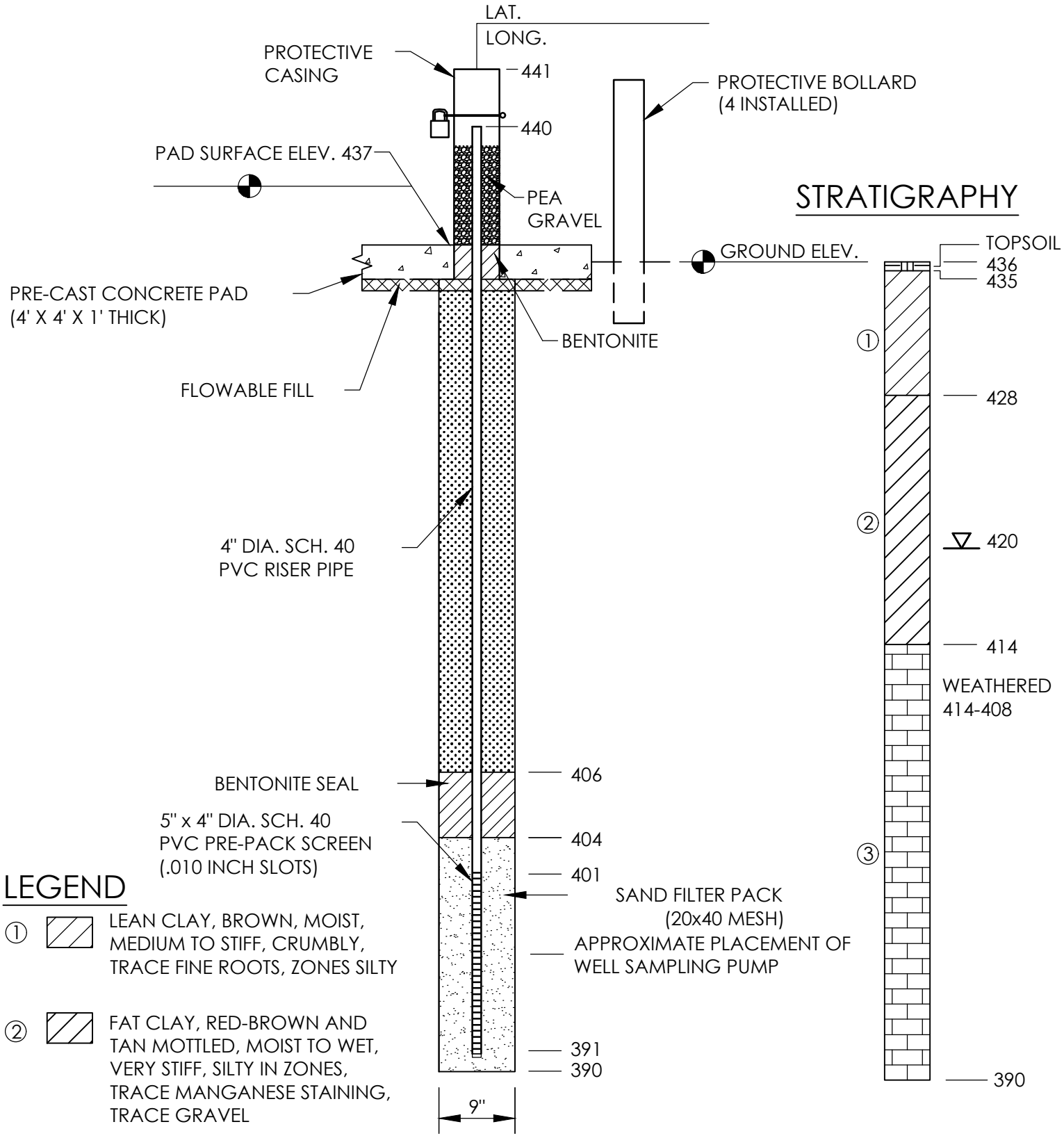
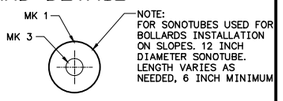


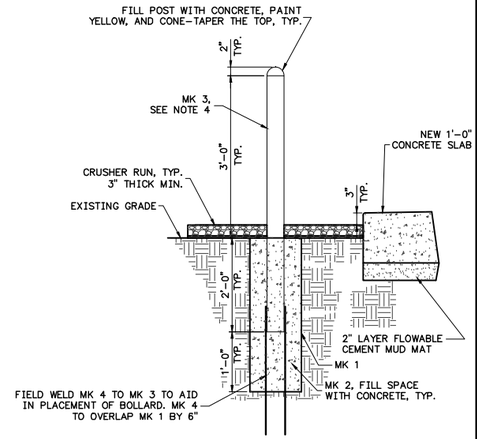
Figure 4. Temporary Well Installation Schematic

NOTE: THIS FIGURE IS AN EXAMPLE MONITORING WELL LOG PROVIDED FOR REFERENCE PURPOSES AND DOES NOT REPRESENT CURRENT SITE CONDITIONS.

BOLLARD DETAIL



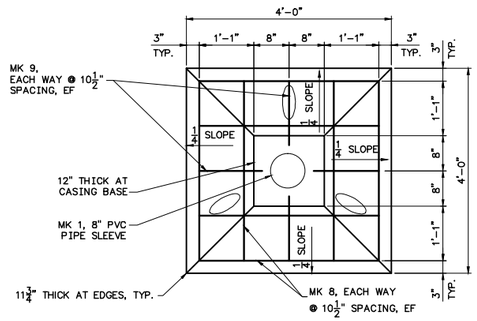
PLAN – BOLLARD



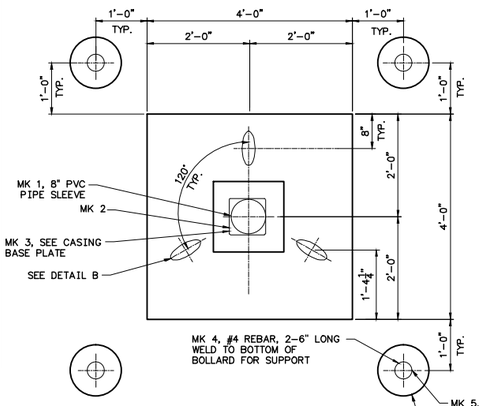
ELEVATION – BOLLARD

BOLLARD DETAIL
MARK NUMBERS AND MATERIAL LIST

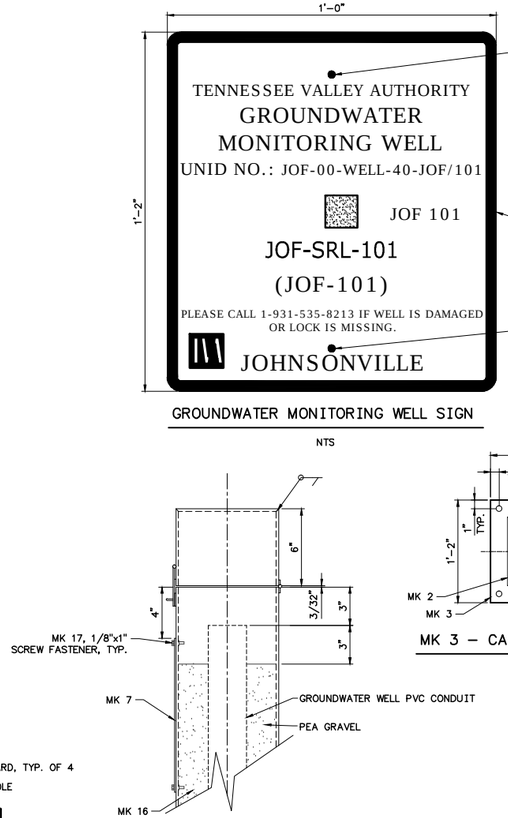
MARK NO.	QUANTITY	DESCRIPTION	PROCURE
1	1 EA	12" SONOTUBE CONCRETE FORM	CONT
2	AS–REQ	CONCRETE, 3000PSI	CONT
3	1 EA	TS 3/16"TX4"DIA.X5'L, CARBON STEEL	CONT
4	2 EA	#4 REBAR, 2–6" LONG	CONT



CONCRETE PAD PLAN & DETAILS



PLAN

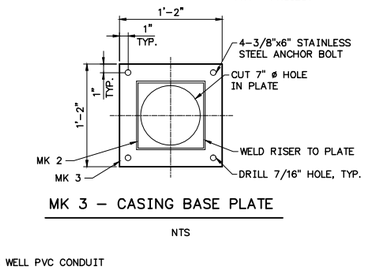


GROUNDWATER MONITORING WELL SIGN

NTS

SECTION A–A

PEDESTAL COVER
3" = 1'–0"



MK 3 – CASING BASE PLATE

NTS

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

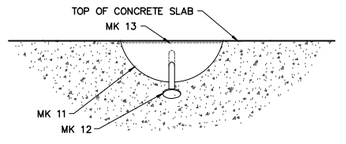
ABBREVIATIONS:

CONT – CONTRACTOR

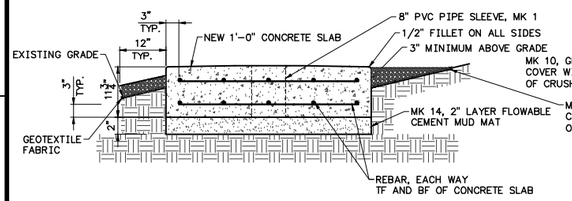
TVA – PROJECT

NOTES:

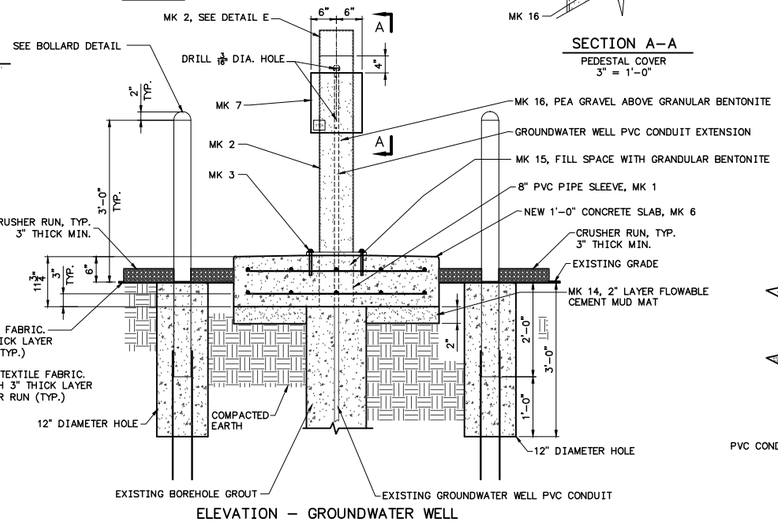
1. ALL STAINLESS STEEL TO BE GRADE 303 UNLESS NOTED OTHERWISE.
2. IMPLEMENT BEST MANAGEMENT PRACTICES PRIOR TO STARTING WORK.
3. PROVIDE TEMPORARY SPILL CONTAINMENT DEVICES IF CONTRACTOR WILL REFUEL EQUIPMENT ONSITE.
4. BOLLARDS PAINTING REQUIREMENTS:
   A. SURFACE PREPARATION:
      CLEAN SURFACES PRIOR TO APPLYING THE PAINT IN ACCORDANCE WITH THE STEEL STRUCTURES PAINTING COUNCIL (SSPC) SP–2 & –3 STANDARDS, "HAND AND POWER TOOL CLEANING". ALL LOSE RUST, LOOSE PAINT, AND OTHER LOOSE DETRIMENTAL FOREIGN MATTER SHALL BE REMOVED. FEATHER THE EDGES OF ANY REMAINING OLD PAINT SO THAT THE REPAINTED SURFACES CAN HAVE A REASONABLY SMOOTH APPEARANCE.
   B. PAINT AND PRIMER – SHERWIN WILLIAMS COATINGS SYSTEM OR AN APPROVED EQUEAL:
      PRIMER
      SHERWIN WILLIAMS DURA PLATE 235 @ 3–5 MILS DFT FOR BARE STEEL OR RUST.
      SHERWIN WILLIAMS POLYSILOXANE 1K @ 1.5–2.5 MILS DFT PER COAT FOR THE PREVIOUSLY PRIMED OR PAINTED SURFACES.
      FINISH COLOR
      SHERWIN WILLIAMS SUNSPOT YELLOW (SW) 1672.
   C. BOLLARDS SHALL RECEIVE ONE COAT OF PRIMER AND TWO COATS OF PAINT.
5. CONCRETE PAD TO HAVE A BROOM FINISH.
6. BENTONITE SHALL BE CETCO C/S OR AN APPROVED EQUAL.
7. PEA GRAVEL SHALL BE WASHED 3/8" SIZE OR AN APPROVED EQUAL.
8. GROUNDWATER MONITORING WELL SIGN SHALL BE PAINTED BLUE, FEDERAL STANDARD NO. 15187.
9. PROVIDE A MASTER LOCK ON THE GROUND WATER MONITORING WELL PROTECTIVE COVER THAT WILL ACCEPT TVA GROUND WATER MONITORING WELL KEY NUMBER 0896 ONLY. LOCKS NOT ACCEPTING KEY 0896 WILL NOT BE ALLOWED UNLESS PRIOR APPROVAL IS OBTAINED FROM TVA. CONTACT THE PLANT'S ENVIRONMENTAL SCIENTIST FOR ASSISTANCE IN OBTAINING THE PROPER LOCK.



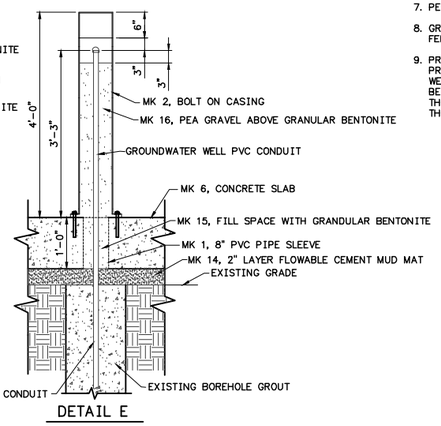
DETAIL B – LIFTING ANCHOR
3" = 1'–0"



4'–0"X4'–0" CONCRETE PAD FOUNDATION
ON SLOPE AREA



ELEVATION – GROUNDWATER WELL



DETAIL E

REV NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	DISCIPLINE INTERFACE
R 0	05–05–2016	J.L.G	C.W.H	J.L.G				SEB	MST		D
INITIAL ISSUE											

SCALE: 1" = 1'–0" EXCEPT AS NOTED

YARD
GROUNDWATER INSTRUMENTATION

TYPICAL GROUNDWATER MONITORING WELL CONCRETE PAD & BOLLARDS PLAN ELEVATION & CONSTRUCTION DETAILS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
J.L. GRAY	C.W. HENSLEY	J.L. GRAY			S.E. BENNETT	M.S. TUPHBOW

JOHNSONVILLE FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2008	DATE	30	C	10W858–08	R 0

TASK COMPLETED BY: | REV NO.

PLOT FACTOR: W_TVA

C.A.D. DRAWING DO NOT ALTER MANUALLY

Figure 5. 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
Water level indicator meter
Oil/water interface 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 G
WATER USE SURVEY SAP

Water Use Survey
Sampling and Analysis Plan
Bull Run Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Bull Run Fossil Plant
Clinton, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 17, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	October 27, 2017
2	Addresses January 29, 2018 TDEC Review Comments and Issued for TDEC Review	March 30, 2018
3	Addresses May 22, 2018 TDEC Review Comments and Issued for TDEC Review	July 13, 2018
4	Addresses TDEC Comments, Applicable Programmatic Revisions, and Issued for TDEC Approval	December 17, 2018

WATER USE SURVEY
SAMPLING AND ANALYSIS PLAN
BULL RUN FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Water Use Survey
Sampling and Analysis Plan
Bull Run Fossil Plant
Tennessee Valley Authority
Clinton, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 17, 2018 Revision 4

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	12/13/18 Date
McClung, Nicholas Anthony Digitally signed by McClung, Nicholas Anthony Date: 2018.12.07 09:46:29 -05'00'	
TVA Investigation Field Lead	Date
Health, Safety, and Environmental (HSE) Manager	12/13/18 Date
Investigation Project Manager	12/6/2018 Date
Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.12.11 12:55:29 -05'00'	
QA Oversight Manager	Date
Laboratory Project Manager	12-12-18 Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

Stantec

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ATTACHMENT E FIELD EQUIPMENT LIST

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 Bull Run Fossil Plant (BRF) on July 13-14, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at BRF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference.

On September 13, 2016, TDEC issued 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 January 9, 2017, TVA submitted BRF 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 one mile of the center of the BRF Plant (Plant) Dry Fly Ash Stack 1 and 2, Dry Fly Ash Stack Lateral Expansion, Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Fly Ash Stilling Pond 2C, and the Railroad Loop Disposal Area (Attachment A). These areas will collectively be referred to as the "Study Area". 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 Field Team Leader's 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 one-mile radius of the center of each of the previously identified units within the BRF Study Area. TVA-owned property will be included in the survey. The water supplies will be sampled if access is granted and if accessible for sampling. A map showing properties within one mile of the Plant is provided in Attachment A. A final map displaying surveyed and sampled wells 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 TIs and Standard Operating Procedures (SOPs), Quality Assurance Project Plan (QAPP; Appendix D of the EIP), SAPs, and HASP.
- Complete required health and safety paperwork and 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, in milligrams per Liter (mg/L)
- Oxidation Reduction Potential, in milliVolts (mV)
- pH, in Standard Units
- Specific Conductance (in microSiemens per centimeter [µS/cm] in accordance with ENV-TI-05.80.42
- Temperature, in degrees Celsius (C°)
- Turbidity, in 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, 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 at 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 Sampling Where There Is No Tap

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. Following completion of system purging, water samples will be collected directly from a pump discharge point into laboratory-supplied bottleware 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	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.

5.5.6 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 tap water, Liquinox® or other appropriate non-phosphatic detergent, and deionized water 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 **Error! Reference source not found.**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 BRF 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
FIGURE

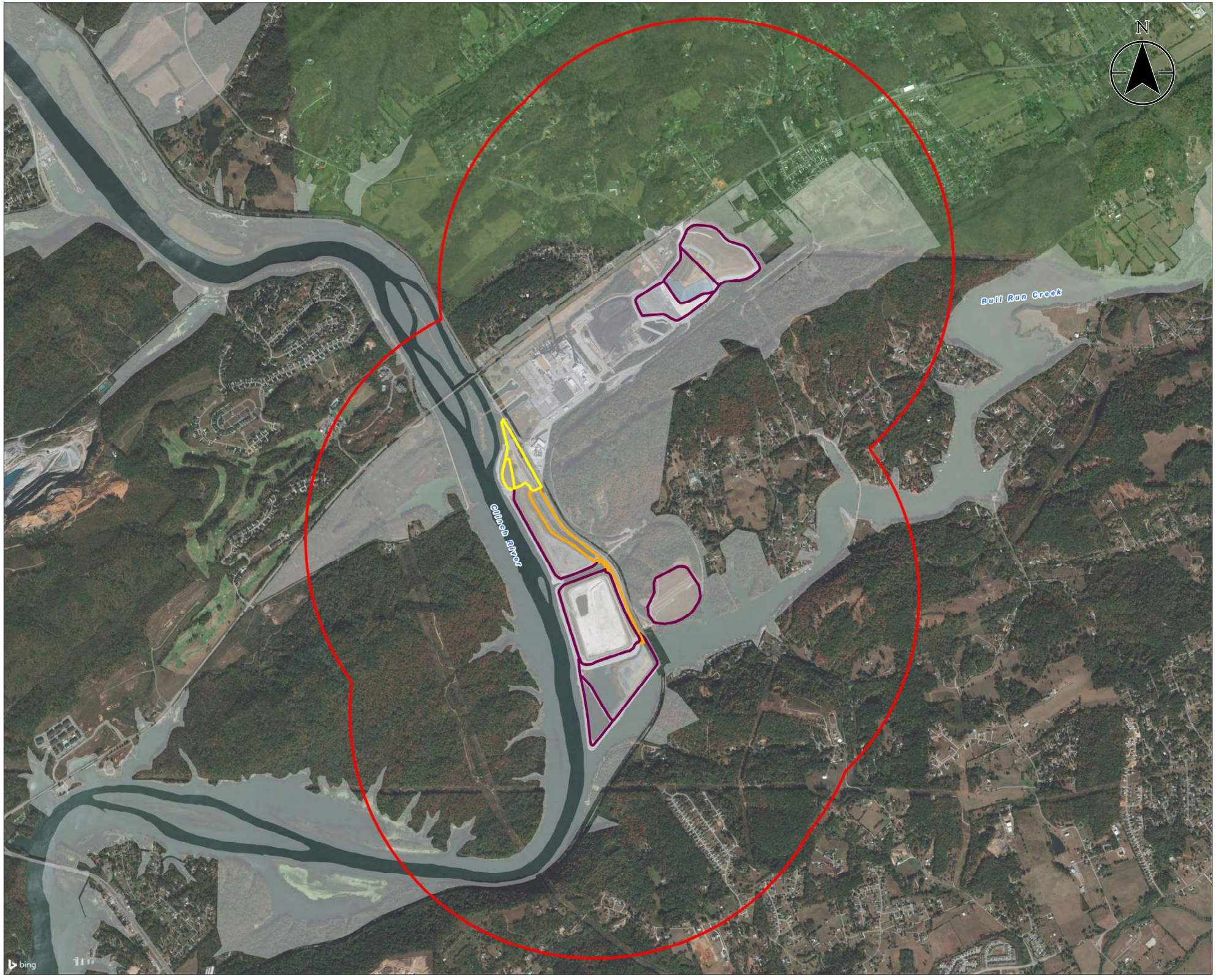

Figure No.
1

Title
BRF 1 Mile Unit Buffer

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

0 1,000 2,000 3,000 4,000 Feet
1:12,000 (At original document size of 22x34)

Legend

- TVA Property Boundary
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)
- 1 Mile Buffer from Center of CCR Units

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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TVA

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I:\TVA-EIP\175566346\gis\mxds\BRF_Units_1_Mile_Buffer.mxd Revised: 2017-10-24 By: mbough

ATTACHMENT B
PRIVATE WATER WELL LIST TEMPLATE

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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

GPS Coordinates: _____

Date: _____

Survey Team No.	Property Identification No.
	KIF-SW-

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 H
GROUNDWATER INVESTIGATION SAP

Groundwater Investigation Sampling and Analysis Plan Bull Run Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Bull Run Fossil Plant
Clinton, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 17, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	October 27, 2017
2	Addresses January 29, 2018 TDEC Review Comments and Issued for TDEC Review	March 30, 2018
3	Addresses May 22, 2018 TDEC Review Comments and Issued for TDEC Review	July 13, 2018
4	Addresses TDEC Comments, Applicable Programmatic Revisions, and Issued for TDEC Approval	December 17, 2018

GROUNDWATER INVESTIGATION
SAMPLING AND ANALYSIS PLAN
BULL RUN FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Groundwater Investigation
Sampling and Analysis Plan
Bull Run Fossil Plant
Tennessee Valley Authority
Clinton, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 17, 2018 Revision 4

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: 12/13/18

McClung, Nicholas Anthony — Digitally signed by McClung, Nicholas Anthony Date: 2018.12.07 09:50:02 -05'00'

TVA Investigation Field Lead — Date

Health, Safety, and Environmental (HSE) Manager — Date: 12/13/18

Investigation Project Manager — Date: 12/6/2018

Rock J. Vitale — Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.12.11 12:55:58 -05'00'

QA Oversight Manager — Date

Laboratory Project Manager — Date: 12.12.18

Charles L. Head
TDEC Senior Advisor — Date

Robert Wilkinson
TDEC CCR Technical Manager — Date

Stantec

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ATTACHMENT B FIELD EQUIPMENT LIST

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 Bull Run Fossil Plant (BRF) on July 13-14, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at BRF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference.

On September 13, 2016, TDEC issued 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 January 9, 2017, TVA submitted BRF 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 BRF 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 the Plant for TDEC Solid Waste Management permit requirements and the United States Environmental Protection Agency (EPA) CCR rule. All groundwater samples collected from monitoring wells from other programs will be used as applicable to the TDEC Order. Duplicate samples will not be collected as part of the Environmental Investigation (EI) 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. However, groundwater sampling events for other programs will be coordinated with sampling events for the EI when both sampling events fall within the same sampling timeframe. In addition, groundwater levels will be measured at wells from other programs during each EI groundwater sampling event to provide information to prepare groundwater contour maps for the Plant. The data collected for other programs will be utilized in the Environmental Assessment Report (EAR).

Piezometers with vibrating wire transducers will be installed at the Dry Ash Stack Phases 1 and 2, and the Railroad Loop Disposal Area. These vibrating wire piezometers are shown on Figure 1. The water level measurements collected from these piezometers will be used to characterize the groundwater flow beneath the units.

Sampling Scope

TVA will measure groundwater levels at the following monitoring and observation wells and piezometers across the site:

- Existing monitoring and observation wells: 1, 2, 47, 48, 49, 50, 10-51, 10-52, BRF-104, BRF-107, F45R, G, H, I, J, MWA, MWC, MWD, MWE, MWG, MWI, MWJ, MWK, S, W06, W07, W08, W09R, W11, MW-3H/P-3;

- Proposed monitoring wells BRF-108, BRF-109, BRF-110, BRF-111, BRF-112, BRF-112-D, BRF-113, BRF-113-D, BRF-114-D, G-D (or piezometer), I-D (or piezometer), J-D (or piezometer), 2-D, BRF-104-D, 47-D, 48-D, 50-D, and S-D; and

- Proposed piezometers BRF-108-PZ, BRF-109-PZ, BRF-110-PZ, BRF-111-PZ, BRF-115-PZ, BRF-116-PZ, G-PZ, I-PZ, and J-PZ.

The lists above may be revised to include the actual wells installed during the investigation.

The Hydrogeological Investigation SAP provides the rationale, locations, and installation methods for proposed monitoring wells.

Surface water elevations will be measured at the existing gauging station (GS-1) in the intake canal from the Clinch River as shown in Figure 1 in Attachment A.

Groundwater samples will be collected for chemical analyses from the proposed monitoring wells BRF-108 through BRF-111, BRF-112, BRF-112-D, BRF-113, BRF-113-D, BRF-114-D, 2-D, BRF-104-D, 47-D, 48-D, 50-D and S-D, and submitted for laboratory analysis of parameters listed in Section 5.2.6.

Figure 1 shows the monitoring and observation 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 and piezometers after execution of the Hydrogeological Investigation SAP. If additional monitoring wells or piezometers are needed to fully characterize groundwater at BRF, then those additional wells and piezometers will be monitored according to this Groundwater Investigation SAP.

Sampling Frequency

TVA plans to conduct six sampling events, conducted at a frequency of one event every two months for one year as part of the EI to characterize seasonal flow direction, rates, and quality. According to 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 and Standard Operating Procedures (SOPs), Quality Assurance Project Plan (QAPP; Appendix D to the EIP), SAPs, and HASP.
- Complete required health and safety documentation and 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 Standard Units
- Specific conductivity - ±5% microSiemens per centimeter (µS/cm) in accordance with ENV-TI-05.80.42
- 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 conductance, 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 Quality Assurance Project Plan (QAPP).

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, based on the final reading collected at completion of purging and directly before the sample was collected. 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 if requested and provided by the analytical laboratory per TVA TI ENV-TI-05.80.04, Field Sampling Quality Control. 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 laboratory to report data prior to investigative sample collection.

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 label removal. Information on sample labels will be recorded in waterproof, non-erasable ink. Specific information regarding sampling labeling and identification is included in and 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 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.
- Access to well locations will be provided 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

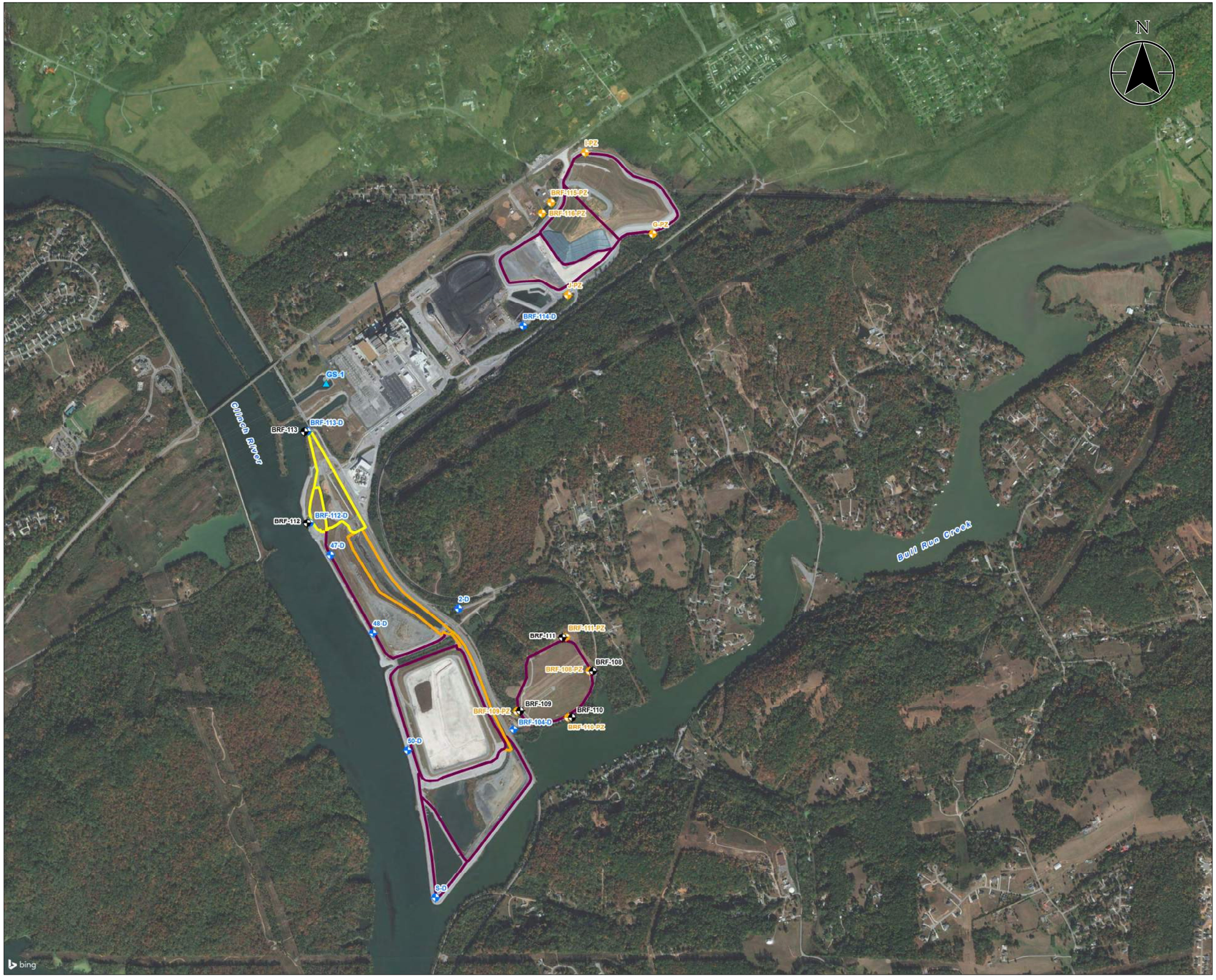

Figure No.
1

Title
Proposed Monitoring Well
Piezometer, and Pilot Hole Locations

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-03-29
Technical Review by TG on 2018-03-29

0 700 1,400 2,100 2,800 Feet
1:8,400 (At original document size of 22x34)

Legend

- Proposed Pilot Hole to be Converted to Piezometer
- Proposed Pilot Hole to be Converted to Monitoring Well
- Proposed Monitoring Well
- Surface Water Gauging Station
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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.

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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 I
EVALUATION OF EXISTING GEOTECHNICAL DATA

Evaluation of Existing Geotechnical Data Bull Run Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Bull Run Fossil Plant
Clinton, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 17, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	October 27, 2017
2	Addresses January 29, 2018 TDEC Review Comments and Issued for TDEC Review	March 30, 2018
3	Addresses May 22, 2018 TDEC Review Comments and Issued for TDEC Review	July 13, 2018
4	Issued for TDEC Approval	December 17, 2018

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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 Bull Run Fossil Plant (BRF) on July 13-14, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at BRF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference.

On September 13, 2016, TDEC issued 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 January 9, 2017, TVA submitted BRF 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.) that 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 that include 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:

1. 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.

2. Spatial coverage of borings and geophysical surveys.

3. 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. 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.

2.3 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 (static and seismic, including liquefaction potential) analyses of existing conditions,
2. Slope stability (static and seismic, including liquefaction potential) 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 KELLBERG (1959)

Table 1. Summary of Evaluation for Kellberg (1959)

Reference:	Kellberg, J. M. 1959. "Preliminary Geologic Investigations, Knoxville Area Steam Plant - Edgemoor and Kirkstall Sites." March.	
Purpose:	Preliminary geologic investigation of two potential steam plant sites	
CCR Unit(s):	Bottom Ash Disposal Area, Gypsum Disposal Area 2A	
Spatial coverage:	200-foot grid spacing across the unit footprints	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	43 borings – Edgemoor
Rock coring:	Yes	43 borings – Edgemoor
Other subsurface data:	Yes	Geologic and structure contour maps
Boring locations surveyed:	Yes	Horizontal boring locations laid out on a 200-foot grid spacing with reported elevations
Data adequate to support three-dimensional model:	Yes	Data to support top of bedrock elevations and general soil and rock stratigraphy
Geometry at time of document representative of 2017 conditions:	No	Borings were performed prior to site development
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:	Yes	Borings can be used for top of rock and bedrock stratigraphy
Other relevant analyses:	No	

3.1.1 Field Activities

Between October 1958 and February 1959, borings were advanced at the Edgemoor and Kirkstall sites. While neither site was chosen for construction of the power plant, the Edgemoor site corresponds to the footprint of the BRF Bottom Ash Disposal Area and Gypsum Disposal Area 2A. As such, only the data from the Edgemoor site is evaluated herein. The program included 43 auger borings with rock coring. The approximate locations for each boring are shown on the boring layout in Figure 1. The borings were spaced in a grid on 200-foot centers trending northwest along the Clinch River.

3.1.2 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. Horizontal boring locations laid out on a 200-foot grid spacing with reported elevations,
    b. Report documents generalized material descriptions and thicknesses,
    c. Results may be used comparatively to more recent explorations.
2. Bedrock stratigraphy
    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 KELLBERG (1962)

Table 2. Summary of Evaluation for Kellberg (1962)

Reference:	Kellberg, J. M. 1962. "Foundation Investigations for the Bull Run Steam Plant."	
Purpose:	Preliminary geologic investigation of the steam plant site	
CCR Unit(s):	None	
Spatial coverage:	200-foot grid spacing across the steam plant footprint	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	257 borings
Rock coring:	Yes	153 borings
Other subsurface data:	Yes	Geologic and structure contour maps
Boring locations surveyed:	Yes	Horizontal boring locations laid out on a 200-foot grid spacing with reported elevations
Data adequate to support three-dimensional model:	Yes	Data to support top of bedrock elevations and general soil and rock stratigraphy
Geometry at time of document representative of 2017 conditions:	No	Borings were performed prior to site development
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:	Yes	Borings can be used for top of rock and bedrock stratigraphy
Other relevant analyses:	No	

3.2.1 Field Activities

Between February to September 1961, 257 auger borings were advanced at the proposed steam plant site for a preliminary foundation investigation. The program included 153 auger borings with rock coring. The borings were generally spaced on a 200-foot grid-oriented northeast, approximately perpendicular to the Clinch River. In select areas, additional borings were added on 100-foot centers or closer as directed.

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. Bedrock stratigraphy

a. Horizontal boring locations laid out on a 200-foot grid spacing with reported elevations

b. Geologic mapping can be correlated to rock cores and top of rock elevations,

c. Geologic mapping methods meet current standard of practice.

3.3 TVA (1985A)

Table 3. Summary of Evaluation for TVA (1985a)

Reference:	Tennessee Valley Authority (TVA). 1985a. "Bull Run Steam Plant - Railroad Loop Ash Pond and Proposed Ash Pond NW of Railroad Loop - Soils Investigation - OE Soils Schedule No. 81.5." February 20.	
Purpose:	Investigation to determine feasibility of a new dredge pond within the railroad loop	
CCR Unit(s):	Railroad Loop Disposal Area	
Spatial coverage:	Approximately 400 feet spacing along the southern portion of the railroad embankment	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	13 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Boring location plan provided, and boring elevations were reported.
Data adequate to support three-dimensional model:	Yes	Data to support dike geometry, foundation soil stratigraphy, and top of bedrock elevation. Borings did not encounter CCR.
Geometry at time of document representative of 2017 conditions:	Yes	Railroad embankment geometry is substantially the same as current. Phreatic surface likely different due to closure of impoundment.
Piezometer installation:	Yes	2 piezometers (now inactive)
In-situ testing:	Yes	Standard penetration test (SPT)
Laboratory testing:	Yes	ASTM standards documented for soil index testing. Shear strength testing standard was undocumented but appears to follow standard testing procedures.
Shear strength parameters:	Yes	Static undrained shear strengths (dike fill and alluvium)
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	CU triaxial testing appears to follow ASTM standards, but is not explicitly documented.
Other relevant analyses:	No	

3.3.1 Field Activities

A geotechnical drilling program was developed that consisted of a total of 13 soil borings: 5 SPT borings, 2 offset borings, and 6 undisturbed sample borings. Please note that one SPT boring and 2 undisturbed sample borings were not located adjacent to the Railroad Loop Disposal Area footprint; therefore, these 3 borings are not relevant and were excluded from consideration. The boring locations were provided but do not document the surveying method (approximate locations are shown on the boring layout in Figure 1).

The borings were advanced using hollow-stem augers powered by a CME-55 drill rig. Drilling and sampling procedures conformed to ASTM D1586, D1587, and D2488. Groundwater measurements were taken upon completion of drilling. Additionally, two piezometers were installed along the railroad embankment.

3.3.2 Laboratory Testing

All samples from the disturbed borings were subjected to index testing including natural moisture content (D2216), specific gravity (D854), Atterberg limits (D4318), and particle-size distribution (D422) tests. An initial unit weight determination for each sample was performed using method SLP2 described in technical manual SM-106.

In addition to index testing, shear strength tests were performed on undisturbed samples at natural moisture content and saturated conditions. Unconsolidated undrained (UU) triaxial strength tests were performed on four samples at their natural moisture content. An additional six consolidated undrained (CU) tests were performed with saturated samples to provide drained and undrained shear strengths. Finally, four samples were subjected to direct shear tests. As part of the shear strength testing, values for natural moisture content, saturation, unit weight, and void ratio were obtained.

3.3.3 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 location plan provided, and boring elevations were reported,
    b. Boring logs document material descriptions and thicknesses,
    c. Results may be used comparatively to more recent explorations.

2. Soil properties (including shear strengths)

    a. Sampling and soil index testing followed ASTM standards. However, shear strength testing did not document the testing method. Based on the lab reports, shear strength testing appeared to follow standard procedures. Thus, results may be used comparatively to more recent testing.

    b. Subsurface conditions are substantially the same as current.

3.4 TVA (1985B)

Table 4. Summary of Evaluation for TVA (1985b)

Reference:	Tennessee Valley Authority (TVA). 1985b. "Memorandum for Bull Run Steam Plant – Ash Ponds 1 and 2A – Soil Investigation – OE Soils Schedule 81.4." Prepared for Tennessee Valley Authority. March 26.	
Purpose:	Soils investigation to provide data for stability analysis of existing dikes and potential remedial treatments	
CCR Unit(s):	Bottom Ash Disposal Area, Gypsum Disposal Area 2A	
Spatial coverage:	Perimeter dikes along Clinch River and Bull Run Creek	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	31 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Boring locations and elevations were reported
Data adequate to support three-dimensional model:	Yes	Data to support perimeter dike geometry, CCR thickness, foundation soil stratigraphy, and top of bedrock elevation.
Geometry at time of document representative of 2017 conditions:	No	Perimeter dike geometry similar. Phreatic surface likely different due to changes in operations (pool now lower, conversion to dry stacking).
Piezometer installation:	Yes	4 piezometers
In-situ testing:	Yes	SPT, Vane Shear Testing (VST)
Laboratory testing:	Yes	ASTM standards documented for soil index testing. Shear strength testing documented the technical procedure.
Shear strength parameters:	Yes	Static undrained shear strengths (dike fill and alluvium)
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Triaxial testing documented testing procedure
Other relevant analyses:	No	

3.4.1 Field Activities

From December 1984 through January 1985, 31 soil borings were advanced in the perimeter dikes and interiors of Bottom Ash Disposal Area 1 and Gypsum Disposal Area 2A. The program included 17 auger borings, 11 undisturbed (Shelby tube) sample borings, two piezometer installation borings, and one vane shear test hole. The approximate locations for each boring are shown on the boring layout in Figure 1. The borings were arranged to sample the various dikes, fill, and foundation soils to support a stability evaluation. Installation logs for the piezometers were not included.

The borings were advanced using hollow-stem augers powered by a CME-55 drill rig. Drilling and sampling procedures conformed to ASTM D1586, D1587, and D2488. Groundwater measurements were taken in open boreholes after drilling. Additionally, four piezometers were installed along the perimeter dikes. Upon completion of drilling, all borings were backfilled. Additional backfill was required several weeks later for borings in which the backfill had settled.

3.4.2 Laboratory Testing

Select samples from the disturbed borings and all samples from the undisturbed borings were subjected to index testing including natural moisture content (D2216), specific gravity (D854), Atterberg limits (D4318), and particle-size distribution (D422) tests. An initial unit weight determination for each sample was performed using methods SLP1 and SLP2 described in technical manual SM-106.

In addition to index testing, shear strength tests were performed on undisturbed samples at natural moisture content and saturated conditions. UU triaxial strength tests were performed on seven samples at their natural moisture content. An additional 11 CU tests were performed with saturated samples to provide drained and undrained shear strengths. Finally, seven samples were subjected to direct shear tests. As part of the shear strength testing, values for natural moisture content, saturation, unit weight, and void ratio were obtained.

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 reported,
    b. Boring logs document material descriptions and thicknesses,
    c. Results may be used comparatively to more recent explorations.

2. CCR and soil properties (including shear strengths)

    a. Sampling and soil index testing followed ASTM standards.

    b. Shear strength testing documented the technical procedure. Thus, results may be used comparatively to more recent testing.

    c. Subsurface conditions are substantially the same as current.

3.5 TVA (1987A)

Table 5. Summary of Evaluation for TVA (1987a)

Reference:	Tennessee Valley Authority (TVA). 1987a. "Bull Run Steam Plant - Fly Ash Stack in Railroad Loop - DNE Soils Schedule 81.9." Prepared for Tennessee Valley Authority. April 29.	
Purpose:	Subsurface characterization of interior berm, stacked fly ash, and foundation soils	
CCR Unit(s):	Railroad Loop Disposal Area	
Spatial coverage:	Interior berm and stacked ash on north side of berm. Borings grouped along two sections through the berm.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	11 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	Boring location plan provided, and boring elevations were reported
Data adequate to support three-dimensional model:	Yes	Data to support dike geometry, CCR thickness, foundation soil stratigraphy, and top of bedrock elevation.
Geometry at time of document representative of 2017 conditions:	Yes	Railroad embankment geometry is substantially the same as current conditions.
Piezometer installation:	Yes	2 piezometers (now inactive)
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	ASTM standards documented for soil index testing. Shear strength testing documented the technical procedure.
Shear strength parameters:	No	
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Triaxial testing methods appear like ASTM methods
Other relevant analyses:	No	

3.5.1 Field Activities

From February 24 to March 4 and April 8 to April 9, 13 soil borings were advanced in the interior berm and fly ash stack of the Railroad Loop Disposal Area. The program included seven SPT borings, four auger borings, and two undisturbed borings. The approximate locations for each boring are shown on the boring layout in Figure 1. A drill-mounted electronic cone penetrometer was used with limited success due to density of the berm fill material and large rock fragments (floaters) near the surface. Thus, the CPT logs were not included in the report.

The borings were advanced using hollow-stem augers powered by a CME-55 drill rig. Drilling and sampling procedures conformed to ASTM D1452, D1586, D1587, and D2488. SPT sampling was performed typically on 5-foot centers through the fill material (berm and CCR) and continuously through the foundation soils. Groundwater measurements were taken in the SPT boreholes at the completion of drilling and 1-hour and 24-hours after drilling. Additionally, 12 drive cylinder density tests (D2937) were performed (six in the berm and six in the CCR) and a bulk sample was taken from each site.

3.5.2 Laboratory Testing

Each disturbed sample was visually classified in the field and tested for moisture content (D2216). Select samples were subjected to material classification tests: Atterberg limit (D4318) and particle-size distribution (D422). Each drive cylinder and undisturbed sample underwent material classification testing including specific gravity (D854) along with unit weight (SLP2).

In addition to index testing, shear strength tests were performed on undisturbed samples at saturated conditions. Consolidated undrained (CU) triaxial strength tests with pore pressure measurements were performed on two undisturbed samples to provide drained and undrained shear strengths. Additionally, bulk samples were remolded into four samples (two each of berm and CCR material) at the average density and moisture content from the drive cylinder tests. Remolded samples of the berm and CCR materials were subjected to UU (D2850) and CU (SLP7) tests. As part of the shear strength testing, values for natural moisture content, saturation, unit weight, and void ratio were obtained.

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 location plan provided, and boring elevations were reported,
    b. Boring logs document material descriptions and thicknesses,

c. Results may be used comparatively to more recent explorations.

2. CCR and soil properties (including shear strengths)

   a. Sampling, soil index, and UU shear strength testing followed ASTM standards. However, CU shear strength testing was performed according to a non-ASTM standard. Thus, results may be used comparatively to more recent testing.

   b. Subsurface conditions are substantially the same as current.

3.6 TVA (1987B)

Table 6. Summary of Evaluation for TVA (1987b)

Reference:	TVA (1987b). "Fly Ash Stack in Railroad Loop, Evaluation of Properties." August 11.	
Purpose:	Derivation of material properties of interior divider berm, stacked fly ash, and foundation soils to support a future slope stability analysis	
CCR Unit(s):	Railroad Loop Disposal Area	
Spatial coverage:	Railroad loop interior divider berm and fly ash stack	
Item	**Yes/No**	**Remarks**
Soil borings:	No	See TVA (1987a)
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	See TVA (1987a)
Data adequate to support three-dimensional model:	Yes	Data to support dike geometry, CCR thickness, foundation soil stratigraphy, and top of bedrock elevation.
Geometry at time of document representative of 2017 conditions:	Yes	Divider berm geometry is substantially the same as current conditions.
Piezometer installation:	No	See TVA (1987a)
In-situ testing:	No	See TVA (1987a)
Laboratory testing:	No	See TVA (1987a)
Shear strength parameters:	Yes	Static drained and undrained strengths (dike fill, CCR, and alluvium)
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Triaxial testing methods appear similar to ASTM methods
Other relevant analyses:	No	

3.6.1 Analysis

Prior laboratory testing results for samples obtained during the exploration of the Railroad Loop Disposal Area interior berm and fly ash stack were evaluated to develop material property parameters to support a future slope stability analysis. The materials were compared to existing results for borrow soil, fly ash, and alluvium. From this evaluation, the soils were grouped into four categories.

Additionally, cross-sections were developed based upon the boring logs generated during the geotechnical exploration noted in TVA (1987a), in conjunction with topographic maps of the railroad loop prior to and after the placement of the interior berm and fly ash fill. The cross-sections represented conditions at the time of survey (approximately June 1987), which are similar to existing conditions except for the inclusion of a final soil cap for closure.

3.6.2 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. Phreatic conditions are similar or more conservative than current.

3.7 YOUNG (1989)

Table 7. Summary of Evaluation for Young (1989)

Reference:	Young, S. 1989. "Leachate Generation from Dry Stacked Fly Ash at the Bull Run Fossil Plant, Part 1: Field Experiments." Report No. WR28-1-49-102. Prepared by TVA Norris Engineering Laboratory. March.	
Purpose:	Field and laboratory studies to support modeling of leachate generation	
CCR Unit(s):	Dry Fly Ash Stack	
Spatial coverage:	Phase 1 and portion of Phase 2 Dry Fly Ash Stack	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	18 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	Surface of fly ash surveyed March 1988. Horizontal locations plotted on scaled plan view.
Data adequate to support three-dimensional model:	Yes	Borings encountered bottom of CCR and in some cases top of rock
Geometry at time of document representative of 2017 conditions:	No	
Piezometer installation:	No	
In-situ testing:	Yes	Permeameter testing, lysimeter measurements
Laboratory testing:	Yes	Testing standards are not documented.
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 18 soil borings - six locations that were drilled three times: November 1987, March 1988, and November 1988. The borings were drilled using hollow-stem augers. In the borings, disturbed and undisturbed (Shelby tube) samples were obtained. Water levels were measured in each of the boreholes during drilling. In addition to drilling, the surface of the CCR material was surveyed and contoured in March 1988.

A Guelph permeameter was used to measure the in-situ hydraulic conductivity of the upper 5 feet of the CCR material. Two sets of six measurements were made in the vicinity of boreholes 3A and 4A. These measurements were taken in August and October of 1986.

3.7.2 Laboratory Testing

The disturbed samples were subjected to gravimetric water content tests. A total of 43 natural moisture content, 41-unit weight, 40 porosity, 26 permeability, and 42 specific gravity tests were performed on Shelby tube samples of both clay foundation soils and CCR fill material.

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 and elevations were provided (graphically only) but did not document the surveying method,
    b. Boring logs document material descriptions and thicknesses,
    c. Results may be used comparatively to more recent explorations.
2. CCR and soil properties
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current.

3.8 SINGLETON (1994)

Table 8. Summary of Evaluation for Singleton (1994)

Reference:	Singleton Laboratories. (Singleton). 1994. "QA/QC for the Geologic Buffer Construction of Stage II Dry Fly Ash Stacking Facility." SL Report 015-672-039A. Prepared for Gilbert/Commonwealth, Inc. November 28.	
Purpose:	QA/QC inspection and testing for minimum requirements of geologic buffer construction for Dry Fly Ash Stack Phase 2	
CCR Unit(s):	Dry Fly Ash Stack	
Spatial coverage:	Phase 2 portion of stack	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	11 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	Boring locations estimated relative to project grid. No elevations were provided but can be estimated based on pre- and post-construction topographic surveys.
Data adequate to support three-dimensional model:	Yes	Data to support clay buffer thickness
Geometry at time of document representative of 2017 conditions:	No	Phase 2 has since been filled with dry stacked ash. Constructed geologic buffer would be substantially unchanged.
Piezometer installation:	No	
In-situ testing:	Yes	Nuclear Density testing
Laboratory testing:	Yes	Hydraulic conductivity testing on undisturbed samples of existing geologic buffer (i.e., foundation soils), remolded borrow soil samples and as-compacted drive cylinder samples. Laboratory 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	

3.8.1 Field Activities

Subsurface soil conditions for Phase 2 of the Dry Fly Ash Stack were investigated to determine the thickness and permeability of the overburden soils. Suitable overburden soils can serve as some or all of the required "geologic buffer." The field exploration was performed between February 24-26, 1993, consisting of 11 borings. Thirteen undisturbed tube samples and 22 bulk samples were collected. The approximate locations for each boring are shown on the boring layout in Figure 2. The borings were advanced using hollow-stem augers powered by an ATV-mounted CME-550 drill rig. Drilling and sampling methods conformed to ASTM D1452, D1587, and D2488.

Following the field exploration, site grading was performed to remove all topsoil, large root zones, and other organic and soft soils. Areas exposed to excavation and stripping were then proofrolled to determine the adequacy of the subgrade. Once the subgrade was approved, a survey was conducted to determine elevations prior to placement of fill to complete the geologic buffer.

The geologic buffer for Phase 2 of the Dry Fly Ash Stack was constructed between August 10, 1994 and October 6, 1994. A qualified inspector from Singleton was on-site during construction to observe the borrow material prior to and during placement, and document equipment, compactive effort (i.e., number of equipment passes), moisture control, and lift thicknesses during placement. Drive-cylinder sampling and nuclear density testing were used to verify fill compliance with specifications.

Upon completion of the geologic buffer construction, a final survey was conducted on October 6, 1994, to obtain the elevation of each point in the established grid system. Final elevations were compared with the initial elevation to determine the thickness of compacted clay buffer. Additionally, 12 Shelby tube (drive cylinder) samples were collected at approximately one sample per three acre-feet.

3.8.2 Laboratory Testing

Undisturbed samples were extruded and tested for moisture content and dry density. Select undisturbed samples were additionally subjected to grain-size analysis (D422), Atterberg limits (D4318), and hydraulic conductivity (D5084) testing. Select bulk samples were subjected to standard Proctor (D698) tests.

Prior to construction, bulk samples were obtained from two potential borrow sources. These bulk samples were subjected to material classification testing including grain-size analysis, Atterberg limits, and specific gravity (D854). Select bulk samples were subjected to standard Proctor (D698) tests to create a family of moisture-density curves. Then, test specimens were remolded to varying moisture contents and dry densities for hydraulic conductivity testing. A total of 16 hydraulic conductivity tests were performed for the three soil classes identified.

Following construction, 12 Shelby tube (drive cylinder) samples were subjected to hydraulic conductivity testing.

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 logs document material descriptions and thicknesses,
    b. Results may be used comparatively to more recent explorations.
2. Soil properties
    a. Sampling and testing followed relevant ASTM standards.

3.9 TVA (1996)

Table 9. Summary of Evaluation for TVA (1996)

Reference:	Tennessee Valley Authority, Norris Engineering Laboratory. (TVA). 1996. "Bull Run Fossil Plant Groundwater Assessment." Report No. WR28-1-49-112." January.	
Purpose:	Development of a conceptual hydrologic (hydrogeologic) framework for the site, with application to contaminant transport and waste management issues.	
CCR Unit(s):	All units	
Spatial coverage:	General plant site	
Item	**Yes/No**	**Remarks**
Soil borings:	No	Installation logs of 33 existing wells
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Boring location and elevations were reported
Data adequate to support three-dimensional model:	Yes	Data support top of rock elevations
Geometry at time of document representative of 2017 conditions:	No	
Piezometer installation:	No	
In-situ testing:	Yes	Well pumping and injection tests, electromagnetic borehole flowmeter surveys, and slug tests.
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	

3.9.1 Field Activities

During the course of groundwater studies since 1980, 33 groundwater monitoring wells have been installed. Five of these monitoring wells had been abandoned by the time of this report. Monitoring well construction data documented the top of ground elevations for most of the installations. Horizontal locations were provided in the local plant coordinate system.

The monitoring wells were installed using a variety of drilling methods, including air-rotary methods and hollow-stem augering, depending upon the target installation depth. Upon completion of drilling, the annular space of the wells was backfilled with granular material to some extent above the screened interval (where applicable) and then grouted to the surface. Ten of the monitoring wells received a bentonite seal above the granular fill material before being grouted to the surface.

During this assessment, 18 of the 33 monitoring wells were subjected to in-situ hydraulic conductivity testing including single-well pumping, well injection, and slug testing of the wells. Electromagnetic (EM) borehole flowmeter surveys were also conducted during some of these tests to examine the variability in horizontal hydraulic conductivity of different strata.

3.9.2 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. Monitoring Wells
    a. Installation methods are documented,
    b. Instrument locations and elevations were reported,
    c. Active instruments are adequate to provide current water level readings.

3.10 MACTEC (2004)

Table 10. Summary of Evaluation for MACTEC (2004)

Reference:	MACTEC Engineering and Consulting, Inc. (MACTEC). 2004. "Report of Geotechnical Exploration, Ash Disposal Area, Bull Run Fossil Plant, Clinton, Tennessee." Prepared for Tennessee Valley Authority. July 13.	
Purpose:	Determine the subsurface conditions of the existing Ash Disposal Area and evaluate the strength, hydraulic conductivity, and consolidation characteristics of the CCR material and alluvial soils	
CCR Unit(s):	Bottom Ash Disposal Area, Gypsum Disposal Area 2A, and Main Ash Pond	
Spatial coverage:	Perimeter of Main Ash Pond, perimeter and interior of Bottom Ash Disposal Area and Gypsum Disposal Area 2A	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	13 borings
Rock coring:	No	
Other subsurface data:	Yes	13 CPT soundings
Boring locations surveyed:	Yes	Surveyed by Parsons E&C and TVA.
Data adequate to support three-dimensional model:	Yes	Data to support dike geometry, CCR thickness, foundation soil stratigraphy, and top of rock elevation.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry is substantially the same as current. However, Gypsum Disposal Area 2A has been constructed and Main Ash Pond has been partially filled since this investigation.
Piezometer installation:	Yes	One piezometer
In-situ testing:	Yes	SPT, CPT with pore pressures
Laboratory testing:	Yes	Testing follows ASTM standards
Shear strength parameters:	Yes	Static drained and undrained strengths (CCR and alluvial clay)
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Material parameters can be used to support stability analyses.
Other relevant analyses:	No	

3.10.1 Field Activities

From May 10-21, 1994, 13 soil borings were advanced at Gypsum Disposal Area 2A, Bottom Ash Disposal Area, and Main Ash Pond. The program included nine SPT borings and four offset borings. Thirteen CPT soundings were performed to supplement the SPT borings. Eleven of the CPT soundings were performed adjacent to SPT boreholes and two CPT soundings were at separate locations. TVA and Parsons E&C located and surveyed the locations in the field. The approximate locations for each boring and sounding are shown in Figure 2.

The borings were advanced using hollow-stem augers powered by an ATV-mounted CME-55 drill rig. Sampling procedures conformed to ASTM D1586 and D1587. SPT testing was performed typically on 3-foot centers with 2-inch outer diameter (OD) split-spoons without liners. 3-inch Shelby tube samples were obtained at select intervals. 3.5-inch OD split-spoons with liners were used to sample the ash at varying depths. Shelby tube samples and 3.5-inch OD split-spoon samples were sealed with wax upon retrieval from the borehole. Groundwater levels were measured during drilling and one 24-hour reading was made in the piezometer. A track-mounted electronic cone penetrometer with pore pressure measurements was used for the CPT soundings.

Upon completion of drilling, the boreholes were plugged with a Type 1 Portland cement-bentonite grout mixture using a tremie pipe method. The borings were backfilled in general accordance with the requirements specified by TVA.

3.10.2 Laboratory Testing

The CCR and soil samples were transported to a MACTEC laboratory where they were subjected to natural moisture content (D2216), unit weight with moisture content, specific gravity (D854), Atterberg limits (D4318), particle-size distribution (D421 or D2217), soil index classification (D2487), CU triaxial compression with pore pressures, permeability (D5084), and consolidation (D2435) testing. Unit weight testing was performed on select samples of the 3.5-inch split-spoon and Shelby tube samples.

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.
2. Piezometers
    a. Locations and elevations were surveyed.
3. CCR and soil properties (including shear strengths)
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current.

3.11 TVA (2005)

Table 11. Summary of Evaluation for TVA (2005)

Reference:	Tennessee Valley Authority Fossil Engineering Services. (TVA). 2005. "Operations Manual, Gypsum and Ash Disposal Areas 1, 1A, and 2A, Permit No. IDL 01-0208." Volume 1 - 3. Revision 2. July.	
Purpose:	Updated operations manual to reflect current conditions, types and quantities of materials generated and contained at the site and provides daily operations and permits to continue operations within the environmental and structural standards established for the site.	
CCR Unit(s):	Gypsum Disposal Area 2A, Bottom Ash Disposal Area	
Spatial coverage:	2 cross-sections of the proposed/permitted Gypsum Disposal Area 2A (oriented approximately north-south and east-west)	
Item	**Yes/No**	**Remarks**
Soil borings:	No	
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:	No	
Shear strength parameters:	Yes	Drained and undrained shear strength (CCR and soil)
Static slope stability:	Yes	1 cross-section (west slope) + typical final cover (veneer)
Seismic slope stability:	Yes	1 cross-section (west slope) + typical final cover (veneer)
Information adequate to support stability evaluation:	Yes	Analyses are representative of proposed stack geometry for both static and pseudostatic stability. Analyses included global and veneer stability.
Other relevant analyses:	Yes	Liquefaction analysis; Newmark analysis

3.11.1 Analysis

Historical boring information were used to establish existing subsurface geometry and material parameters of the different soils at the section location. The selection of the slope stability cross-sections was dependent upon the steepness of slopes, the existing and proposed geometry of the sections, and the proximity of the toe of the slope to Clinch River. Based on these criteria, the proposed geometry for Gypsum Disposal Area 2A was considered more severe than for the proposed Bottom Ash Disposal Area. Two cross sections, through the west and south slopes of Gypsum Disposal Area 2A were considered for analysis, and the south slope was selected as more critical. Only the more critical section was analyzed for global stability. The analysis was performed with and without possible inclusion of bottom ash columns installed through the foundation soils along the toe of the south slope.

The global stability of Gypsum Disposal Area 2A was evaluated using limit equilibrium methods as implemented in the STEDWIN/STABL5M software and additionally used UTEXAS3 to check the pseudostatic analyses results. Analyses were completed for static loading for long-term, steady-state seepage conditions and two-stage conditions were evaluated for pseudostatic loading. The drained and undrained shear strength parameters for the CCR and soils used in the analyses were selected from historical reports by MACTEC and TVA.

The stability analyses evaluated circular and translational two-dimensional failure surfaces. This report states that the results of the slope stability analyses provided acceptable factors of safety for the proposed future stack geometry for Gypsum Disposal Area 2A if recommendations are followed for the installation of bottom ash columns along the toe of the south slope.

With regard to seismic loading, the authors conclude that permanent deformations would be tolerable. Also, they conclude that any liquefaction in the foundation soil or the sluiced ash would be in isolated pockets and thus not a concern for global stability. However, they suggest that construction of the proposed bottom ash columns would reduce the potential for liquefaction related slope instability.

The veneer stability of the proposed final closure cap was analyzed using limit equilibrium methods. Several options were developed for the closure cap involving lean clay borrow soil (with or without gypsum mixing treatment) and with or without a geocomposite drainage layer. Analyses were performed for static, long-term conditions (drained and undrained), and pseudostatic loading conditions. Minimum required shear strengths of the potential cover soil materials were computed for each load case. The project-specific materials mentioned above must have laboratory tests performed to verify that the actual strengths meet or exceed the minimum required.

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. Static and seismic slope stability analyses

    a. Material parameters are representative of current.

    b. Surface and subsurface geometry (proposed design) is more conservative than at present.

    c. Pool elevations and phreatic conditions are similar or more conservative than current.

    d. Analysis methods meet current standard of practice.

3.12 URS (2005)

Table 12. Summary of Evaluation for URS (2005)

Reference:	URS Corporation. (URS). 2005. "Tennessee Valley Authority, Bull Run Fossil Plant, Clinton, Tennessee." Prepared for ADVATECH, LLC. August 18.	
Purpose:	Provide geotechnical recommendations for the proposed improvements (i.e., site work, structure foundations, seismic design, etc.) to Bull Run Fossil Plant	
CCR Unit(s):	Dry Fly Ash Stack Lateral Expansion, Bottom Ash Disposal Area	
Spatial coverage:	Borings are primarily at the power house, but some are near the historical disposal area north of Bottom Ash Disposal Area and the Lateral Expansion of Dry Fly Ash Stack	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	50 borings (14 relevant to the study area)
Rock coring:	Yes	34 borings (3 relevant to the study area)
Other subsurface data:	No	
Boring locations surveyed:	No	Boring locations were reported (graphically) and elevations were surveyed
Data adequate to support three-dimensional model:	Yes	Data to support CCR thickness, foundation soil and bedrock stratigraphy (including top of rock elevation)
Geometry at time of document representative of 2017 conditions:	Yes/No	Area north of Bottom Ash Disposal Area is substantially the same as current. However, area near Lateral Expansion of Dry Fly Ash Stack has since been developed.
Piezometer installation:	No	
In-situ testing:	Yes	SPT, Electrical Resistivity
Laboratory testing:	Yes	Testing follows ASTM standards
Shear strength parameters:	Yes	Undrained shear strength (residual clay)
Static slope stability:	No	
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Material parameters can be used to support stability analyses.
Other relevant analyses:	No	

3.12.1 Field Activities

A subsurface exploration program was designed that consisted of 50 borings drilled between October 18 and November 10, 2004. Of these 50 borings, only 14 borings (including three with rock coring) are in the vicinity of the footprints of either the Bottom Ash Disposal Area or the Dry Fly Ash Stack Lateral Expansion. The borings were drilled using CME 55 and Mobile B-57A drill rigs with hollow stem augers. The approximate boring locations are shown in Figures 1 and 2.

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. Groundwater levels were measured during drilling.

In addition to drilling activities, URS was contracted to perform in-situ resistivity testing using a Wenner electrode array in general accordance with ASTM G57-95a. This work was performed at six locations between October 12 - 14, 2004 with five locations around the main plant and one location near the Bottom Ash Disposal Area. The resistivity testing was related to design of electrical grounding systems.

3.12.2 Laboratory Testing

SPT and Shelby tube samples were subjected to natural moisture content (D2216) testing. Select samples representing the dominant soil layers were subjected to soil classification tests that included Atterberg limits (D4318), specific gravity (D854), and sieve analyses (D422) tests. Undisturbed samples were extruded and subjected to unit weight determination and UU triaxial compression testing.

3.12.3 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 reported (graphically only) and elevations were surveyed,
    b. Boring logs document material descriptions and thicknesses,
2. Soil properties
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current.

3.13 MACTEC (2006)

Table 13. Summary of Evaluation for MACTEC (2006)

Reference:	MACTEC Engineering and Consulting, Inc. (MACTEC). 2006. "Report of Geotechnical Exploration, Proposed Dry Ash Expansion Area, Bull Run Fossil Plant, Clinton, Tennessee." Prepared for Tennessee Valley Authority. January 9.	
Purpose:	Explore subsurface conditions for a proposed lateral and vertical expansion of the Dry Fly Ash Stack and provide recommendations for geotechnical aspects of design and construction	
CCR Unit(s):	Dry Fly Ash Stack	
Spatial coverage:	Majority of borings located within Lateral Expansion footprint with additional borings in Phase 1 and Phase 2	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	71 borings
Rock coring:	Yes	13 borings
Other subsurface data:	No	
Boring locations surveyed:	Yes	Boring locations were surveyed by others
Data adequate to support three-dimensional model:	Yes	Data support CCR thickness, dike geometry, foundation soil stratigraphy, top of rock, bedrock stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Phase 1 is substantially the same as current. However, Phase 2 has since been filled and the Lateral Expansion has since been constructed and filling is underway.
Piezometer installation:	Yes	6 piezometers, screened in residuum and/or bedrock
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Testing follows ASTM standards. Hydraulic conductivity and triaxial shear strength testing did not document testing standard but appear to follow ASTM procedure.
Shear strength parameters:	Yes	Drained and undrained strengths
Static slope stability:	Yes	4 cross-sections through proposed retaining wall.
Seismic slope stability:	No	
Information adequate to support stability evaluation:	No	Analyses are representative of obsolete proposed geometry
Other relevant analyses:	Yes	Settlement analyses for retaining wall at 5 cross-sections

3.13.1 Field Activities

A subsurface exploration program was designed that consisted of a total of 71 borings; 58 locations with 13 offset borings. The boring locations within Phase 1 and 2 of the Dry Fly Ash Stack were selected and staked by MACTEC. The Lateral Expansion (hydrogeological) borings were selected and staked by TVA. Upon completion of drilling, the boring locations were surveyed, and the results provided to MACTEC. The approximate locations are shown in Figure 2.

The borings were advanced by either an ATV-mounted CME-55 or truck-mounted CME-75 drill rig using hollow-stem augers. Water level readings were taken during drilling. An additional water level reading was taken at each borehole a minimum of 24 hours after drilling. SPT testing (D1586) was performed typically on 2.5-foot centers in the upper 10 feet of each boring and then on 5-foot centers thereafter until encountering refusal. Also, 3-inch Shelby tube samples were obtained at select intervals in general accordance with ASTM D1587. Upon encountering auger refusal, the bedrock was cored at 13 locations using NQ-size core barrels in Phase 1 and Phase 2 sections of the Dry Fly Ash Stack and using HQ-size core barrels in the Lateral Expansion.

Upon completion of field activities, the boreholes without piezometers were plugged with a cement-bentonite grout mixture using a tremie pipe method. Piezometers were installed in six borings. 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 consisted of soil auger cuttings from the drilling process for the borehole.

3.13.2 Laboratory Testing

All soil samples were visually classified in the field. Upon transporting the SPT, Shelby tube, and bulk samples to the laboratory, select samples were subjected to natural moisture content (D2216) tests. Select SPT and bulk soil samples were subjected to Atterberg limits (D4318), specific gravity (D854), and sieve and hydrometer analyses (D421 or D2217 along with D422) tests. Bulk ash samples were subjected to standard Proctor compaction (D698) tests. Select Shelby tube samples were subjected to CU triaxial compression, direct shear (D3080), one-dimensional consolidation (D2435), permeability, and unconfined compressive strength (D2166) tests. Select Shelby tube and remolded bulk soil samples were subjected to UU triaxial compression shear strength tests.

3.13.3 Analysis

Settlement analyses were performed at 5 selected locations along the proposed MSE wall alignment (sections B-B' through F-F'). Settlement calculations were performed along the centerline of the foundation bases of the various sections. Settlements were calculated using a stress distribution theory for flexible foundations of finite width and infinite length. Elastic settlement of the materials underlying the foundations was assumed and material's elastic parameters were based on correlations with published information.

Consolidation settlement of the saturated materials underlying the foundation bases were modeled based on one-dimensional consolidation theory with parameters obtained by laboratory testing of the obtained on-site soil samples. Secondary consolidation settlement was assumed to be minimal and fall within the settlement estimation error for the elastic and consolidation settlements.

In addition to settlement analyses, four critical cross-sections were analyzed for external stability of proposed MSE walls against bearing capacity, overturning, and sliding. Also, the proposed retaining walls were analyzed for global slope stability. The reinforcement length was assumed to be approximately 110% of the height of the wall. Both short-term and long-term stability analyses were performed with undrained and drained strength parameters, respectively.

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,
2. Piezometers
    a. Installation methods meet current standard of practice,
    b. Locations and elevations were surveyed,
3. CCR and soil properties (including shear strengths)
    a. Sampling and testing followed relevant ASTM standards.

3.14 TVA (2006)

Table 14. Summary of Evaluation for TVA (2006)

Reference:	Tennessee Valley Authority River System Operations and Environment Research and Technology Applications. (TVA). 2006. "Bull Run Fossil Plant, Hydrogeologic Evaluation of Expanded Dry Fly Ash Disposal Area." November.	
Purpose:	Hydrogeologic evaluation of proposed horizontal and vertical expansion of the Dry Fly Ash Stack, to assess the suitability of the proposed disposal site with respect to applicable TDEC standards.	
CCR Unit(s):	Dry Fly Ash Stack	
Spatial coverage:	Dry Fly Ash Stack	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	27 borings over two separate explorations
Rock coring:	Yes	4 borings
Other subsurface data:	No	
Boring locations surveyed:	Yes	Boring location and elevations were reported
Data adequate to support three-dimensional model:	Yes	Top of rock elevations and bedrock stratigraphy
Geometry at time of document representative of 2017 conditions:	No	Lateral Expansion has since been constructed.
Piezometer installation:	No	
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Soil Index testing follows ASTM standards. Hydraulic conductivity testing follows non-ASTM standard.
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 15 soil borings and 6 offset borings in 1989 by Geologic Associates, Inc. They advanced the borings to refusal without sampling or testing.

An additional geotechnical drilling program was developed that consisted of 6 soil borings in 1991. Law Engineering advanced each of the six borings a minimum of 15 feet below the water table and installed an observation well. Four of these borings had to be extended by means of rock coring to achieve the required depth. SPT testing was performed directly below each Shelby tube sample obtained during this exploration.

The boring locations for both explorations were chosen and surveyed by TVA personnel (approximate locations are shown on the boring layout in Figure 2).

3.14.2 Laboratory Testing

All soil samples obtained from the Law 1991 exploration were visually classified in the field. Upon transporting the Shelby tube and bulk samples to the laboratory, select bulk samples were subjected to soil classification tests (D2487) that included Atterberg limits (D4318), specific gravity (D854), and particle size distribution (D422) tests. Bulk samples were also subjected to remolded hydraulic conductivity tests and standard Proctor tests. Undisturbed Shelby tube samples were extruded and subjected to hydraulic conductivity (EM 1110-2-1906) tests.

3.14.3 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 and sounding locations and elevations were reported,
    b. Boring logs document material descriptions and thicknesses,

3.15 STANTEC (2010A)

Table 15. Summary of Evaluation for Stantec (2010a)

Reference:	Stantec Consulting Services, Inc. (Stantec). 2010a. "Report of Geotechnical Exploration: Bottom Ash Disposal Area 1, Gypsum Disposal Area 2A, and Fly Ash Pond Area 2, Bull Run Fossil Plant, Anderson County, Tennessee." Prepared for Tennessee Valley Authority. April 12.	
Purpose:	Geotechnical exploration, seepage, and slope stability analyses of the referenced CCR units.	
CCR Unit(s):	Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C	
Spatial coverage:	Perimeter dikes and CCR slopes of the units. A smaller number of borings on the Bottom Ash Disposal Area 1 interior.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	93 borings
Rock coring:	Yes	5 borings
Other subsurface data:	Yes	8 CPT soundings
Boring locations surveyed:	Yes	Surveyed by TVA prior to drilling
Data adequate to support three-dimensional model:	Yes	Data support dike geometry, foundation soil stratigraphy, top of rock elevation, and bedrock stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar. Stone buttress has since been added to south perimeter dike for Gypsum Disposal Area 2A.
Piezometer installation:	Yes	42 piezometers, screened in CCR, clay, and sand
In-situ testing:	Yes	SPT, CPT, installed Slope Inclinometers
Laboratory testing:	Yes	Testing follows ASTM standards
Shear strength parameters:	Yes	Static drained strengths
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 stability of each unit's perimeter dikes.
Other relevant analyses:	Yes	Seepage modeling

3.15.1 Field Activities

The geotechnical exploration program included 93 borings (including offset boring from original sample borings) and 8 CPT soundings completed between June 3 and August 14, 2009. Boring locations were selected and staked by Stantec personnel (approximate boring locations are shown on the boring layout in Figure 1). The borings were performed using a drill rig equipped with hollow-stem augers. SPT sampling was performed continuously in accordance with ASTM D1586. Undisturbed samples were obtained in accordance with ASTM D1587.

Upon completion of drilling, piezometers were installed in 42 borings and slope inclinometers were installed in 5 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 and borings with slope inclinometer casing were backfilled with cement-bentonite grout.

3.15.2 Laboratory Testing

Select disturbed (SPT) and undisturbed (Shelby tube) samples obtained during conventional drilling were subjected to the following laboratory tests: Atterberg limits (D4318), specific gravity (D854), density (D2937), USCS classification (D2487), gradation (D422), and falling head permeability (D5084). Additionally, Shelby tube samples were subjected to twenty-seven CU triaxial compression (D4767) tests, three UU triaxial compression (D2850) tests, seven unconfined compression tests (D2166), and seven Direct Simple Shear (D6528) tests.

3.15.3 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 each section location. The selection of the slope stability cross-sections was dependent upon the steepness of slopes, the geometry of the sections, the piezometric surface, and the subsurface conditions. Based on these criteria, eight (8) cross sections (Sections F, I, K, L, N, O, R, and S) were selected for seepage and slope stability analyses and one cross-section (Section D) was selected for slope stability analysis only (due to no active pool present at the structure to conduct seepage analysis).

The stability of the Bottom Ash Disposal Area (Area 1), Gypsum Disposal Area (Area 2A) and Fly Ash Pond (Area 2) dikes were evaluated using limit equilibrium methods as implemented in the SLOPE/W module. Analyses were completed for static loading for long-term, steady-state seepage conditions. The drained shear strength parameters were derived using both current and historical laboratory test data (consolidated-undrained triaxial tests, direct simple shear tests, standard penetration testing data, and classification testing data) and Stantec's experience with these materials in similar applications.

The stability analyses focused on the potential for exterior slope global failure and exterior slope non-global failure along the exterior slopes of assessed CCR Units. Specifically, these include the exterior slopes of the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C. The results of these analyses showed that the CCR Unit slopes did not meet the established criteria for a long-term factor of safety of 1.5 for a deep-seated failure at cross-sections I, K, L, N, O, R, and S. Additionally, based on the assessed seepage gradients, several of these locations did not meet the required factor of safety against soil piping.

This report briefly discussed certain options TVA could consider improving the stability of perimeter dike areas not meeting the recommended criteria for long term stability against slope failure and soil piping.

3.15.4 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. CCR and 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. In areas of critical failure surfaces, surface and subsurface geometry is substantially the same at present (except for subsequent buttressing). Additional/future CCR stacking on interior (i.e., at top of stack) does not affect critical failure surfaces near perimeter.

    c. Pool elevations and phreatic conditions are similar to or more conservative than current.

    d. Analysis methods meet current standard of practice.

3.16 STANTEC (2010B)

Table 16. Summary of Evaluation for Stantec (2010b)

Reference:	Stantec Consulting Services, Inc. (Stantec). 2010b. "Subsurface Logs and Instrumentation Diagram (logs only)." March.	
Purpose:	Additional borings and instrumentation installation	
CCR Unit(s):	Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C	
Spatial coverage:	One location each along the perimeter dike for Gypsum Disposal Area 2A and Fly Ash Stilling Pond 2C	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	3 borings
Rock coring:	Yes	2 borings
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, foundation soil stratigraphy, and top of rock elevation.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar. Stone buttress has since been added to outslope of southern perimeter dike for Gypsum Disposal Area 2A.
Piezometer installation:	Yes	1 piezometer, screened in dike fill
In-situ testing:	Yes	SPT, Slope Inclinometers
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

The geotechnical exploration program included 3 borings completed between March 10-12, 2010. Boring locations were selected and staked by Stantec personnel (approximate boring locations are shown on the boring layout in Figure 1). The borings were performed using a drill rig with hollow-stem augers. Undisturbed samples were obtained in the upper 12 feet of each boring in accordance with ASTM D1587. SPT sampling was performed continuously below 12 feet in accordance with ASTM D1586.

Upon completion of drilling, a piezometer was installed in 1 boring and slope inclinometer casing was installed in 2 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 with slope inclinometer casing were backfilled with cement-bentonite grout.

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 is substantially the same as current (except for subsequent buttressing).
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.

3.17 STANTEC (2010C)

Table 17. Summary of Evaluation for Stantec (2010c)

Reference:	Stantec Consulting Services, Inc. (Stantec). 2010c. "Subsurface Logs (logs only)." September.	
Purpose:	Additional borings and instrumentation installation to monitor post-construction rock buttress conditions	
CCR Unit(s):	Gypsum Disposal Area 2A	
Spatial coverage:	Southern perimeter dike	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	9 borings
Rock coring:	Yes	1 boring
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, foundation soil stratigraphy, and top of rock elevation.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions similar.
Piezometer installation:	Yes	4 piezometers, screened in CCR
In-situ testing:	Yes	SPT, Slope Inclinometers
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

The geotechnical exploration program included 9 borings completed between August 31 and September 10, 2010. Boring locations were selected and staked by Stantec personnel (approximate boring locations are shown on the boring layout in Figure 1). The borings were performed using a drill rig with hollow-stem augers. Undisturbed samples were obtained in accordance with ASTM D1587. SPT sampling (ASTM D1586) was performed continuously after augering through the buttress material.

Upon completion of drilling, piezometers were installed in 4 borings and slope inclinometer casing was installed in 5 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 with slope inclinometer casing were backfilled with cement-bentonite grout.

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 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.

3.18 STANTEC (2011A)

Table 18. Summary of Evaluation for Stantec (2011a)

Reference:	Stantec Consulting Services, Inc. (Stantec). 2011a. "Report of Geotechnical Exploration and Evaluation of Slope Stability, Fly Ash Dry Stack - Phase II, Bull Run Fossil Plant, Clinton, Anderson County, Tennessee." Prepared for Tennessee Valley Authority. February 8.	
Purpose:	To perform a general evaluation of the slope stability of Dry Fly Ash Stack Phases 1 and 2.	
CCR Unit(s):	Phases 1 and 2 of the Dry Fly Ash Stack	
Spatial coverage:	Two cross sections in the Phase 1 area and one cross-section in the Phase 2 area.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	37 borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	23 of the borings were surveyed by TVA after drilling. 14 borings could not be surveyed; thus, locations were estimated.
Data adequate to support three-dimensional model:	Yes	Data supports Dry Fly Ash Stack geometry and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	Yes	Phase 1 of the Dry Fly Ash Stack geometry and phreatic conditions similar to current. Phase 2 cross section has since changed due to Lateral Expansion.
Piezometer installation:	Yes	11 piezometers, screened in CCR and clay
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Testing followed relevant ASTM standards
Shear strength parameters:	Yes	Drained strengths
Static slope stability:	Yes	3 cross-sections
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses are representative of long term, static stability of the stack.
Other relevant analyses:	No	

3.18.1 Field Activities

The geotechnical exploration program included 37 SPT borings (including offset borings from original sample borings). Approximate boring locations are shown on the boring layout in Figure 2. The borings were performed using a track-mounted drill rig with hollow-stem augers. SPT sampling was performed continuously in accordance with ASTM D1586.

Undisturbed Shelby tube samples were obtained in accordance with ASTM D1587 at depths determined by Stantec personnel within cohesive soil layers. Upon completion of drilling, the locations and surface elevations of a majority of the borings were surveyed by TVA survey personnel. Exceptions to this occurred at STN-72, 73A, 76A, 86, 94A, 95A, 98A, 100A, 102, 104, 105, 106, 109 and 110 where the borings were not surveyed, and the locations and elevations were approximated from the topographic survey mapping.

Upon completion of drilling, piezometers were installed at select boring locations. The annular backfill for the piezometer consisted of sand around the screened interval, a bentonite seal, then grout to the ground surface. All other borings were backfilled using cement bentonite grout for the full depth. Four (4) sets of temporary well readings were taken between the installation of the piezometers and the publication of this report. These piezometer readings provided an estimate of the piezometric surface fluctuation at the site, over the period of the readings.

3.18.2 Laboratory Testing

Select SPT samples were subjected to natural moisture content (D2216) tests, along with index tests that included Atterberg limits (D4318), unit weight, specific gravity (D854), and sieve and hydrometer analyses (D422) tests. Additionally, consolidated-undrained (CU) triaxial testing with pore pressure measurements (ASTM D4767) were performed on selected specimens extruded from the Shelby tubes.

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 materials at each section location. The selection of the slope stability cross-sections was dependent upon the steepness of slopes, the geometry of the sections, the piezometric surface, existing signs of instability, and the subsurface conditions. Based on these criteria, three cross sections (Sections A-A', B-B', and C-C') were selected for slope stability analyses.

The stability of the existing Phase 1 and Phase 2 areas of the Dry Fly Ash Stack were evaluated using limit equilibrium methods as implemented in the SLOPE/W module. Analyses were completed for static loading for long-term conditions. Additionally, the distribution of pore water pressures within the ash stack were calculated using the static water table. The drained shear strength parameters were derived using both current and historical laboratory test data (consolidated-undrained triaxial tests, standard penetration testing data, and classification testing data) and Stantec's experience with these materials in similar applications.

The stability analyses focused on the potential for both global failures and maintenance failures. The term "global failure" in this regard refers to relatively deep-seated slope failures (≥ 10 feet) that could result in displacement of ash outside of the permitted limits of the facility before corrective measures can be implemented. Furthermore, the term 'Maintenance Failure' refers to relatively shallow slides (≤3 feet) that can be stabilized before it becomes detrimental to the overall stability of the stack.

The analyses were evaluated with respect to the guidelines presented in the USACE Engineering Manual EM 1110-2-1902 "Slope Stability" which stipulates that slopes should have a minimum factor of safety of 1.5 for long term loading conditions. The results of the stability analyses show that one cross-section (section B-B') did not meet the minimum factor of safety requirement for long term stability. However, preliminary analyses indicated that remedial measures such as a small riprap buttress at the toe of the slope will increase the long-term factor of safety to the desired value of 1.5.

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. Most of the boring locations and elevations were surveyed,
    b. Boring logs document material descriptions and thicknesses,
    c. Foundation geometry is substantially the same as current.
2. Piezometers
    a. Installation methods meet current standard of practice,
    b. Most of the piezometer locations and elevations were surveyed,
3. CCR and 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 at present.

    c. Pool elevations and phreatic conditions are similar or more conservative than current.

    d. Analysis methods meet current standard of practice.

3.19 STANTEC (2011B)

Table 19. Summary of Evaluation for Stantec (2011b)

Reference:	Stantec Consulting Services, Inc. (Stantec). 2011b. "Report of Geotechnical Exploration and Evaluation of Slope Stability, Fly Ash Dry Stack - Stabilization Project and Proposed Expansion, Bull Run Fossil Plant, Clinton, Anderson County, Tennessee." Prepared for Tennessee Valley Authority. November 22.	
Purpose:	To perform an assessment of the existing subsurface conditions, perform an engineering analysis of the stability of the existing stack slopes as well as the effect of the proposed expansion (lateral and vertical) on the existing stack and provide recommendations for corrective and preparative measures for the proposed stack expansion.	
CCR Unit(s):	Dry Fly Ash Stack Phases 1 and 2 and Lateral Expansion	
Spatial coverage:	North perimeter of Phase 1 and East Perimeter of Phase 2, with proposed lateral and vertical expansions superimposed	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	35 borings
Rock coring:	No	
Other subsurface data:	Yes	16 CPT soundings with pore pressure dissipation tests
Boring locations surveyed:	Yes	Surveyed by TVA prior to drilling
Data adequate to support three-dimensional model:	Yes	Data supports Dry Fly Ash Stack geometry and foundation soil stratigraphy.
Geometry at time of document representative of 2017 conditions:	No	Phases 1 and 2 have since been buttressed, proposed expansion geometry has since been altered.
Piezometer installation:	Yes	5 borings with open standpipe piezometers, 13 borings with vibrating wire piezometers
In-situ testing:	Yes	SPT, CPTu, and Slug Tests
Laboratory testing:	Yes	Testing follows ASTM standards
Shear strength parameters:	Yes	12 CU triaxial tests on CCR, existing clay foundation and expansion area clay foundation soils
Static slope stability:	Yes	6 cross-sections for existing, buttressed, and proposed build-out geometries
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses with buttress are representative of long-term, static slope stability of the current Dry Fly Ash Stack at the modeled sections.
Other relevant analyses:	Yes	Seepage modeling

3.19.1 Field Activities

The geotechnical exploration program included 35 SPT borings (including offset borings from original sample borings). Approximate boring locations are shown on the boring layout in Figure 2. The borings were performed using both a CME-1050 ATV and a CME-85 Truck drill rig with hollow-stem augers. SPT sampling was performed continuously in accordance with ASTM D1586. Undisturbed samples were obtained in accordance with ASTM D1587. Prior to drilling, TVA surveyed and staked all of the boring locations. However, some of the boring locations (STN-112, 114, 118, 128, 138, 139, and 146) were field adjusted by Stantec engineers due to accessibility issues for the drill rigs.

Upon completion of drilling, piezometers were installed in 18 borings including 5 standpipe piezometers and 13 vibrating wire piezometers. The annular backfill for the standpipe piezometers consisted of a sand filter pack to some distance above the screened zone followed by a bentonite seal to just below the ground surface. The vibrating wire piezometers were grouted to just below the ground surface after the transducers were in place. Borings without piezometers were backfilled with either bentonite-cement grout or auger cuttings.

Falling head slug tests were performed on the active Stantec open standpipe piezometers. This included both the most recently installed piezometers as well as those installed as part of the Phase 2 exploration in 2010. Eight tests were performed in piezometers that were screened in Fly Ash, and five tests were performed in piezometers that were screened in the Foundation Clay Fill material.

3.19.2 Laboratory Testing

The disturbed (SPT) and undisturbed (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), and falling head permeability (D5084) tests.

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 and seepage modeling conducted in Seep/W. The selection of the slope stability cross-sections was dependent upon the steepness of slopes, the geometry of the sections, the piezometric surface, and the subsurface conditions. Based on these criteria, six (6) cross sections (Sections B-B', D-D', E-E', F-F', G-G', and H-H') were selected for seepage and slope stability analyses. All six of the cross-sections were analyzed with respect to the existing conditions and the proposed expansion build-out configuration.

Additionally, cross-sections B-B', D-D', E-E', and H-H' were analyzed with respect to two existing stack configuration conceptual repairs and a proposed expansion build-out conceptual repair.

The stability of the Dry Fly Ash Stack was evaluated using limit equilibrium methods as implemented in the SLOPE/W module. Analyses were completed for static loading for long-term, steady-state seepage conditions. The drained shear strength parameters were derived using both current and historical laboratory test data (consolidated-undrained triaxial tests, standard penetration testing data, and classification testing data) and Stantec's experience with these materials in similar applications.

The stability analyses focused on optimized deep (>10ft depth) and global (>20 ft. depth) failures and non-optimized shallow failures for the assessed cross-sections. The results of the stability analyses indicated that several sections of the existing configuration along the north and southeast slopes (Sections B-B', D-D', E-E', and H-H') of the stack did not have the minimum target factor of safety against slope failure (shallow or deep seated) under long term loading conditions.

This report briefly discussed certain options TVA could consider improving the stability of Dry Fly Ash Stack areas not meeting the minimum target factor of safety for long-term static stability.

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. Dry Fly Ash Stack and foundation geometry is substantially the same as current (except for subsequent buttressing).
2. Piezometers
    a. Installation methods meet current standard of practice,
    b. Locations and elevations were surveyed,
    c. Active instruments are adequate to provide current water level readings.

3. CCR and 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 URS (2011)

Table 20. Summary of Evaluation for URS (2011)

Reference:	URS. 2011. "TVA Bull Run Fossil Plant, Bottom Ash Disposal Area 1, Gypsum Disposal Area 2A, and Ash Disposal Area 2, Seepage and Slope Stability Remediation". Revision 0. Prepared for Tennessee Valley Authority. July 20.	
Purpose:	Engineering study analyzing effectiveness of the proposed work plans to improve perimeter dike slope stability for each unit. Recommendations for future operational controls were also provided.	
CCR Unit(s):	Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C	
Spatial coverage:	11 cross-sections along the perimeter dikes of the four units	
Item	**Yes/No**	**Remarks**
Soil borings:	No	
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 are substantially the same as current for most of the units. Stone buttress has since been added to south perimeter dike of Gypsum Disposal Area 2A.
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	Yes	Static drained strengths
Static slope stability:	Yes	8 cross-sections
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses are representative of long term, static stability of each unit's perimeter dikes.
Other relevant analyses:	Yes	Seepage modeling

3.20.1 Analysis

Historical boring information 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 and seepage modeling conducted in SEEP/W. The selection of the slope stability cross-sections was dependent upon the steepness of slopes, the

geometry of the sections, the piezometric surface, and the subsurface conditions. Based on these criteria, eight (8) cross sections (Sections F-F', H-H', I-I', J-J', N-N', O-O', R-R', and S-S') were selected for seepage and slope stability analyses. All eight of the cross-sections were analyzed with respect to the proposed construction detailed in work plans for subsurface drainage and slope improvements, perimeter maintenance and improvements, and grouting of abandoned pipes.

The stability of the subject units was evaluated using limit equilibrium methods as implemented in the SLOPE/W module. Analyses were completed for static loading for long-term, steady-state seepage conditions. The drained shear strength parameters were derived using historical laboratory test data (consolidated-undrained triaxial tests, standard penetration testing data, and classification testing data) and URS's experience with these materials in similar applications.

The stability analyses focused on global failures for the assessed cross-sections. The results of the stability analyses indicated that the proposed slope configurations and improvements met the minimum target factor of safety against slope failure (shallow or deep seated) under long term loading conditions.

This report briefly discussed certain operational control options that TVA could consider maintaining the improved stability of the perimeter dikes.

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. CCR and soil properties (including shear strengths)
    a. Subsurface conditions are substantially the same as current.
2. Static slope stability analyses
    a. Material parameters are representative of current.
    b. In areas of critical failure surfaces, surface and subsurface geometry is substantially the same at present (except for subsequent buttressing). Additional/future CCR stacking on interior (i.e., at top of stack) does not affect critical failure surfaces near perimeter.
    c. Pool elevations and phreatic conditions are similar to or more conservative than current.
    d. Analysis methods meet current standard of practice.

3.21 CEC (2012)

Table 21. Summary of Evaluation for CEC (2012)

Reference:	Civil and Environmental Consultants, Inc. (CEC). 2012. "Bull Run Fossil Plant Class II Landfill Operations Manual." Prepared for Tennessee Valley Authority. April 4.	
Purpose:	Assess slope stability for the proposed Lateral Expansion of the Dry Fly Ash Stack	
CCR Unit(s):	Dry Fly Ash Stack Phases 1 and 2 and Lateral Expansion	
Spatial coverage:	2 cross sections of the proposed Lateral Expansion	
Item	**Yes/No**	**Remarks**
Soil borings:	No	
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:	No	
Shear strength parameters:	Yes	Drained shear strength (CCR and soil) and direct shear strengths for liners
Static slope stability:	Yes	2 cross-sections
Seismic slope stability:	Yes	2 cross-sections
Information adequate to support stability evaluation:	Yes	Analyses are representative of static and seismic stability of the proposed Lateral Expansion of the Dry Fly Ash Stack
Other relevant analyses:	Yes	Consideration of liquefaction; Simplified seismic displacement analyses

3.21.1 Analysis

Historical boring information were used to establish existing subsurface geometry and material parameters of the different soils at the section location. The selection of the slope stability cross-sections was dependent upon the steepness of slopes, the existing and proposed geometry of the sections, and the existing geosynthetic liner(s) in the Dry Fly Ash Stack. Based on these criteria, two critical cross sections (Sections A-A and B-B) were selected for slope stability analyses

The stability of the proposed Lateral Expansion (i.e., Phase III) of the Dry Fly Ash Stack was evaluated using limit equilibrium methods as implemented in the Slide 6.0 software developed by Rocscience. Analyses were completed for static and seismic loading for long-term, steady-state seepage conditions. The drained shear strength parameters for the CCR and soils used in the analyses were selected from historical reports by GEI Consultants, Inc. and Stantec Consulting Services, Inc. The direct shear strength parameters for the liner system were based on Geosynthetic Research Institute's recommendations.

The stability analyses evaluated the selected cross sections with respect to circular and translational two-dimensional failure surfaces. This report states that the results of the slope stability analyses provided acceptable factors of safety for the proposed Lateral Expansion design of the Dry Fly Ash Stack.

3.21.2 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 and seismic slope stability analyses

    a. Material parameters are representative of current.

    b. Surface and subsurface geometry (proposed design) is substantially the same at present.

    c. Pool elevations and phreatic conditions are similar or more conservative than current.

    d. Analysis methods meet current standard of practice.

3.22 CEC (2014)

Table 22. Summary of Evaluation for CEC (2014)

Reference:	Civil and Environmental Consultants, Inc. (CEC). 2014. "Construction Quality Assurance (CQA) Certification Report, Bull Run Fossil Plant, Clinton, Tennessee." Prepared for Tennessee Valley Authority. December.	
Purpose:	Summarizes the CQA monitoring and testing program conducted during the construction of the Lateral Expansion liner system and associated infrastructure	
CCR Unit(s):	Dry Fly Ash Stack Lateral Expansion	
Spatial coverage:	Dry Fly Ash Stack Lateral Expansion	
Item	**Yes/No**	**Remarks**
Soil borings:	No	
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	No	
Data adequate to support three-dimensional model:	Yes	Data to support geologic buffer and liner geometry/thickness
Geometry at time of document representative of 2017 conditions:	Yes	Leachate collection system and capillary break layer have since been modified. Constructed geologic buffer and compacted clay liner would be substantially unchanged.
Piezometer installation:	No	
In-situ testing:	Yes	Nuclear Density-Moisture testing
Laboratory testing:	Yes	Hydraulic conductivity testing on undisturbed samples of existing geologic buffer (i.e., foundation soils), remolded borrow soil samples, and as-compacted drive cylinder samples. Laboratory 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:	Yes	Field (destructive and non-destructive) testing of geomembrane seams

3.22.1 Field Activities

First, the expansion area was stripped of topsoil and crushed stone that covered a laydown area in the footprint of Cells 2 and 3. A temporary dam was installed to allow dewatering of Cells 2 and 3 and excavated down to competent rock. Then Cell 1 was dewatered, and the overburden was excavated and stacked on top of the Dry Fly Ash Stack. Once all three cells were excavated to competent rock, structural fill was brought in. On-site material was used where allowable as structural fill to bring the areas up to subgrade. Additional structural fill (approximately 105,000 yd^3) was brought from an off-site borrow area to construct the cell berms and roadway. Twelve bulk samples of this material were collected for testing prior to construction. Structural fill was placed in maximum 12-inch lifts and compacted to 95% of maximum dry unit weight at moisture contents above optimum (per ASTM D698). These lifts were tested using a nuclear density gauge at a rate of 1 test per lift per acre. In addition to field density testing, 131 Shelby tube samples were collected to meet the 1 test per lift per acre requirement.

Once subgrade had been approved, then 69,200 yd^3 of clay liner material could be hauled on-site. The 2-foot thick clay liner was placed in four 6-inch lifts and compacted to 95% of maximum dry unit weight at 3-5% above optimum moisture content (per D698). The final 6-in lift of clay liner was screened to remove large rocks and debris before being hauled to the site. These lifts were tested using a nuclear density gauge at a rate of 4 test per lift per acre. In addition to field density testing, 96 Shelby tube samples were collected to meet the 1 test per lift per acre requirement. There were 9 tests that did not meet the minimum specification for permeability. These areas had to be reworked and additional Shelby tube sample taken for analysis.

A 60-mm thick high-density polyethylene (HDPE) geomembrane liner was installed overlying the clay liner. Upon completion of the installation of the geomembrane liner, a geocomposite drainage net was installed. The installation was monitored and tested by CEC in accordance with design specifications.

Finally, approximately 69,200 yd^3 of capillary break drainage layer was constructed over the geomembrane liner in one, 2-foot thick lift. The material was sources from an off-site manufacturer and was specified to have a hydraulic conductivity equal to or greater than $1x10^{-4}$ cm/sec. Ten bulk samples were collected for conformance testing.

3.22.2 Laboratory Testing

Prior to construction, bulk samples were obtained from two potential borrow sources. These bulk samples were subjected to index testing including grain-size analysis, Atterberg limits, and specific gravity (D854). Select bulk samples were subjected to standard Proctor (D698) tests to create a family of curves. Then, test specimens were remolded to varying moisture contents and dry densities for hydraulic conductivity testing.

Following construction of each successive soil layer (i.e., geologic buffer, clay liner, and drainage layer), samples were subjected to hydraulic conductivity testing to compare to project specifications.

3.22.3 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 construction surveys

    a. Locations and elevations were surveyed,

    b. Daily field logs and laboratory testing sheets document material descriptions and thicknesses,

    c. Perimeter dike and foundation geometry is substantially the same as current.

2. Soil and geosynthetic liner properties

    a. Sampling and testing followed relevant standards.

    b. Subsurface conditions are substantially the same as current.

3.23 STANTEC & GEI (2014)

Table 23. Summary of Evaluation for Stantec & GEI (2014)

Reference:	Stantec Consulting Services, Inc. and GEI Consultants, Inc. (Stantec & GEI). 2014. "USEPA CCR Impoundment Assessment, Bull Run Fossil Plant (BRF), Bottom Ash Disposal Area 1 and Gypsum Disposal Area 2A, Clinton, Tennessee." Prepared for Tennessee Valley Authority. December 15.	
Purpose:	Assessment of liquefaction potential and post-earthquake stability of existing conditions at Bottom Ash Disposal Area and Gypsum Disposal Area 2A	
CCR Unit(s):	Bottom Ash Disposal Area and Gypsum Disposal Area 2A	
Spatial coverage:	4 cross-sections along western perimeter dike (i.e., along Clinch River)	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	16 borings (refer to Geocomp (2017) for logs)
Rock coring:	No	
Other subsurface data:	Yes	14 seismic CPT soundings (refer to Geocomp (2017) for logs)
Boring locations surveyed:	Yes	Borings surveyed by TVA
Data adequate to support three-dimensional model:	Yes	Data support dike geometry, CCR thickness, foundation soil stratigraphy, and top of rock elevation
Geometry at time of document representative of 2017 conditions:	Yes	Dike geometry and phreatic conditions are substantially the same as current conditions.
Piezometer installation:	No	
In-situ testing:	Yes	SPT, seismic CPT
Laboratory testing:	Yes	Testing followed ASTM standards
Shear strength parameters:	Yes	Static, undrained shear strengths (unsaturated soils), seismic shear strengths (for unliquefied and liquefied soils)
Static slope stability:	No	
Seismic slope stability:	Yes	2 cross-sections for post-earthquake conditions
Information adequate to support stability evaluation:	Yes	Subsurface data is relevant, analyses have been superseded by Geocomp (2017)
Other relevant analyses:	Yes	Liquefaction triggering

3.23.1 Field Activities

To support TVA's response to the USEPA CCR Impoundment Assessment, a supplemental evaluation was performed for the Bottom Ash Disposal Area and Gypsum Disposal Area 2A. A subsurface exploration program, completed between September 5 - 18, 2014, was designed that consisted of a total of 30 locations: 8 SPT borings, 8 Shelby tube sample borings, and 14 SCPT soundings, across four cross-sections. The borings and soundings were performed at two cross-sections each near both the crest of the ash dikes and the raised dikes for Bottom Ash Disposal Area 1 (labeled C-C' and D-D') and Gypsum Disposal Area 2 (labeled H-H' and I-I'). The approximate locations are shown in Figure 1. Please refer to Geocomp 2017 for the boring and sounding logs as they were not included with this report.

The borings were performed using a CME 85 truck-mounted drill rig with mud rotary drilling methods in accordance with ASTM D5783. Split spoon sampling was performed continuously beginning at a target depth specified by the engineer in accordance with ASTM D1586. Undisturbed (Shelby tube) samples were obtained in accordance with ASTM D1587.

The SCPT soundings were performed using a CME 85 truck-mounted drill rig in general accordance with ASTM D5778. 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 2.5-foot intervals.

3.23.2 Laboratory Testing

The disturbed (SPT) and undisturbed 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), and sieve with hydrometer analysis (D422).

3.23.3 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.

The design earthquake had a return period of 2,500 years. Site-specific seismic amplification analyses (i.e., ground response analyses) used scaled ground motion time histories that were originally developed for Kingston Fossil Plant. Scaling was performed to account for differing source-to-site distances for Bull Run. The scaled acceleration time histories were used to obtain seismic shear stresses in the soil and ash at Bull Run Fossil Plant.

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). The results of the site-specific ground response analyses were used to obtain the Cyclic Stress Ratio (CSR) imposed by the design earthquake on the soil. If a layer was deemed to liquefy, then its residual undrained shear strength was assigned in the post-earthquake slope stability analysis.

3.23.4 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. CCR and soil properties
    a. Sampling and testing followed relevant ASTM standards.
    b. Subsurface conditions are substantially the same as current.
3. 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.

3.24 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, Well Installation and Closures Groundwater Monitoring Optimization - Phase 3, Bull Run Fossil Plant, Anderson County, Tennessee." Prepared for Tennessee Valley Authority. January 31.	
Purpose:	Document groundwater monitoring well installations, re-developments, and abandonments, per the Groundwater Monitoring Optimization (GMO) for CCR units at BRF.	
CCR Unit(s):	Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, Dry Fly Ash Stack Phase 1 and 2, Dry Fly Ash Lateral Expansion, Proposed Landfill, and the Railroad Loop Disposal Area.	
Spatial coverage:	Perimeters of the above units.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	2 borings
Rock coring:	Yes	1 boring
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 foundation soil thickness/stratigraphy, top of bedrock elevation, and bedrock stratigraphy
Geometry at time of document representative of 2017 conditions:	Yes	Unit geometry and phreatic conditions similar.
Piezometer installation:	Yes	One new monitoring well installed
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

Field activities included installation of one new monitoring well, nineteen monitoring well closures, and the re-development of 30 existing monitoring wells. Two soil borings were performed during this exploration, one of which was extended into bedrock. The work was performed by qualified Stantec drill crews using truck-mounted drill rigs under the direction of a licensed Tennessee driller (#949). 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 new well (BRF_AshS_107) was installed using a truck mounted rotary drill rig equipped with hollow stem augers. The new well boring along with sample boring BRF_GypS_50 (adjacent to the existing well with the same identifier) were performed by advancing hollow-stem augers through the soil overburden. SPTs were performed at 2½-foot depth intervals through the soil overburden. The split-spoon samples were placed into glass jars with lids and transported to Stantec's Lexington, Kentucky laboratory. Upon completion of overburden sampling for BRF_AshS_107, eight-inch air rotary tooling (using filtered air) was utilized to continue the borehole into bedrock to the target depth. The subsurface materials were logged by a Stantec project geologist or engineer for material type, color, moisture content, consistency, and other notable composition characteristics.

The new well consisted of a four-inch diameter by ten-foot long Schedule 40 PVC pre-packed well screen (0.010-inch slots) and riser. The screen and riser consisted of flush-joint, threaded PVC pipe. A four-inch diameter Schedule 40 PVC bottom well plug measuring approximately three inches in length was threaded onto the bottom of the screen. The PVC riser extended above the ground surface and was capped with a temporary plug or slip cap. The annular space was backfilled with a sand filter pack (20/40 mesh – Global No. 7 sand) extending from the bottom of the borehole to an elevation corresponding to approximately two to three feet above the well screen.

Upon completion of the field work performed, the soil borings and well locations were surveyed onto the Tennessee state plane coordinate system by Stantec (approximate locations are shown in Figures 1 and 2).

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.

3.25 GEOCOMP (2017)

Table 25. Summary of Evaluation for Geocomp (2017)

Reference:	Geocomp Consulting, Inc. (Geocomp). 2017. "Tennessee Valley Authority Stability Assessment Supplemental Site Exploration Bull Run Fossil Plant, Bottom Ash Disposal Area, Gypsum Disposal Area, and Fly Ash Pond DRAFT Report" Volume 1 - 4. Prepared for Tennessee Valley Authority. May.
Purpose:	Evaluation of the static and seismic performance of existing conditions at the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, and Main Ash Pond.
CCR Unit(s):	Bottom Ash Disposal Area, Gypsum Disposal Area 2A, and Main Ash Pond
Spatial coverage:	Analysis of 3 cross-sections (one per unit) along the perimeter dikes

Reference:	Geocomp Consulting, Inc. (Geocomp). 2017. "Tennessee Valley Authority Stability Assessment Supplemental Site Exploration Bull Run Fossil Plant, Bottom Ash Disposal Area, Gypsum Disposal Area, and Fly Ash Pond DRAFT Report" Volume 1 - 4. Prepared for Tennessee Valley Authority. May.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	16 borings
Rock coring:	No	
Other subsurface data:	Yes	7 SCPTu soundings
Boring locations surveyed:	Yes	Surveyed by TVA after drilling.
Data adequate to support three-dimensional model:	Yes	Data support dike geometry, CCR thickness, foundation soil stratigraphy, and top of bedrock elevation.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter dike geometry and phreatic conditions are substantially the same as current conditions.
Piezometer installation:	Yes	6 borings instrumented with strings of vibrating wire piezometers; up to 6 sensors per boring (29 sensors total); sensing zones in alluvium, CCR, and dike fill.
In-situ testing:	Yes	SPT, SCPTu with shear wave velocity and pore pressure dissipation, cross-hole seismic velocity and gamma density
Laboratory testing:	Yes	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	3 cross-sections: B-D', I-I', and S-S' (one for each unit)
Seismic slope stability:	Yes	3 cross-sections: B-D', I-I', and S-S' (one for each unit)
Information adequate to support stability evaluation:	Yes	Analyses are representative of static, post-earthquake and pseudostatic stability of existing dike perimeters.
Other relevant analyses:	Yes	Liquefaction triggering analyses

3.25.1 Field Activities

The geotechnical exploration program included soil borings (with disturbed and undisturbed sampling) and SCPTu soundings (approximate locations are shown in Figure 1). A total of sixteen borings and seven SCPTu soundings were performed. At the Bottom Ash Disposal Area, a total of 5 borings and 3 SCPTu soundings were performed at Sections B-B' and D-D'. At the Gypsum Disposal Area 2A, 7 borings and 3 soundings were performed at Section I-I'. At the Main Ash Pond, 4 borings and 1 sounding were performed at Section S-S'.

The borings were performed using a CME 75 truck-mounted drill rig with mud rotary drilling methods in accordance with ASTM D5783. Split spoon sampling was performed at approximately 2.5 feet intervals in accordance with ASTM D1586. SPT hammer energy verification was performed on one borehole in accordance with ASTM D4633. The SCPTu soundings were performed using a 20-ton CPT track rig in general accordance with ASTM D5778.

Undisturbed samples were obtained with an Osterberg sampler in accordance with ASTM D6519. In material too stiff for an Osterberg sampler, Shelby tube sampling was used in accordance with ASTM D1587. Split spoon and undisturbed samples were transported in a wooden crate designed to limit disturbance.

SCPTu soundings were advanced at seven locations. 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 2.5-foot intervals.

Cross-hole seismic velocity and gamma density testing was performed by ARM Geophysics at three cross-sections. These tests were performed within the three cased boreholes at the crest of the ash dike for cross-section D-D', intermediate bench for cross-section I-I', and crest of the raised dike for cross-section S-S'. The cross-hole seismic velocity testing was performed using a downhole source and geophone/receiver combination at approximately 5-foot intervals in accordance with ASTM D4428. Four series of tests were performed at each cross-section for the full depth of the borehole. The gamma density testing was used to measure in-situ bulk density of the subsurface soils in comparison to SCPTu and laboratory testing results.

Upon completion of drilling, a multi-level vibrating wire piezometer (VWPZ) string was installed into selected boreholes at each of the three cross-sections. Each VWPZ string was then 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.

3.25.2 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), one-dimensional consolidation (constant strain) with pore pressures (D4186), direct shear (D3080), direct simple shear (D6528), and cyclic direct simple shear (D6528). 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.

3.25.3 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.

Three representative critical cross sections were subjected to an evaluation for short-term and long-term static slope stability. The evaluations were based on two-dimensional limit equilibrium slope stability.

A site-specific seismic study was conducted on the design response spectra developed by USGS. The design earthquake had a return period of 2,500 years. 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 to liquefy, 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 (short-term and long-term) and post-earthquake conditions. Two-dimensional non-linear analyses were performed for pseudo-static conditions. Seismic 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.

3.25.4 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. Vibrating Wire 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. CCR and 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.

3.26 AECOM (2017A)

Table 26. Summary of Evaluation for AECOM (2017a)

Reference:	AECOM. 2017a. "Stilling Pond Lining and Repurposing, Basis of Design Calculations, TVA Bull Run Fossil Plant, Anderson County, Tennessee" Prepared for Tennessee Valley Authority. July.	
Purpose:	Assessment of the static slope stability for the existing, during construction, and designed closure (i.e., repurposed) conditions of the Fly Ash Stilling Pond 2C. Note that the CCR will be removed from the pond footprint as part of construction.	
CCR Unit(s):	Fly Ash Stilling Pond 2C	
Spatial coverage:	Analysis of 3 cross-sections along the interior and perimeter dikes for the Fly Ash Stilling Pond 2C.	
Item	**Yes/No**	**Remarks**
Soil borings:	Yes	7 borings + 2 offset borings
Rock coring:	No	
Other subsurface data:	No	
Boring locations surveyed:	Yes	Boring locations and elevations were reported
Data adequate to support three-dimensional model:	Yes	Data support dike geometry, CCR thickness, foundation soil stratigraphy, and top of bedrock elevation.
Geometry at time of document representative of 2017 conditions:	Yes	Perimeter and interior dike geometry and phreatic conditions are substantially the same as current conditions. Analyses represent the future repurposed condition.
Piezometer installation:	Yes	2 piezometers, screened in CCR
In-situ testing:	Yes	SPT
Laboratory testing:	Yes	Testing followed ASTM standards
Shear strength parameters:	Yes	Drained and undrained shear strengths (alluvium, CCR, dike fill, and liner system)
Static slope stability:	Yes	3 cross-sections for existing (steady-state and rapid drawdown), construction (interim, temporary loading, and end), closure (steady-state and temporary loading), and liner stability
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses are representative of existing, during and end of construction, and closure conditions
Other relevant analyses:	Yes	Seepage model, hydraulic and hydrologic analysis of proposed closure design, structural stability of proposed outlet structure, sump pump requirements during construction

3.26.1 Field Activities

The geotechnical exploration program included 7 SPT borings and 2 offset borings for instrument installation. Approximate boring locations are shown on the boring layout in Figure 2. The borings were performed using a CME 55 ATV-mounted drill rig with hollow-stem augers. SPT sampling was performed continuously in accordance with ASTM D1586. Undisturbed (Shelby and piston tube) samples were obtained in accordance with ASTM D1587 and ASTM D6519 at depths determined by the onsite geologist. Groundwater levels were taken at the time of drilling and select intervals after drilling was completed.

Upon completion of drilling, piezometers were installed at two boring locations along the interior dike. The annular backfill for the piezometer consisted of sand around the screened interval, a bentonite seal, then grout to the ground surface. All other borings were backfilled using cement bentonite grout by means of the tremie method to near the ground surface, followed by gravel to the surface.

3.26.2 Laboratory Testing

The disturbed (SPT) and undisturbed soil samples obtained during conventional drilling were subjected to the following laboratory tests: natural moisture content (D2216), Atterberg limits (D4318), specific gravity (D854), grain size analysis (D422), USDA soil classification, CU triaxial with pore pressure measurements (D4767), UU triaxial (D2850), crumb dispersion (D6572), pinhole erosion (D4647), and falling head hydraulic conductivity (D5084) tests.

3.26.3 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 and seepage modeling conducted in SEEP/W. The selection of the slope stability cross-sections was based upon the steepness of slopes, the geometry of the sections, the piezometric surface, and the subsurface conditions. Based on these criteria, three (3) cross sections (Sections C-C', E-E', and G-G') were selected for seepage and slope stability analyses. Note that the CCR will be removed from the pond footprint as part of construction.

The drained and undrained shear strength parameters were derived using both current and historical laboratory test data (CU and UU triaxial tests, standard penetration testing data, and classification testing data) along with typical values based on material type.

The stability analyses were performed using limit equilibrium methods as implemented in the SLOPE/W module. All three of the cross-sections were analyzed with respect to the existing (steady-state and rapid drawdown), construction (interim, temporary loading, and end), and closure (steady-state and temporary loading) conditions. An additional analysis was performed on all three cross-sections for a translational failure along the liner surface.

The results of the stability analyses indicated that the existing configuration of cross-sections C-C' and E-E' did not meet the minimum target factor of safety against slope failure during rapid drawdown conditions. Thus, the stilling pond must be dewatered at a recommended slower rate of 0.5 feet per day to avoid a rapid drawdown scenario. Additionally, an underdrain system must be installed along the interior dike (cross-section C-C') immediately following excavation of the slopes to maintain the target factor of safety during construction. All other conditions met the target factor of safety against slope failure.

3.26.4 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. CCR and 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 to current.
    d. Analyses are representative of future construction and closure conditions

e. Analysis methods meet current standard of practice.

3.27 AECOM (2017B)

Table 27. Summary of Evaluation for AECOM (2017b)

Reference:	AECOM. 2017b. "Fly Ash Pond Closure, Basis of Design Calculations, DRAFT, TVA Bull Run Fossil Plant, Anderson County, Tennessee" Prepared for Tennessee Valley Authority. August.	
Purpose:	Assessment of the settlement, static slope stability, and uplift for the designed closure conditions of the Main Ash Pond.	
CCR Unit(s):	Main Ash Pond	
Spatial coverage:	Proposed Main Ash Pond closure (repurposed lined pond), including perimeter dike and interior divider dike.	
Item	**Yes/No**	**Remarks**
Soil borings:	No	
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 and interior dike geometry and phreatic conditions are substantially the same as current conditions. Analyses represent the future closed/repurposed condition.
Piezometer installation:	No	
In-situ testing:	No	
Laboratory testing:	No	
Shear strength parameters:	No	
Static slope stability:	Yes	5 cross-sections (C-C', R-R', S-S', 1-1' and 2-2')
Seismic slope stability:	No	
Information adequate to support stability evaluation:	Yes	Analyses are representative of design closure conditions
Other relevant analyses:	Yes	Seepage model (cross-section L-L' and 2-2'), hydraulic and hydrologic analysis, settlement analysis (cross-sections E-E', F-F', and G-G'), hydrostatic uplift analysis for repurposed lined pond

3.27.1 Analysis

Historical boring information was 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 and seepage modeling conducted in SEEP/W. The selection of the slope stability cross-sections was based upon the steepness of slopes, the geometry of the sections, the piezometric surface, and the subsurface conditions. Based on these criteria, five (5) cross sections (Sections C-C', R-R', S-S', 1-1', and 2-2') were selected for slope stability analyses.

The stability analyses were performed using limit equilibrium methods as implemented in the SLOPE/W module. All of the cross-sections were analyzed with respect to deep-seated global stability. Two cross-sections were also analyzed for veneer stability of the pond liner. The drained and undrained shear strength parameters were derived from historical laboratory test data (CU and UU triaxial tests, standard penetration testing data, and classification testing data) along with typical values based on material type. The results of the stability analyses indicated that the closure configuration of the analyzed cross-sections met the minimum target factor of safety against slope failure for post-closure conditions and for veneer stability.

3.27.2 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. CCR and soil properties (including shear strengths)
    a. Subsurface conditions are substantially the same as current.
2. 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 to current,
    d. Analyses are representative for future closure conditions,
    e. Analysis methods meet current standard of practice.

4.0 ADDITIONAL DISCUSSION OF SELECTED INFORMATION REQUESTS

4.1 TDEC GENERAL INFORMATION REQUEST NO. 5

Settlement analysis reference on page 84 of the multisite order presentation appears to have been misinterpreted from a previous TDEC questions. Please provide available documents relating to foundation settlement that may have or is calculated to occur as a result of the CCR loading on the natural foundation.

TVA Response

Slide 84 of the Investigation Conference presentation discusses settlement related to total suspended solids within the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C. This information request clarifies that TDEC is requesting information related to foundation settlement at each unit. Foundation settlement could occur due to three primary factors:

1. Immediate (i.e., elastic) settlements occur immediately, in response to an increase in stress. Such settlements are relatively small and have already occurred in units no longer receiving CCR. Therefore, elastic settlements are not discussed herein.

2. Consolidation settlement is time-dependent and typically associated with increasing effective stresses within saturated, low hydraulic conductivity soils. The rate of consolidation is a function of the hydraulic conductivity of the soil and the length of the drainage path.

3. Settlement could be due to loss of support from the underlying foundation soil and/or rock. This could be due to mechanisms such as internal erosion, collapse of voids in rock, etc.

Foundation settlement beneath a unit could vary spatially due to variations in several factors, such as imposed stresses, consolidation properties, foundation soil thickness, geometry of voids in rock, etc. Differential settlements may be important when such lateral variations occur over a relatively short distance. A summary for each unit, in relation to this request, is presented below:

Bottom Ash Disposal Area (IDL 01-000-0208): Settlement analyses are not available for this unit. However, based on construction history, existing conditions, and planned closure discussed below for this unit, the potential for additional settlement is considered to be negligible.

The footprint of the Bottom Ash Disposal Area was originally developed in 1967 as a surface impoundment, Ash Disposal Area 1. Based on subsurface characterization in Stantec (2010), foundation soils consist of alluvial clays over alluvial sands. The total foundation soil thickness is fairly uniform, ranging from about 15 to 25 feet, with the alluvial clays being thicker than the alluvial sands. The top of rock elevation is fairly uniform, varying by less than 10 feet across the footprint.

Perimeter dikes were constructed to form the impoundment and fly ash was sluiced to the area from 1967 to 1985. In 1985, the impoundment stopped receiving fly ash and was filled with bottom ash. From 1986 to 2015, bottom ash was stacked above the sluiced ash. No new material has been placed in the unit since 2015. More recently, stacked bottom ash was excavated from a portion of the unit, for beneficial reuse as structural fill in the Main Ash Pond. Closure design is ongoing and consists of minor regrading of the top of the unit to establish positive surface drainage, maintaining the existing side slope geometry, then installing a final cap over the unit.

The stresses in the foundation soils beneath the unit increased gradually over the 48 years that CCR was placed in the unit. Consolidation settlements would have occurred gradually, proportional to the rate of CCR placement. Since CCR placement ceased in 2015, only minor increases in stresses may have occurred as pore pressures in the CCR decrease. The more recent excavation of CCR further reduced the stresses in the foundation. In comparison to the current size of the stack, the future minor regrading of the top and addition of the final cap will not contribute significantly to the imposed stresses and thus would be expected to cause only minor consolidation, if any.

With regard to differential settlement, the foundation soils are relatively consistent in type and thickness beneath the unit. The changing height of the stack would lead to lateral variation in stresses and resulting consolidation. However, these changes in stress are gradual (laterally); thus, the settlement profile would also be gradual and sharp changes are unlikely. Again, because the unit has not received CCR since 2015, there is negligible potential for future differential settlement due to loading. The underlying bedrock is the Conasauga Group limestone and Rome Formation shale, and available rock coring information does not indicate significant karst activity (Stantec 2010; TVA 2004; Kellberg 1959). As such, differential settlement due to formation or collapse of voids is unlikely.

Gypsum Disposal Area 2A (IDL 01-000-0208): Settlement analyses are not available for this unit but are ongoing as part of the closure design. The closure design will consider settlement due to the loading caused by minor regrading of the top and addition of the final cover, as necessary to maintain appropriate surface drainage. The results of this analysis will be provided in the EAR. However, based on construction history, existing conditions, and planned closure discussed below for this unit, the potential for additional settlement is considered to be negligible.

The footprint of the Gypsum Disposal Area 2A was part of an area originally developed in 1967 as a surface impoundment, Ash Disposal Area 2. Based on subsurface characterization in Stantec (2010), foundation soils consist of alluvial clays over alluvial sands. The total foundation soil thickness is variable, ranging from about 10 to 40 feet, with the alluvial clays being thicker than the alluvial sands. The top of rock elevation is fairly uniform, varying by less than 10 feet across the footprint.

Perimeter dikes were constructed to form the impoundment and fly ash was sluiced to the area from 1971 to 1981. In 1981, an internal dike was constructed to subdivide Area 2A, which continued to be used for sluiced fly ash until 1989. From 1989 to 2004, Area 2A was used for dry stacking of bottom ash. From 2006 to 2008, the area was converted to Gypsum Disposal Area 2A, which came online in 2008. No new material has been placed in the unit since 2015. Closure design is ongoing and consists of minor regrading of the top of the unit to establish positive surface drainage, maintaining the existing side slope geometry, then installing a final cap over the unit.

The stresses in the foundation soils beneath the unit increased gradually over the 44 years that CCR was placed in the unit. Consolidation settlements would have occurred gradually, proportional to the rate of CCR placement. Since CCR placement ceased in 2015, only minor increases in stresses may have occurred as pore pressures in the CCR decrease. In comparison to the current size of the stack, the future minor regrading of the top and addition of the final cap will not contribute significantly to the imposed stresses and thus would be expected to cause only minor consolidation, if any.

With regard to differential settlement, the foundation soils are relatively consistent in type and the thickness changes gradually beneath the unit. The changing height of the stack would lead to lateral variation in stresses and resulting consolidation. However, these changes in stress are gradual (laterally); thus, the settlement profile would also be gradual and sharp changes are unlikely. Again, because the unit has not received CCR since 2015, there is negligible potential for future differential settlement due to loading. The underlying bedrock is the Conasauga Group limestone and Rome Formation shale, and available rock coring information does not indicate significant karst activity (Stantec 2010; TVA 2004; Kellberg 1959). As such, differential settlement due to formation or collapse of voids is unlikely.

Main Ash Pond, Fly Ash Stilling Pond 2C: AECOM (2017b) performed settlement analyses of the proposed closed/repurposed condition of the Main Ash Pond. The calculations demonstrate that the closure cap will maintain adequate positive drainage after settlement occurs. The results of this analysis will be provided in the EAR.

Settlement analyses are not available for Fly Ash Stilling Pond 2C. However, based on construction history, existing conditions, and planned closure discussed below for these units, the potential for additional settlement for the Fly Ash Stilling Pond 2C is considered to be negligible. In addition, the planned closure includes removal of the CCR from the stilling pond footprint (AECOM 2017a). The CCR removed from the stilling pond will be disposed of in a permitted facility.

The footprint of the Main Ash Pond and Fly Ash Stilling Pond 2C was part of an area originally developed in 1967 as a surface impoundment, Ash Disposal Area 2. Based on subsurface characterization in Stantec (2010), foundation soils consist of alluvial clays over alluvial sands. The total foundation soil thickness is fairly consistent, ranging from about 15 to 30 feet, with the alluvial clays being thicker than the alluvial sands. The top of rock elevation is fairly uniform, varying by less than 10 feet across the footprint.

Perimeter dikes were constructed to form the impoundment and fly ash was sluiced to the area starting in 1971. In 1976, an internal dike was constructed to subdivide the Main Ash Pond from the Fly Ash Stilling Pond 2C. The Main Ash Pond continued to be used for sluiced fly ash and some sluiced bottom ash until 2015. Some dry stacked bottom ash was relocated from the Bottom Ash Disposal Area to the eastern portion of the Main Ash Pond to raise the grade, in preparation for closure. No new material has been placed in the unit since 2015.

The stresses in the foundation soils beneath the unit increased gradually over the 44 years that CCR was placed in the unit. Consolidation settlements would have occurred gradually, proportional to the rate of CCR placement. Since CCR placement ceased in 2015, stresses within the Fly Ash Stilling Pond 2C and the Main Ash Pond would be relatively unchanged. Removing CCR and repurposing these areas during the closure process should only change the stresses by a minor amount, depending on the final grading. The placement of the final cap in the eastern portion of the Main Ash Pond increases the stresses relative to current conditions, and the resulting settlement is accounted for in the closure design (AECOM 2017b).

With regard to differential settlement, the foundation soils are relatively consistent in type and the thickness changes gradually beneath the units. The capping of the dry stacked material in the closed eastern portion of the Main Ash Pond would lead to lateral variation in stresses and resulting consolidation. However, these changes in stress are gradual (laterally); thus, the settlement profile would also be gradual and sharp changes are unlikely. Because the Fly Ash Stilling Pond 2C and the western portion of the Main Ash Pond have not received CCR since 2015, and due to the nature of the closure design there is negligible potential for future differential settlement due to loading. The underlying bedrock is the Conasauga Group limestone and Rome Formation shale, and available rock coring information does not indicate significant karst activity (Stantec 2010; TVA 2004; Kellberg 1959). As such, differential settlement due to formation or collapse of voids is unlikely.

Railroad Loop Disposal Area: Settlement analyses are not available for this unit. However, based on construction history and existing conditions discussed below for this unit, the potential for additional settlement is considered to be negligible.

The footprint of the Railroad Loop Disposal Area was originally developed in 1981 as a pair of surface impoundments (East Pond and West Pond) to accept dredged fly ash from Ash Disposal Area 2. Beginning in 1986, ash was excavated from the East and West Ponds and stacked against the hillside in the northern half of the unit.

This restored capacity in the ponds to accept additional sluiced ash. From 1990 to 1995, sluiced ash was periodically placed in the ponds and ash was stacked on the hillside. In 1995, the unit was closed, and a final soil cap was installed.

Based on subsurface characterization by TVA (1995), foundation soils consist of residual clays. The foundation soils are thin, ranging from 0 to 10 feet. The top of rock elevation slopes north to south, varying by over 30 feet across the footprint.

The stresses in the foundation soils beneath the unit have not changed significantly since the unit was closed in 1995. Regardless of the current stresses and the soil properties, no significant consolidation settlements are expected in the future.

With regard to differential settlement, the foundation soils are relatively consistent in type and thickness beneath the unit. The changing height of the stack would lead to lateral variation in stresses and resulting consolidation. However, these changes in stress are gradual (laterally); thus, the settlement profile would also be gradual and sharp changes are unlikely. Again, because the unit has not received CCR since 1995, there is negligible potential for future differential settlement due to loading. The underlying bedrock is the Conasauga Group limestone and Rome Formation shale, and available rock coring information does not indicate significant karst activity (Stantec 2010; TVA 2004; Kellberg 1959). As such, differential settlement due to formation or collapse of voids is unlikely.

Dry Fly Ash Stack Phase 1 and 2 (IDL 01-103-0080): Settlement analyses are not available for this unit. However, based on construction history and existing conditions discussed below for this unit, the potential for additional settlement is considered to be negligible.

The footprint of the Dry Fly Ash Stack Phase 1 was originally developed in 1983 and stacking of dry fly ash continued until 1992, when a soil cap was placed on the exterior slopes. In 1989, stacking of dry fly ash began in Phase 2. A portion of Phase 2 overlaps on an interior slope of Phase 1. Stacking in Phase 2 continued until 2015, when the Lateral Expansion was completed. A soil cap was placed on the exterior slopes. As the Lateral Expansion is filled, a portion of it will overlap an interior slope of Phase 2.

Based on subsurface characterization by TVA (2006) and Stantec (2011a, 2011b), foundation soils consist of residual clays and clayey fill that was placed as part of the "geologic buffer" below the units. The foundation soils vary in thickness, ranging from 5 to 25 feet, although typical values are less than 15 feet. Foundation soils are generally thinner beneath Phases 1 and 2 and slightly thicker beneath the Lateral Expansion. The top of rock elevation slopes north to south, varying by over 70 feet across the footprint.

The stresses in the foundation soils beneath the Phases 1 and 2 increased gradually over the 9 years and 26 years, respectively, that CCR was placed in the units. Consolidation settlements would have occurred gradually, proportional to the rate of CCR placement. In Phase 1, the stresses in the foundation soils beneath the unit have not changed significantly since stacking in the unit ceased in 1992. In Phase 2, stacking ceased in 2015, except for the portion that overlaps with the Lateral Expansion (which is addressed as part of the discussion of the Lateral Expansion below).

With regard to differential settlement, the foundation soils are consistent in type and gradually changing in thickness beneath the unit. The changing height of the stack would lead to lateral variation in stresses and resulting consolidation. However, these changes in stress are gradual (laterally); thus, the settlement profile would also be gradual and sharp changes are unlikely. Again, because Phases 1 and 2 have not received CCR since 1992 and 2015, respectively, there is little potential for future differential settlement due to loading. The underlying bedrock is the Chickamauga Formation, consisting of shaley limestone and interbedded shale. During pre-construction foundation investigations of the powerhouse site, which is also founded on the Chickamauga Formation, numerous cavities were encountered. Most cavities were soil-filled, although a few were open voids of up to 10 feet thick (Kellberg 1962). More recent borings performed specifically in the vicinity of the Dry Fly Ash Stack found some open cavities, but the thickness was 2 feet or less (MACTEC 2006; TVA 2006; URS 2005). However, there is no evidence of sinkhole development at the Dry Fly Ash Stack due to the shale content of the limestone and the shale interbeds. TVA concluded that there was a low potential for future sinkhole subsidence (TVA 2006). As such, differential settlement due to formation or collapse of voids is unlikely.

Dry Fly Ash Stack Lateral Expansion (IDL 01-103-0080): Settlement analyses are not available for this unit. MACTEC (2006) performed settlement analyses for a proposed retaining wall that was considered as part of a lateral and vertical expansion of the Dry Fly Ash Stack. However, the vertical expansion and the retaining wall were eliminated from consideration and the geometry of the Lateral Expansion was revised, consistent with the current permit. The Lateral Expansion became active in 2015 and continues to accept dry stacked CCR materials. TVA will perform an updated settlement analysis for the permitted geometry as part of the ongoing CCR Rule demonstration for unstable areas. The analysis will consider the filling performed to date, as well as the projected filling of the unit to its final geometry. The results of this analysis will be provided in the EAR.

With regard to differential settlement, the foundation soils are consistent in type and gradually changing in thickness beneath the unit. The changing height of the stack would lead to lateral variation in stresses and resulting consolidation. However, these changes in stress are gradual (laterally); thus, the settlement profile would also be gradual and sharp changes are unlikely. The underlying bedrock is the Chickamauga Formation, consisting of shaley limestone and interbedded shale. During pre-construction foundation investigations of the powerhouse site, which is also founded on the Chickamauga Formation, numerous cavities were encountered.

Most cavities were soil-filled, although a few were open voids of up to 10 feet thick (Kellberg 1962). More recent borings performed specifically in the vicinity of the Dry Fly Ash Stack found some open cavities, but the thickness was 2 feet or less (MACTEC 2006; TVA 2006; URS 2005). However, there is no evidence of sinkhole development at the Dry Fly Ash Stack due to the shale content of the limestone and the shale interbeds. TVA concluded that there was a low potential for future sinkhole subsidence (TVA 2006). As such, differential settlement due to formation or collapse of voids is unlikely.

A design feature of the Lateral Expansion was a concrete box culvert installed beneath the unit, to contain an unnamed tributary of Worthington Creek. With respect to the structural capacity of the box culvert, CEC (2012) reports:

> "Additionally, MACTEC performed structural integrity calculations of the box culvert containing Worthington Creek under the proposed waste mass. The culvert was determined to withstand the anticipated loading of the waste mass with the MSE wall which is approximately 100 feet taller than the proposed waste mass. Therefore, the box culvert should withstand the loading of the proposed waste mass."

With respect to potential differential settlement due to the presence of the culvert, settlement analyses are not available. However, the design drawings (TVA Drawing No. 10W299-17R0, in particular) and the Construction Quality Assurance (CQA) Certification Report (CEC 2014) does document several construction measures that should reduce the potential for differential settlement. According to the design drawings, the existing subgrade soils were to be proof rolled prior to placing structural fill. Compacted structural fill and crushed stone were placed to provide a foundation for the culvert. On-site construction observation and field density testing were performed on the structural fill and crushed stone. Compacted crushed stone was also placed along the sides of the box culvert, up to the top of the culvert. Next, compacted clayey soil for the geologic buffer (5 feet thick) was placed over the entire unit footprint, including over top of the culvert. The bottom liner and leachate collection system were then constructed. The subgrade preparation beneath the culvert provides for soils that are relatively thin and unlikely to settle significantly. The placement of the overlying geologic buffer layer across the entire unit footprint acts as a bridging layer that would also reduce the potential for abrupt differential settlement along the culvert alignment. The influence of this culvert with respect to differential settlement will be considered further as part of the settlement analyses in the CCR Rule unstable areas demonstration.

Closure: Additional settlement analyses are only anticipated for Gypsum Disposal Area 2A and the Dry Fly Ash Stack Lateral Expansion (including consideration of the culvert beneath the unit). The analyses for the Gypsum Disposal Area 2A will be performed as part of the ongoing closure design process. The analyses for the Lateral Expansion will be performed as part of the ongoing CCR Rule unstable areas demonstration. The analyses for the Main Ash Pond have been performed as part of the ongoing closure design process (AECOM 2017a).

In addition to other required submittals to TDEC, TVA will submit pertinent data and information from other activities used in the Environmental Investigation in the EAR. For the other units, the potential for future settlements is judged to be low, and additional analyses are not warranted.

4.2 TDEC BOTTOM ASH/GYPSUM PONDS INFORMATION REQUEST NO. 3

The nature of groundwater flow and hydraulic interconnection between the waste, dykes, natural soils, and the ultimate discharge to the reservoir or deeper geologic formations are unknown. Vertical gradients between saturated waste, groundwater in unconsolidated deposits, and groundwater in bedrock have not been characterized. The dynamics of groundwater flow through the waste, dykes, pond floor and underlying soils, and bedrock need to be characterized to determine if potential contaminants from the waste fill migrate (or have the potential to migrate) from the unit and not be monitored by the existing shallow groundwater monitoring network.

TVA Response

During the October 4, 2017, EIP update meeting, TDEC requested more information regarding the potential for preferential seepage pathways through the foundation soils, via stream channels that were present prior to development of the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C. In particular, Figure 3 shows the pre-construction channels of Bull Run Creek and Worthington Branch crossing the CCR unit perimeters at several different locations.

There is limited information available on how the foundation was prepared during original perimeter dike construction. It is unclear if more pervious stream deposits were present, and if so whether they were excavated or otherwise treated prior to placing fill. A review was performed of the available historical documentation (construction records, etc.) and existing borings advanced within or near the pre-construction Bull Run Creek and Worthington Branch channels.

Based on the available TVA mapping (Drawing 10N213-14), the pre-construction Bull Run Creek channel crosses the Fly Ash Stilling Pond 2C (FASP2C) perimeter four times: once on the western perimeter dike (adjacent to the Clinch River) and three times along the southern perimeter dike (adjacent to the current Bull Run Creek alignment). Between 2004 and 2015, eleven borings have been advanced at or near these pre-construction channel crossings (see Figure 3).

Nine of these borings encountered clay as the uppermost foundation soil (see Figure 4). Two borings, STN-93 and STN-43, encountered silt and sand, respectively, as the uppermost foundation soil. As discussed in Section 3.4.13 of the EIP, it is apparent that the sand and gravel in STN-43 is a unique condition in this area. Several other borings in the vicinity, performed during multiple subsurface exploration programs, encountered the alluvial clay soil. Therefore, the stratigraphy present at STN-43 is judged to not be laterally extensive.

STN-93 was advanced through the southern perimeter dike and encountered silt as the uppermost foundation soil. Borings advanced to the east of STN-93 encountered alluvial clay material, indicating that the silt encountered is not laterally extensive to the east. However, borings were not advanced directly to the west of STN-93 to ascertain whether the silt is continuous in this direction.

The pre-construction Worthington Branch channel crosses through the footprint of the Former Disposal Area, Sluice Channel, Bottom Ash Disposal Area, and Gypsum Disposal Area 2A. The pre-construction Worthington Branch channel crosses the disposal area a total of five times, as shown on Figure 3. Between 2004 and 2015, thirty-one borings have been advanced within or near this pre-construction Worthington Creek channel. Three of these borings encountered silt as the uppermost foundation soil; the other twenty-eight encountered clay.

One (STN-13) of the borings advanced within/near the pre-construction Worthington Branch channel within the Bottom Ash Disposal Area encountered silt as the uppermost foundation soil (Figure 4). It cannot be determined if this silt layer is continuous because there are no other borings in the immediate vicinity. Two borings (STN-24 and STN-25) advanced within/near the pre-construction Worthington Branch channel within the Gypsum Disposal Area 2A encountered silt as the uppermost foundation soil. These borings are located adjacent to each other, and it may be inferred that the pervious layer is continuous between these two borings.

The pre-construction stream channel locations shown on TVA Drawing No. 10N213-14 were originally mapped on TVA Drawing No. 822K1273 (1959) using available topographic survey from 1956. Perimeter dike construction commenced in 1962. Because the location of the pre-construction stream channels is known with a reasonable degree of certainty, a supplemental field exploration to target the pre-construction stream channel alignments is the preferred approach to characterize the uppermost foundation soils present at each perimeter crossing. This supplemental field exploration will consist of lines of closely spaced CPTs performed in the vicinity of the pre-construction stream channel crossings. For additional details regarding the CPT locations and the exploration plan, refer to the Exploratory Drilling SAP (Appendix K) and Figure 3.

5.0 ASSUMPTIONS AND LIMITATIONS

In preparing this document, TVA has made the following assumptions:

- The summaries presented herein cannot fully communicate the information contained in each document. Refer to the individual reference documents for additional context and detail.

6.0 REFERENCES

References are provided in the summary table for each document discussed herein.

ATTACHMENT A
FIGURES

Figure No.

1

Title

Existing Borings
Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Fly Ash Stilling Pond 2C, Railroad Loop & Main Ash Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Existing Boring
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

Stantec

TVA

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Figure No.
2

Title
Existing Borings
Dry Fly Ash Stack

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2017-09-25
Technical Review by TG on 2017-09-25

0 150 300 450 600 Feet
1:1,800 (At original document size of 22x34)

Legend

- Existing Boring
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

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U:\TVA-EIP\175566346\gis\mxds\BRF_Existing_Borings_DryFly.mxd Revised: 2017-09-25 By: mbough

Figure No.

3

Title

Proposed Cone Penetration Testing - Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Fly Ash Stilling Pond 2C, and Main Ash Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175568274

Prepared by TKR on 2018-12-13
Technical Review by TG on 2018-12-13

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Proposed Cone Penetration Test
- Historic Creek Alignment
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Historical TVA Drawing 10N213-14 (1977) is shown.
4. CPT borings on 20 feet spacing at historical Bull Run Creek alignment.
5. CPT borings on 5 feet spacing at historical Worthington Branch alignment.

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I:\TVA-EP\175568274_BRF_Phase2\gis\mxd\BRF_Proposed_CPT_South.mxd Revised: 2018-12-13 By: mbough

Figure No.
4

Title
Uppermost Foundation Soil Data
Bottom Ash Disposal Area, Gypsum Disposal Area 2A,
Fly Ash Stilling Pond 2C, Railroad Loop & Main Ash Pond

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-03-28
Technical Review by TG on 2018-03-28

0 250 500 750 1,000 Feet
1:3,600 (At original document size of 22x34)

Legend

Bedrock	▣	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Clay	Ⓒ	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Clayey Sand	◉	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Clayey Fill	▲	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Sand	●	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Silt	⬟	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*

CCR Unit Area (Approximate)

Former Disposal Area (Approximate)

Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

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TVA

P:\BRF Foundation_Soils_South\04.mxd Revised: 2018-03-28 By: mbough

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APPENDIX J
STABILITY SAP

Stability
Sampling and Analysis Plan
Bull Run Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Bull Run Fossil Plant
Clinton, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc
Lexington, Kentucky

December 17, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	October 27, 2017
2	Addresses January 29, 2018 TDEC Review Comments and Issued for TDEC Review	March 30, 2018
3	Addresses May 22, 2018 TDEC Review Comments and Issued for TDEC Review	July 13, 2018
4	Issued for TDEC Approval	December 17, 2018

STABILITY
SAMPLING AND ANALYSIS PLAN
BULL RUN FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Stability
Sampling and Analysis Plan
Bull Run Fossil Plant
Tennessee Valley Authority
Clinton, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 17, 2018 Revision 4

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	12/13/18 Date
McClung, Nicholas Anthony — Digitally signed by McClung, Nicholas Anthony Date: 2018.12.07 09:50:33 -05'00'	
TVA Investigation Field Lead	Date
Health, Safety, and Environmental (HSE) Manager	12/13/18 Date
Investigation Project Manager	12/6/2018 Date
Rock J. Vitale — Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@enwstd.com, c=US Date: 2018.12.11 12:56:26 -05'00'	
QA Oversight Manager	Date
Laboratory Project Manager	12/6/2018 Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

Stantec

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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 Bull Run Fossil Plant (BRF) on July 13-14, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at BRF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference.

On September 13, 2016, TDEC issued 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 January 9, 2017, TVA submitted BRF 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 BRF (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 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 BRF. Rationale for individual analyses are discussed below.

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
Bottom Ash Disposal Area (Closed Condition)					
Gypsum Disposal Area 2A (Closed Condition)					
Main Ash Pond (Closed/Repurposed Condition)			x[4]	x	x[4]
Fly Ash Stilling Pond 2C (Closed/Repurposed Condition)			x[4]	x	x[4]
Railroad Loop Disposal Area (Closed Condition)	x	x	x	x	x
Dry Fly Ash Stack Phase 1 and Phase 2 (Closed Condition)			x	x	x
Dry Fly Ash Stack Lateral Expansion (Future Build-out Condition)		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.
[4] After the closure design is finalized, it will be compared against analyses for the existing conditions. The existing conditions analyses may prove adequate to represent the closed conditions.

The rationale for the proposed analyses is as follows:

- The scope of work for the ongoing closure/repurposing design for the Main Ash Pond and Fly Ash Stilling Pond 2C specifically excluded seismic load cases (AECOM 2017a, 2017b).

- As highlighted in the EIP, the Railroad Loop Disposal Area lacks documented slope stability analyses for all load cases.

- Also highlighted in the EIP, the Dry Fly Ash Stack Phase 1 lacks documented slope stability analyses for seismic load cases.

- Similar to Phase 1, the Dry Fly Ash Stack Phase 2 lacks documented slope stability analyses for seismic load cases.

- The future build-out condition of the Dry Fly Ash Stack Lateral Expansion lacks documented slope stability analyses for static and seismic veneer stability, as well as the post-earthquake case (including consideration of liquefaction potential).

- No analyses are proposed for the Bottom Ash Disposal Area and Gypsum Disposal Area 2A. These units have existing analyses that are representative of the static and seismic cases in Table 1.

Other load cases that are not proposed in Table 1 have existing analyses that are representative.

Refer to the figures in Attachment A for a layout of the 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.

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.

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 5.4.2)
- 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,
- United States 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 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)
- 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

AECOM (2017a). "Fly Ash Pond Closure, Basis of Design Calculations, DRAFT, TVA Bull Run Fossil Plant, Anderson County, Tennessee." Prepared for Tennessee Valley Authority. August.

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United States Army Corps of Engineers (2003). "Slope stability." EM 1110-2-1902, October, Washington D.C.

United States Environmental Protection Agency (EPA). (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]	Simp. Displ.[1], Global	Simp. Displ.[1], Veneer[2]	Post-EQ[3], Global
Dry Fly Ash Stack Phase 1 & 2 (Closed Condition)	B, C, D, E, G, H	E, F, H	D	D	D
Dry Fly Ash Stack Lateral Expansion (Future Build-out Condition)	F, CA, CB	CA	CA, CB	CA	CA

[1] Simp. Displ. = Simplified 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 was analyzed.

Blue cells are completed analyses. Yellow cells are proposed analyses.

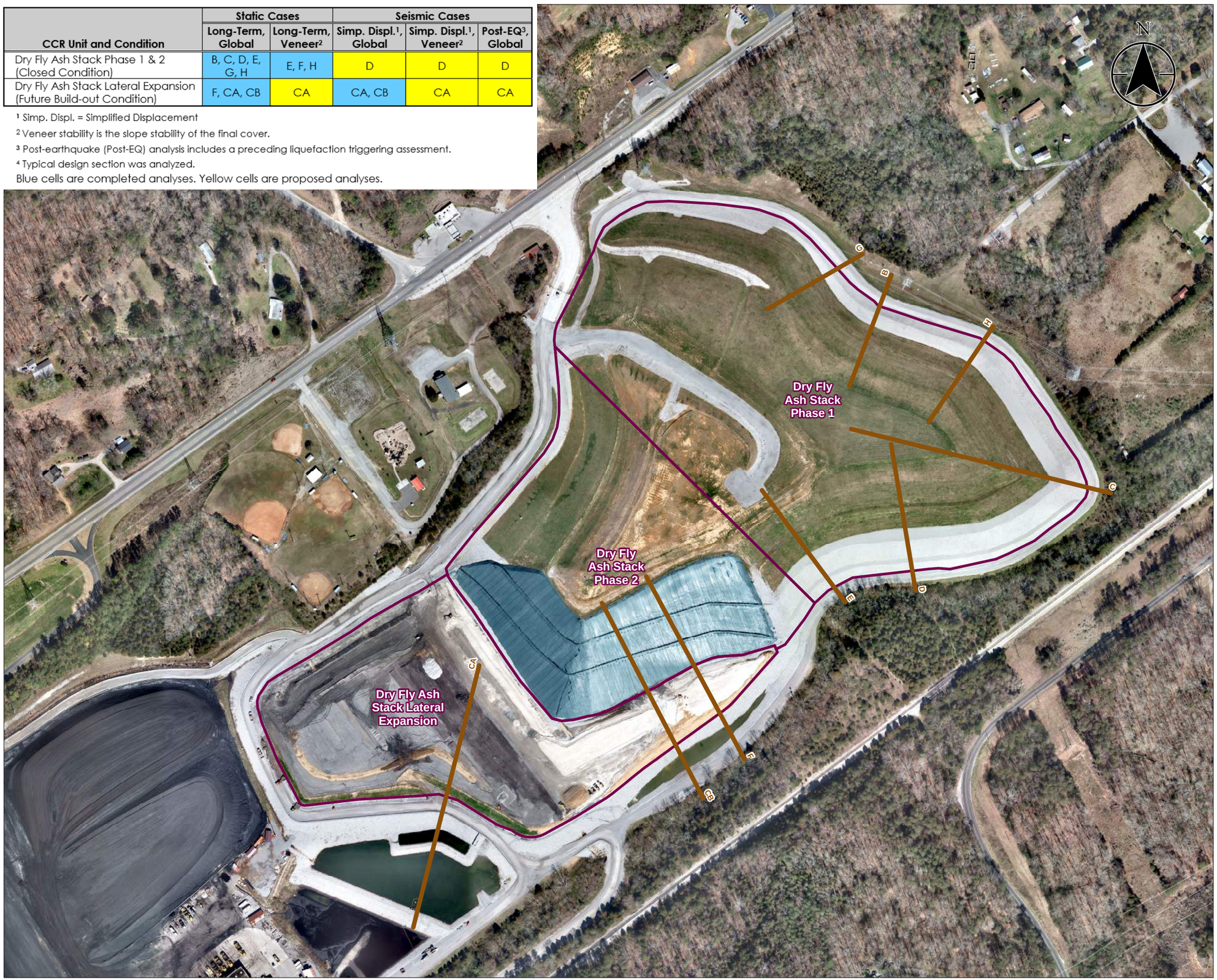

Figure No.
1

Title
Completed and Proposed Stability Analyses
Dry Fly Ash Stack

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

0 150 300 450 600 Feet
1:1,800 (At original document size of 22x34)

Legend

Stability Cross Section

CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

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TVA

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CCR Unit and Condition	Static Cases		Seismic Cases		
	Long-Term, Global	Long-Term, Veneer[2]	Simp. Displ.[1], Global	Simp. Displ.[1], Veneer[2]	Post-EQ[3], Global
Bottom Ash Disposal Area (Closed Condition)	D, F	Typ.[4]	D	Typ.[4]	D
Gypsum Disposal Area 2A (Closed Condition)	F, H, I, J, K, L	Typ.[4]	I	Typ.[4]	I
Main Ash Pond (Closed/Repurposed Condition)	R, S, L, A1, A2, AC	A2, AC	A1	A2	A1
Fly Ash Stilling Pond 2C (Closed/Repurposed Condition)	N, O, AC, AE, AG	AE	AE	AE	AE
Railroad Loop Disposal Area (Closed Condition)	RL	RL	RL	RL	RL

[1] Simp. Displ. = Simplified 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 was analyzed.

Blue cells are completed analyses. Yellow cells are proposed analyses.

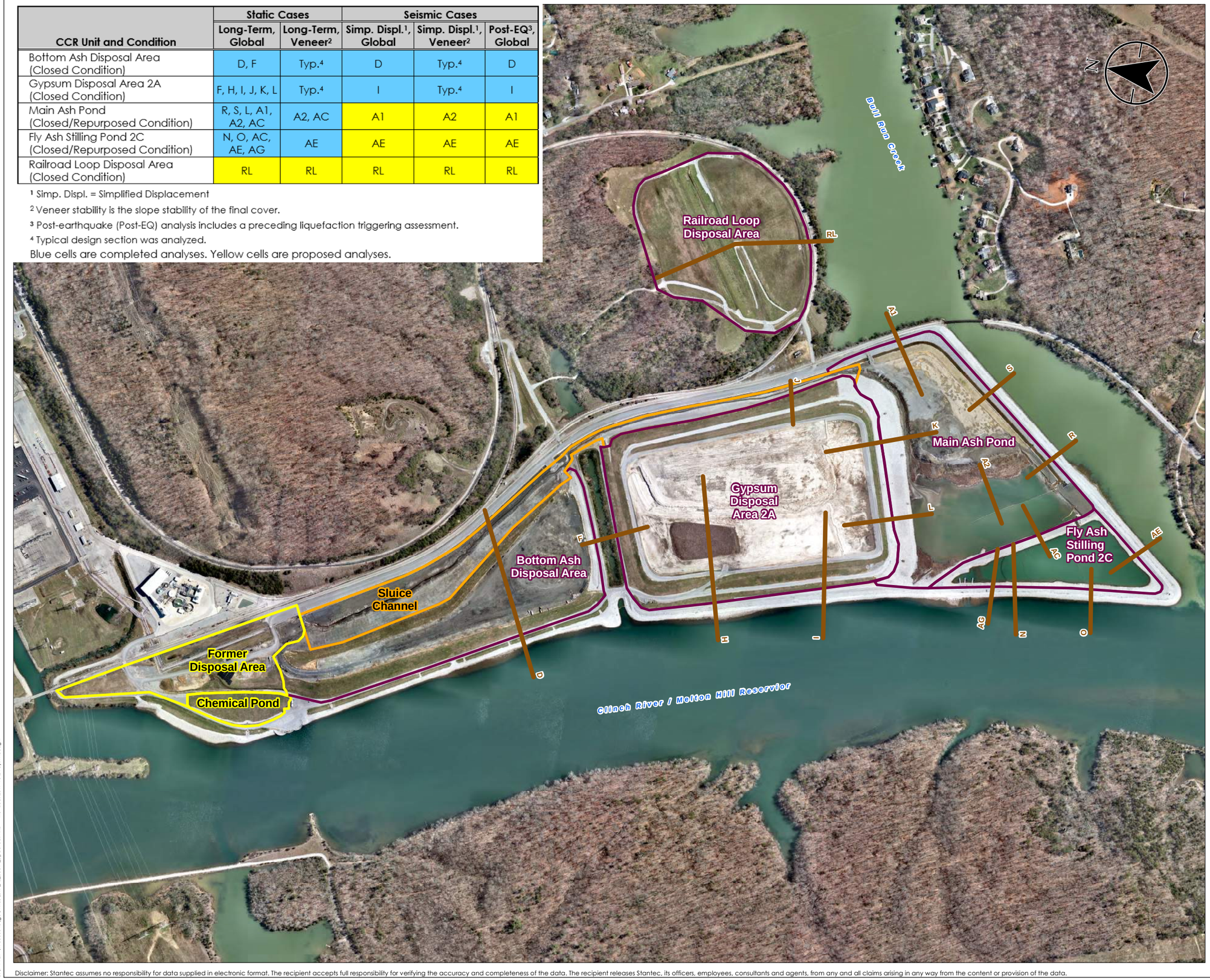

Figure No.

2

Title

Completed and Proposed Stability Analyses
Bottom Ash Disposal Area, Gypsum Disposal Area 2A,
Fly Ash Stilling Pond 2C, Railroad Loop & Main Ash Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

0 250 500 750 1,000 Feet

1:3,600 (At original document size of 22x34)

Legend

- Stability Cross Section
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

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APPENDIX K
GROUNDWATER MONITORING DATA

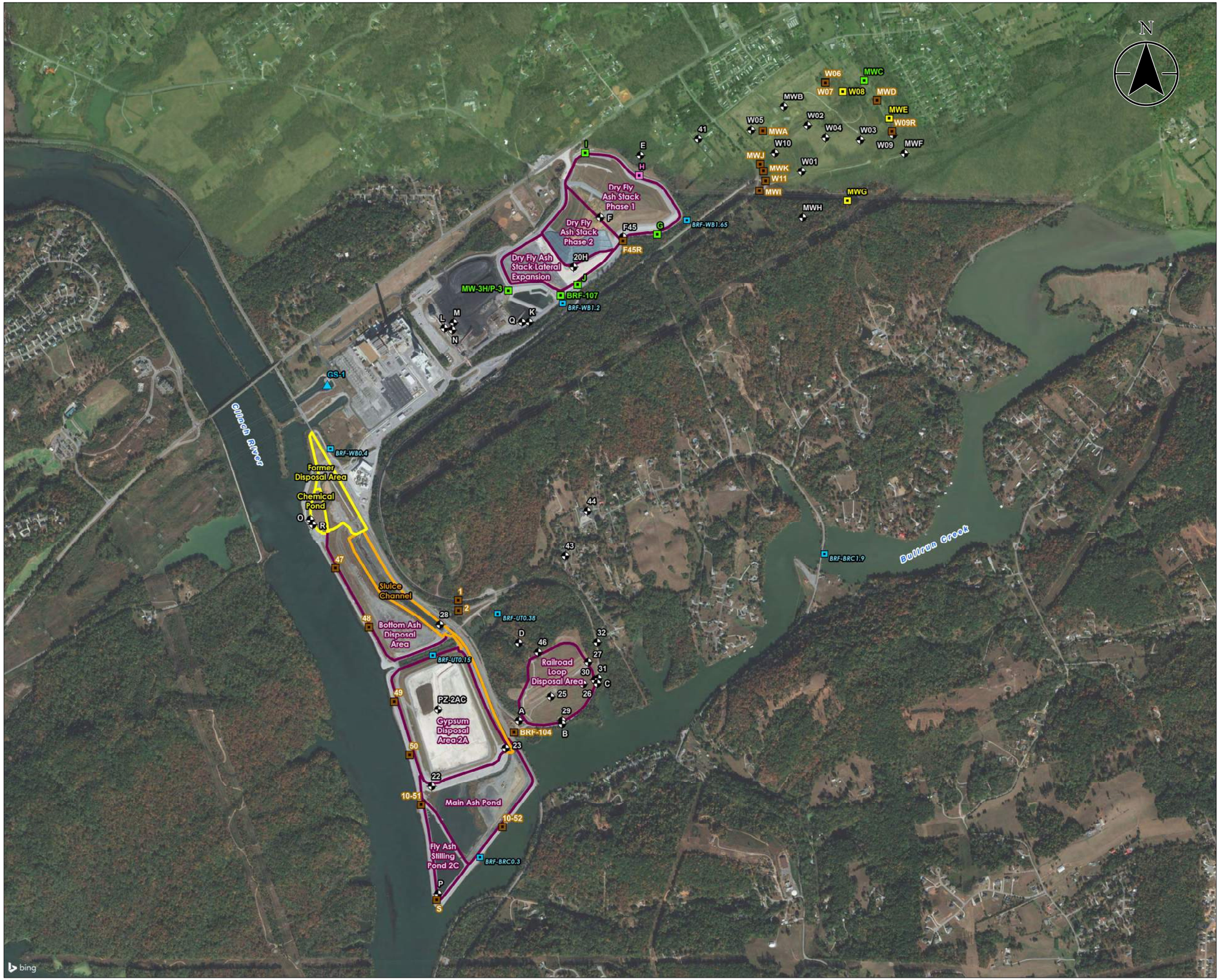

Figure No.

1

Title

Closed and Existing Monitoring Wells and Surface Water Samples

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346
Prepared by LMB on 2018-03-28
Technical Review by TG on 2018-03-28

0 700 1,400 2,100 2,800 Feet

1:8,400 (At original document size of 22x34)

Legend

- Existing Monitoring Well (Other)
- Existing Monitoring Well (State and CCR Rule Compliance)
- Observation Well (State Compliance)
- Existing Monitoring Well (State Compliance)
- Closed Monitoring Well
- Surface Water Sample Location
- Surface Water Gauging Station
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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U:\TVA-EIP\175566346\gis\mxds\Exhibit\Updates_20180228\BRF_Surface_Steam_Closed_Existing_Well\20180328.mxd Revised: 2018-03-28 By: TRink

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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	-
BRF-1	1	Apr-87		220	<1	1	--	<1	<500	0.2	62.7	4	--	15	11000	34	--	26.5	23000	<0.2	--	17	--	--	4	--	--	11	--	--	--	--	--	380	6	--	45
		Jun-87		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-92		1700	<1	6	760	<1	<500	0.1	38	3	--	30	40000	1	--	15	13000	<0.2	<20	12	--	2.9	<1	--	<10	9.3	150	<50	--	--	--	20	5	--	1
		May-93		1300	<1	4	250	<1	<500	--	28	1	--	<10	28000	1	--	11	9700	--	--	--	--	2.4	<1	--	--	8.6	90	--	--	--	--	<10	3	--	32
		Nov-93		620	<1	4	260	1	<500	<0.1	28	1	--	<10	32000	<1	--	12	11000	--	--	20	--	2.3	--	--	--	8.2	130	--	--	--	--	<10	4	--	26
		May-94		2900	2	4	240	<1	<500	0.3	19	6	--	<10	28000	<1	<10	9.4	6300	--	--	14	--	1.9	<1	--	<10	8.9	<50	--	--	--	--	30	3	--	28
		Dec-94		720	2	8	200	<1	<500	0.1	26	3	--	<10	35000	<1	--	11	10000	--	--	19	--	2.1	--	--	--	8.3	70	--	--	--	<10	<10	4	--	21
		May-95		150	1	5	270	<1	<500	0.1	30	2	--	<10	29000	<1	--	13	13000	--	--	12	--	2.5	<1	--	--	9	90	--	--	--	--	<10	5	--	18
		Nov-95		1600	3	5	260	<1	<500	0.1	24	4	37	<10	32000	1	--	12	10000	<0.2	--	14	--	2.3	<1	--	<10	8.4	70	<2	--	--	<10	10	3	<0.1	17
		Jun-96		1500	1	3	170	<1	<500	0.4	17	<1	35	<10	33000	2	--	8.2	5800	<0.2	--	16	--	1	<1	--	<10	9	50	<2	--	--	<10	10	3	0.1	22
		Nov-96		1000	<1	6	280	<1	<500	0.3	13	2	--	<10	32000	<1	--	9.9	9300	--	--	17	--	2.3	2	--	--	8.3	80	--	--	--	--	10	4	--	17
		Jun-97		1400	<1	6	1200	<1	<500	0.9	18	2	--	<10	25000	2	--	8.8	6700	--	--	11	--	2.1	<1	--	--	9.9	50	--	--	--	--	50	3	--	18
		May-99		280	<1	8	600	19	<200	0.3	25	5	31	<10	28000	<1	--	13	14000	<0.2	--	10	--	2.8	2	--	<10	9.2	90	<2	--	--	<10	10	3	<0.1	22
		Jun-99		460	<1	4	540	<1	<200	0.2	27	4	7	<10	30000	<1	--	13	15000	<0.2	--	10	--	2.8	<1	--	<10	8.9	120	<2	--	--	<10	<10	4	<0.1	18
		Jul-99		470	<1	6	680	<1	<200	0.3	30	4	20	<10	33000	<1	--	13	16000	<0.2	--	9	--	2.6	<1	--	<10	8.9	90	<2	--	--	<10	10	3	<0.1	20
		Aug-99		2200	<1	4	320	<1	<200	<0.1	19	8	43	<10	24000	1	--	9.1	7500	<0.2	--	--	--	--	<1	--	<10	--	<50	<2	--	--	<10	<10	4	0.1	34
		Sep-99		400	<1	4	330	<1	<200	<0.1	23	2	42	<10	25000	<1	--	10	10000	<0.2	--	14	--	2	<1	--	<10	9	70	<2	--	--	<10	10	3	<0.1	27
		Oct-99		1700	<1	4	500	<1	<200	0.3	18	8	37	<10	21000	<1	--	9.4	10000	<0.2	--	14	--	2.4	<1	--	<10	8.6	<50	<2	--	--	<10	<10	3	0.1	28
		Nov-99		1500	<1	4	780	<1	<200	0.2	30	5	18	<10	33000	2	--	16	20000	<0.2	--	12	--	3.4	<1	--	<10	8	150	<2	--	--	<10	20	4	<0.1	12
		Dec-99		1200	<1	5.8	1000	<1	<200	<0.1	35	10	12	<10	36000	<1	--	18	25000	<0.2	<20	8.5	--	3.8	<1	--	<10	7.8	180	<2	<50	58	<10	20	4.3	<0.1	13
		May-00		3200	<1	8.1	860	<1	<200	0.19	28	14	21	<10	37000	<1	--	16	21000	<0.2	<20	13	--	3.7	<1	7600	<10	8.8	160	<2	91	69	<10	41	4.6	<0.1	13
		Nov-00		370	2.9	8	1100	<1	<200	0.52	30	<1	<1	<10	30000	<1	--	16	20000	<0.2	<20	20	--	3.9	<1	--	<10	8.4	170	<2	<50	7.7	<10	14	4.6	<0.1	40
		May-01		330	<1	3.2	690	<1	<200	1.3	21	1.5	12	<10	20000	5.2	--	12	15000	<0.2	<20	<1	--	3.6	<1	3800	<10	8.2	120	<2	<50	5.8	<10	<10	5	0.11	20
		Aug-06		4400	<3	5	1200	<1	<200	<0.1	43	12	33	<10	39000	2	--	19	19000	<0.1	<20	11	<0.01	3.4	1	--	<10	9.7	200	<2	--	--	<10	10	5.1	0.13	22
		Aug-06		6300	<3	6	1300	<1	<200	0.1	43	16	34	<10	42000	3	--	19	19000	<0.1	<20	14	<0.01	4.4	<1	--	<10	9.6	200	<2	--	--	<10	20	5.2	0.12	20
		Nov-06		2100	<3	4	1500	<1	<200	<0.1	40	3	6	<10	38000	1	--	19	21000	<0.1	<20	2	0.02	4.9	<1	--	<10	6.7	220	<2	--	--	<10	20	5.1	0.13	17
		Feb-07		15000	<1	6.5	1600	<2	<200	<0.5	37	19	20	5.1	44000	2.8	--	20	20000	<0.2	<5	14	<0.1	9.1	1.7	--	<0.5	10	220	<1	--	--	17	170	3	0.12	15
		May-07		6400	<1	7.2	1800	<1	<200	<0.5	38	17	16	3.1	43000	1.9	--	21	22000	<0.2	<5	10	<0.1	6.8	1.6	--	0.66	8.5	230	<1	--	--	<10	71	2.9	0.11	15
		Aug-07		3800	<1	5	61	<1	2200	<0.5	310	7.7	13	1.2	7200	1.2	--	70	5800	<0.2	27	5.9	<0.1	14	<1	--	<0.5	17	3400	<1	--	--	<10	42	2.5	<0.1	14
		Nov-07		4700	<1	4.9	1100	<2	<200	<0.5	41	7.7	20	2.4	38000	1.1	--	19	18000	<0.2	<5	6.1	<0.1	5.2	<1	--	<0.5	9.6	200	<1	--	--	<10	62	5.2	0.33	19
		Feb-08		3800	<1	5	1600	<2	<200	<0.5	40	2.2	12	1.2	39000	<1	--	21	22000	<0.2	<5	3.4	<0.1	5.4	<1	--	<0.5	8.4	210	<1	--	--	<10	79	3.2	0.12	13
		May-08		1600	<1	3.5	1500	<1	<200	<0.5	40	2.7	4.4	1.6	41000	<1	--	21	21000	<0.2	<5	3.7	<0.1	4.8	<1	--	<0.5	9.6	210	<1	--	--	<10	54	3.6	<0.1	15
		May-09		990	<1	4.2	1400	<2	<200	<0.5	38	3.8	2.9	1.2	36000	<1	--	20	19000	<0.2	5.5	3.9	<0.1	4.8	<1	--	<0.5	9.4	210	<1	--	--	<10	69	4.8	0.14	11
		Nov-09		500	<1	3.4	1400	<1	<200	<0.5	35	<10	<10	<2	22000	<5	--	19	19000	<0.2	<5	1.3	<0.1	4.6	<1	--	10	8.1	190	<1	<1	--	<10	48	3.6	<0.1	<5
		Nov-09		470	<1	3.2	1500	<1	<200	<0.5	34	<10	<10	<2	22000	<5	--	19	20000	<0.2	<5	1.4	<0.1	4.6	<1	--	<10	7.9	190	<1	<1	--	<10	94	3.6	0.15	<5
		May-10		660	<1	2.6	1700	<1	<200	<0.5	--	<2	2.2	<2	36000	<1	--	20	20000	<0.2	<5	1.6	<0.1	5.3	<1	--	<1	8.7	210	<1	<1	--	<2	55	3.8	0.13	<5
		Nov-10		--	<1	3.4	<2	<1	--	<0.5	--	<2	2.1	<2	--	<1	--	--	--	<0.2	--	1.4	--	--	<1	--	<1	--	--	<1	<1	--	<2	83	--	--	--

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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	-
BRF-1 (cont)	1	May-11		1500	<1	1.8	1600	<1	<200	<0.5	36	<2	2.9	<2	36000	<1	--	21	20000	<0.2	<5	--	<0.1	4.7	<1	--	<1	8.1	220	<1	<1	--	<2	<10	4	--	13
		Nov-11		<100	<1	4.4	<2	<1	<200	<0.5	31	<2	1.2	<2	35000	<1	--	18	21000	<0.2	<5	<1	<0.1	4.4	<1	--	<1	7.3	200	<1	<1	--	<2	<10	3.8	--	<5
		May-12		--	<1	4.2	1900	<1	--	<0.5	--	<2	1.1	<2	--	<1	--	--	--	<0.2	--	<1	--	--	1.7	--	<1	--	--	<1	<1	--	<2	64	--	--	--
		May-12		--	<1	4.4	1800	<1	--	<0.5	--	<2	1.2	<2	--	<1	--	--	--	<0.2	--	<1	--	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		May-12		--	<1	4.1	1900	<1	--	<0.5	--	<2	1	<2	--	<1	--	--	--	<0.2	--	<1	<0.1	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	0.16	--
		Nov-12		--	<1	2.7	1800	<1	--	<0.5	--	<2	1.2	<2	--	<1	--	--	--	<0.2	--	<1	--	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		Nov-12		--	<1	3	1800	<1	--	<0.5	--	<2	1.5	<2	--	<1	--	--	--	<0.2	--	<1	<0.1	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	0.24	--
		May-13		<100	<1	<5	1800	<1	<200	<0.5	30	<10	<5	<10	30000	<1	--	20	19000	<0.2	<10	<5	<0.1	5	<5	--	<1	8.2	210	<1	<1	--	<10	<50	3.8	0.2	<5
		Aug-13		4860	<2	4.38	1690	<2	<50	<1	34.4	8.07	4.95	5.18	38000	2.63	--	18.7	17800	<0.2	<2	6.59	<0.1	5.34	<2	--	<2	7.11	184	<2	<50	--	6.89	<25	3.83	<0.1	2.1
		Feb-14		<100	<2	5.54	1940	<2	<50	<1	31.1	11.8	<2	<10	39100	<2	--	19.2	19600	<0.2	<50	<2	<0.1	4.74	<2	--	<5	7.81	199	<2	<2	--	<20	<50	3.26	0.12	<1
		Aug-14		--	<2	4.34	**2180**	<4	--	<1	--	<2	<20	<10	--	<2	--	--	--	<0.2	--	<20	<0.1	--	<20	--	<5	--	--	<2	<2	--	<20	<50	--	0.12	--
		Feb-15		--	<2	5.72	**2180**	<2	--	<1	--	8.14	2.41	<10	--	<2	--	--	--	<0.2	--	<10	--	--	12.1	--	<5	--	--	<2	<2	--	2.5	<25	--	--	--
		Aug-15		--	<2	4.47	**2240**	<2	--	<1	--	<2	2.54	<10	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<5	--	--	<2	--	--	<2	<25	--	0.11	--
		Feb-16		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-10-51	10-51	May-11		2000	<1	2	81	<1	<200	<0.5	94	4.4	1.5	2.4	2000	1.6	--	12	400	<0.2	8.8	6	<0.1	1.2	<1	--	<1	4.3	110	<1	<1	--	4.4	10	3.3	--	11
		Nov-11		270	<1	1.2	74	<1	<200	<0.5	95	<2	<1	<2	220	<1	--	12	460	<0.2	<5	1.9	<0.1	0.98	<1	--	<1	4	120	<1	<1	--	<2	<10	3.6	--	8
		May-12		--	<1	1.9	74	<1	--	<0.5	--	<2	--	--	--	<1	--	--	--	<0.2	--	3.9	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	<0.1	--
		Nov-12		--	<1	1	66	<1	--	<0.5	--	<2	--	--	--	<1	--	--	--	<0.2	--	3.6	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	<0.1	--
		Nov-12		--	<1	1.1	71	<1	--	<0.5	--	<2	--	--	--	<1	--	--	--	<0.2	--	4	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	<0.1	--
		May-13		--	<1	<5	69	<1	--	<0.5	--	<2	--	--	--	<1	--	--	--	<0.2	--	4.1	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	<0.1	--
		Aug-13		342	<2	<2	76.4	<2	151	<1	103	<2	<2	<2	371	<2	--	12.5	410	<0.2	<2	<2	<0.1	<1	<2	--	<2	4.7	116	<2	--	--	<2	<25	3.38	0.12	3.21
		Feb-14		--	<2	<2	77.2	<2	--	<1	--	<5	--	--	--	<5	--	--	--	<0.2	--	<10	<0.1	--	<10	--	<5	--	--	<2	--	--	--	--	--	<0.1	--
		Feb-14		--	<2	<2	76.8	<2	--	<1	--	<5	--	--	--	<5	--	--	--	<0.2	--	<10	<0.1	--	<10	--	<5	--	--	<2	--	--	--	--	--	<0.1	--
		Aug-14		--	<2	<2	83.5	<2	--	<1	--	<5	--	--	--	<5	--	--	--	<0.2	--	<10	1.86	--	<10	--	<5	--	--	<2	--	--	--	--	--	0.11	--
		Feb-16		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-10-52	10-52	May-11		760	--	--	--	--	<200	--	110	--	--	--	20000	--	--	23	350	--	<5	--	<0.1	1.9	--	--	--	12	280	--	--	--	--	--	5.2	--	<5
		May-11		740	--	--	--	--	<200	--	100	--	--	--	20000	--	--	23	360	--	6	--	<0.1	1.9	--	--	--	12	280	--	--	--	--	--	5.3	--	<5
		May-11		--	<1	**27**	420	<1	--	<0.5	--	2.4	2.8	<2	--	1.4	--	--	--	<0.2	--	4.4	--	--	<1	--	<1	--	--	<1	<1	--	2.2	20	--	--	--
		May-11		--	<1	**26**	450	<1	--	<0.5	--	<2	2.8	<2	--	1.7	--	--	--	<0.2	--	4	--	--	7.3	--	<1	--	--	<1	<1	--	2.8	18	--	--	--
		Nov-11		710	<1	**28**	450	<1	<200	<0.5	100	<2	1.6	<2	20000	<1	--	23	340	<0.2	<5	2	<0.1	2.4	<1	--	<1	11	300	<1	<1	--	2.2	<10	5.4	--	<5
		May-12		--	<1	**32**	450	1.8	--	<0.5	--	<2	--	--	--	1	--	--	--	<0.2	--	4.8	<0.1	--	<1	--	5.3	--	--	<1	--	--	--	--	--	0.17	--
		May-12		--	<1	**28**	470	<1	--	<0.5	--	<2	--	--	--	<1	--	--	--	<0.2	--	2.3	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	<0.1	--
		Nov-12		--	<1	**22**	510	<1	--	<0.5	--	<2	--	--	--	<1	--	--	--	<0.2	--	2.8	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	<0.1	--
		May-13		--	<1	**31**	500	<1	--	<0.5	--	3.5	--	--	--	<1	--	--	--	<0.2	--	1.7	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	<0.1	--
		Aug-13		274	<2	**26.4**	514	<2	171	<1	106	<2	<2	<2	17800	<2	--	20.7	297	<0.2	<2	<2	<0.1	2.14	<2	--	<2	10.8	292	<2	--	--	<2	<25	5.06	<0.1	<1
		Aug-13		258	<2	**26.1**	512	<2	178	<1	105	<2	<2	<2	17700	<2	--	20.6	300	<0.2	<2	<2	<0.1	2.12	<2	--	<2	10.9	292	<2	--	--	<2	<25	5.05	<0.1	<1
		Feb-14		--	<2	**26.6**	581	<2	--	1.1	--	<5	--	--	--	<5	--	--	--	<0.2	--	<10	<0.1	--	<10	--	<5	--	--	<2	--	--	--	--	--	<0.1	--

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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**	**-**
BRF-10-52 (cont)	10-52	Aug-14		--	<2	**26.8**	661	<2	--	<1	--	<5	--	--	--	5	--	--	--	<0.2	--	<10	<0.1	--	<10	--	<5	--	--	<2	--	--	--	--	--	<0.1	--
		Feb-16		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-2	2	Apr-87		100	<1	<1	--	<1	<500	0.4	100	2	--	73	140	2	--	34.6	3900	<0.2	--	34	--	--	<1	--	--	12	--	--	--	--	--	110	8	--	160
		Jun-87		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Aug-09		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-20H	20H	Feb-08		<100	<1	8.5	39	<2	6200	<0.5	320	3.4	1.2	2.7	<100	<1	--	48	72	<0.2	220	7.4	2.1	6.6	**190**	--	<0.5	43	1000	<1	--	--	<10	<10	7.5	0.15	810
BRF-22	22	Feb-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Aug-91		260000	--	**870**	2000	--	<500	0.6	70	47	230	640	91000	**67**	220	28	1200	--	<20	56	<0.01	20	**190**	1400	--	5.1	1400	--	--	--	1000	1100	4	--	130
		Nov-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Dec-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-23	23	Feb-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Aug-91		370000	--	**1300**	440	--	<500	1	60	**110**	340	1000	190000	**86**	430	31	840	--	<20	**110**	<0.01	36	**190**	920	--	6.8	370	--	--	--	130	1000	3	--	34
		Nov-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Dec-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-25	25	Feb-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Jun-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Dec-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-26	26	Feb-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Jun-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Dec-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-27	27	Feb-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Jun-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Dec-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-28	28	Feb-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Aug-91		530	--	**63**	360	--	<500	0.1	61	<1	6	<10	13000	<1	120	13	340	--	<20	3	0.02	7.2	2	10000	--	12	1000	--	--	--	10	10	3	--	26
		Nov-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Dec-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-29	29	Apr-91		<50	--	<1	70	--	<500	0.2	44	1	29	<10	340	<1	<10	6.1	4700	--	<20	<1	0.31	1.6	10	2000	--	2.9	70	--	--	--	<10	20	2	--	20
		Jun-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-91		72000	--	**69**	370	--	<500	1	120	<1	--	50	96000	**39**	10	22	3600	--	<20	69	--	3.6	2	28000	--	4.4	170	--	--	--	160	3	--	26
		Nov-92		94000	<1	5	370	2	<500	<0.1	120	64	--	70	130000	**59**	--	21	3200	<0.2	<20	56	--	4.5	3	--	<10	2.9	310	<50	--	--	--	170	2	--	33
		May-93		28000	<1	2	230	<1	<500	--	95	42	--	20	40000	**38**	--	12	1300	--	--	--	--	2.8	<1	--	--	2.1	140	--	--	--	--	50	2	--	23
		May-93		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-93		67000	<1	<1	270	2	<500	0.1	110	7	--	<10	76000	13	--	18	1700	--	--	12	--	2.8	--	--	--	2.3	360	--	--	--	--	100	2	--	40

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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**	**-**
BRF-29 (cont)	29	May-94		12000	<1	2	110	<1	<500	0.2	97	18	--	<10	13000	8	<10	11	580	--	--	15	--	2.1	5	--	<10	1.9	120	--	--	--	--	20	2	--	17
		Nov-94		46000	2	2	210	2	<500	0.2	100	37	32	20	59000	**29**	--	16	2300	<0.2	--	34	--	--	3	--	<10	--	160	<2	--	--	60	80	2	0.2	30
		May-95		7100	2	1	70	<1	<500	<0.1	89	7	--	<10	8900	4	--	10	270	--	--	6	--	2.2	14	--	--	3	110	--	--	--	--	10	1	--	20
		Nov-95		19000	1	2	100	1	<500	0.1	89	13	13	<10	23000	11	--	12	910	<0.2	--	14	--	2.8	19	--	<10	2.5	100	<2	--	--	20	30	1	<0.1	26
		Jun-96		3300	<1	1	40	<1	<500	0.1	78	<1	2	<10	3700	4	--	8	36	<0.2	--	4	--	1.8	10	--	<10	2.2	100	<2	--	--	<10	<10	1	0.2	20
		Nov-96		80	<1	<1	50	<1	<500	0.6	54	7	--	<10	110	<1	--	8.9	11	--	--	6	--	2.9	16	--	--	1.9	70	--	--	--	--	<10	2	--	23
		Nov-96		5900	<1	<1	60	<1	<500	<0.1	100	3	--	<10	6000	3	--	11	88	--	--	4	--	3.4	16	--	--	2.5	140	--	--	--	--	<10	3	--	54
		Jun-97		15000	<1	<1	80	<1	<500	<0.1	89	15	--	<10	17000	5	--	11	200	--	--	13	--	2.2	<1	--	--	2	110	--	--	--	--	20	1	--	15
		Nov-02		1400	<1	<1	50	<1	<200	<0.1	94	<1	<1	<10	1300	<1	--	9.1	49	<0.1	<20	<1	--	2.3	3.4	--	<10	1.9	140	<2	<50	20	<10	<10	1.6	0.14	31
BRF-30	30	Apr-91		130	--	1	80	--	<500	0.4	55	8	42	<10	730	<1	<10	36	5900	--	<20	21	0.02	3	<1	8000	--	7	180	--	--	--	<10	10	7	--	180
		Jun-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-91		29000	--	**14**	400	--	<500	<0.1	53	32	--	20	42000	**22**	--	17	2400	--	--	40	--	3.5	--	19000	--	4.1	170	--	--	--	--	80	4	--	72
		Nov-02		1300	<1	<1	90	<1	600	2.8	120	<1	4	10	1900	<1	--	24	1600	<0.1	<20	5.7	--	2.8	<1	--	<10	6.4	230	<2	<50	19	<10	<10	3.8	0.13	160
BRF-31	31	Apr-91		<50	--	2	40	--	<500	0.3	39	<1	44	<10	2600	<1	<10	9.5	12000	--	<20	3	0.01	2.6	<1	4000	--	4.4	50	--	--	--	<10	30	4	--	78
		Jun-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-91		90000	--	**16**	720	--	<500	0.4	52	24	--	80	140000	1	30	22	12000	--	<20	86	--	4.1	<1	43000	--	4.3	<50	--	--	--	--	230	4	--	89
		Nov-92		<0.2	<1	2	80	<1	<500	0.4	45	4	--	30	13000	10	--	7.6	10000	<0.2	<20	3	--	2.4	<1	--	<10	4.3	<50	<50	--	--	--	20	4	--	87
		May-93		4600	<1	<1	70	<1	<500	--	48	3	--	<10	9500	4	--	7.5	11000	--	--	--	--	2.1	<1	--	--	4.3	100	--	--	--	--	<10	3	--	92
		Nov-93		40000	<1	1	270	2	<500	0.9	48	9	--	10	68000	**20**	--	14	11000	--	--	12	--	2.4	--	--	--	4.2	270	--	--	--	--	100	3	--	61
		May-94		45000	<1	5	260	<1	<500	2	51	48	--	30	73000	**37**	<10	15	12000	--	--	41	--	2.5	<1	--	<10	4.3	120	--	--	--	--	100	4	--	58
		Dec-94		7500	2	<1	120	<1	<500	0.2	41	22	--	<10	14000	**17**	--	8.1	10000	--	--	23	--	2.2	--	--	--	3.9	<50	--	--	--	<10	20	3	--	68
		May-95		9500	1	3	100	<1	<500	0.3	42	10	--	<10	19000	13	--	8.5	9600	--	--	10	--	2.1	<1	--	--	4	70	--	--	--	--	20	2	--	53
		Nov-95		14000	<1	2	90	1	<500	0.2	38	10	26	<10	24000	14	--	8.9	8800	<0.2	--	20	--	2.5	<1	--	<10	4.4	50	<2	--	--	10	30	3	<0.1	69
		Jun-96		3000	<1	6	40	<1	<500	0.3	38	<1	21	<10	13000	5	--	6.9	9100	<0.2	--	9	--	1.7	<1	--	<10	4	60	<2	--	--	<10	10	3	0.1	60
		Nov-96		19000	<1	10	120	<1	<500	0.4	25	18	--	<10	40000	**21**	--	10	9200	--	--	21	--	3.6	<1	--	--	4.9	100	--	--	--	--	40	3	--	54
		Jun-97		3000	<1	6	50	<1	<500	<0.1	49	7	--	<10	13000	6	--	11	9700	--	--	9	--	1.8	<1	--	--	5.3	70	--	--	--	--	70	3	--	65
BRF-32	32	Apr-91		<50	--	2	40	--	<500	0.2	86	<1	3	<10	24	1	<10	11	1700	--	<20	<1	<0.01	2.2	<1	4600	--	3	100	--	--	--	<10	<10	2	--	53
		Jun-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-91		4300	--	2	<10	--	<500	<0.1	84	5	--	10	3800	4	--	8.6	2500	--	--	17	--	2	--	6300	--	2.5	150	--	--	--	--	20	2	--	34
BRF-41	41	May-91		70	--	<1	80	--	<500	0.3	49	<1	2	<10	7900	2	80	13	96	--	<20	<1	<0.01	2.6	2	--	--	330	710	--	--	--	<10	250	28	--	25
		Aug-91		<50	--	<1	60	--	<500	0.1	56	<1	<1	<10	7700	<1	60	15	76	--	<20	1	0.02	2.3	<1	4900	--	52	630	--	--	--	<10	140	20	--	9
BRF-43	43	May-91		260	--	<1	90	--	<500	0.6	89	<1	3	52	22000	5	<10	16	140	--	<20	<1	0.07	2.2	5	--	--	16	160	--	--	--	<10	1000	4	--	56
		Aug-91		850	--	<1	90	--	<500	0.8	98	2	1	<10	35000	11	10	20	57	--	<20	53	0.26	2.6	<1	7400	--	20	200	--	--	--	<10	1300	4	--	52
BRF-44	44	May-91		360	--	1	250	--	<500	0.8	12	11	<1	<10	1200	4	60	2.7	140	--	<20	5	0.02	3.3	5	--	--	150	250	--	--	--	<10	<10	8	--	84
		Aug-91		410	--	4	230	--	530	2	17	<1	9	<10	13000	10	60	3.6	1300	--	<20	17	0.02	2.9	<1	6700	--	140	210	--	--	--	<10	80	9	--	150
		Sep-91		<50	--	**17**	270	--	<500	0.4	77	<1	1	<10	1900	1	50	15	520	--	<20	4	0.05	3.7	2	8900	--	100	730	--	--	--	<10	<10	11	--	260
BRF-46	46	Nov-93		1800	<1	<1	80	<1	<500	4	140	12	--	<10	2900	4	20	30	80	<0.2	--	13	0.03	2.9	<1	--	<10	7.1	340	--	--	--	--	60	2	--	60

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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	-
BRF-46 (cont)	46	May-94		660	<1	<1	100	<1	<500	0.6	150	6	<1	<10	2300	3	20	30	38	<0.2	--	--	0.03	2.4	<1	--	<10	5.1	290	<50	--	--	<10	20	3	<0.1	50
		Aug-94		--	--	<1	--	--	--	0.1	--	<1	<1	--	--	<1	--	--	--	<0.2	--	2	--	--	<1	--	--	--	--	<50	--	--	<10	--	--	<0.1	--
		Nov-94		150	2	<1	60	<1	<500	0.2	120	3	<1	<10	1300	<1	--	27	34	<0.2	--	2	0.03	--	<1	--	<10	--	270	<2	--	--	<10	10	2	<0.1	78
		May-95		290	1	<1	90	<1	<500	0.4	120	50	2	<10	2100	2	--	27	64	<0.2	--	21	--	2.3	<1	--	<10	5	260	<2	--	--	<10	10	2	<0.1	42
		Nov-95		290	1	<1	70	<1	<500	4	110	3	3	10	4400	8	--	27	81	<0.2	--	6	--	3.5	<1	--	<10	7.3	250	<2	--	--	<10	50	2	<0.1	60
		Jun-96		430	<1	1	90	<1	<500	2	120	<1	5	10	2300	6	--	26	390	<0.2	--	8	--	3.2	<1	--	<10	5.3	250	<2	--	--	<10	20	3	0.3	43
		Nov-96		220	<1	<1	80	<1	<500	1	130	<1	2	<10	1700	4	--	28	78	<0.2	--	3	--	3.7	2	--	<10	6.2	330	<2	--	--	<10	20	3	<0.1	52
		Jun-97		670	<1	5	90	<1	<500	1	120	1	2	<10	3400	2	--	25	460	<0.2	--	4	--	2.7	<1	--	<10	5.5	250	<2	--	--	<10	20	3	<0.1	38
		Oct-97		300	<1	2	100	<1	<500	0.1	130	<1	12	20	12000	11	--	28	460	<0.2	--	4	--	3.6	<1	--	<10	6.6	270	<2	--	--	<10	70	2	<0.1	61
		May-98		410	<1	<1	100	<1	<200	2	120	<1	5	<10	7100	9	--	25	240	0.3	--	8	--	2.8	<1	--	<10	5.2	230	<2	--	--	<10	50	3	<0.1	48
		Nov-98		<50	<1	<1	90	<1	<200	<0.1	130	5	3	<10	2200	12	--	25	57	<0.2	--	2	--	2.4	<1	--	<10	6.5	260	<1	--	--	<10	10	2	<0.1	67
		May-99		<50	<1	<1	70	<1	<200	0.3	110	4	3	<10	1200	<1	--	26	18	<0.2	--	<1	--	2.7	<1	--	<10	5.3	190	<2	--	--	<10	30	2	<0.1	57
		Nov-02		310	<1	<1	80	<1	<200	0.26	140	11	99	10	5200	4	--	32	170	<0.1	<20	8	--	0.99	<1	--	<10	6.3	350	<2	<50	<5	<10	20	1.4	0.73	82
BRF-47	47	May-99		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	<0.1	1000
		Jun-99		660	<1	<1	30	<1	1700	0.4	280	2	170	<10	780	2	--	62	17000	<0.2	--	18	--	7.7	<1	--	<10	13	2000	<2	--	--	<10	<10	3	<0.1	880
		Jul-99		21000	4	**11**	130	<1	2000	0.6	320	50	42	10	31000	**19**	--	70	17000	<0.2	--	50	--	9.8	<1	--	<10	12	2700	<2	--	--	30	80	2	0.1	1200
		Aug-99		84000	3	<1	490	<1	2000	1.7	320	**150**	61	80	140000	**140**	--	79	16000	0.2	--	--	--	--	<1	--	<10	--	3000	<2	--	--	140	310	2	0.1	1200
		Sep-99		4500	3	5	60	<1	2400	0.3	330	7	53	<10	7200	3	--	73	12000	<0.2	--	21	--	13	<1	--	<10	14	3500	<2	--	--	<10	20	2	0.1	1200
		Oct-99		640	2	<1	40	<1	1800	0.3	250	<1	23	<10	790	<1	--	56	12000	<0.2	--	51	--	11	<1	--	<10	12	2600	<2	--	--	<10	<10	2	<0.1	1100
		Nov-99		13000	<1	3	140	<1	2200	0.5	290	5	26	30	14000	8	--	63	12000	<0.2	--	22	--	12	2	--	<10	11	3000	<2	--	--	10	50	2	0.2	860
		Dec-99		320	<1	<1	40	<1	2100	0.22	280	1	18	<10	470	<1	--	62	12000	<0.2	20	8	--	10	3	--	<10	11	2900	<2	<50	6	<10	10	2.8	<0.1	720
		May-00		360	<1	<1	36	<1	1700	0.36	270	<1	23	12	890	<1	--	63	11000	<0.2	30	8.9	--	11	<1	4200	<10	11	3200	<2	130	<5	<10	<10	3.6	0.17	850
		Nov-00		620	2	2.5	41	<1	1900	0.87	260	11	15	<10	2700	<1	--	59	7900	<0.2	52	8	--	11	<1	--	<10	11	2900	<2	<50	14	<10	19	2.8	0.15	840
		May-01		90	<1	<1	30	<1	<200	0.58	0.47	<1	9.8	45	140	<1	--	0.12	<5	<0.2	<20	2	--	9.3	<1	5300	<10	9.9	<50	<2	<50	<5	<10	160	2.9	0.18	760
		May-04		4400	<0.6	8.5	50	<1	1000	0.31	280	4.7	19.7	<10	20000	2.6	--	62	6800	<0.1	90	13.1	<0.01	11	0.6	--	<10	13	2900	<0.1	50	110	<10	<10	3.2	0.15	930
		Aug-06		3500	<3	3	60	<1	2100	0.3	340	6	15	<10	10000	1	--	75	6400	<0.1	40	11	<0.01	13	4	--	<10	17	3800	<2	--	--	<10	20	3.9	0.16	1100
		Nov-06		2100	3	3	45	<1	2200	0.1	340	2	13	<10	7000	<1	--	74	5800	<0.1	40	5	0.01	14	<1	--	<10	13	3700	<2	--	--	<10	40	4.8	0.16	1100
		Feb-07		18000	<1	7.1	220	<2	2400	0.65	330	34	22	12	20000	7.9	--	78	6700	<0.2	42	32	<0.1	16	1	--	<0.5	17	3700	<1	--	--	23	200	2.4	0.1	1100
		May-07		11000	<1	4.8	84	<1	2100	0.5	340	33	37	9.3	13000	6.4	--	76	8100	<0.2	24	2.9	<0.1	15	1.7	--	0.57	16	3700	<1	--	--	14	84	2.2	0.11	1100
		Aug-07		240	<1	2.5	41	<5	<200	<0.5	60	4.9	11	5.2	290	2.1	--	5.6	130	<0.2	<5	10	<0.1	1.8	<1	--	<0.5	4.5	240	<1	--	--	<10	86	2.5	<0.1	1000
		Nov-07		4300	<1	2.6	49	<2	2300	<0.5	320	9.9	38	4.8	6600	1.9	--	71	6300	<0.2	25	16	<0.1	13	<1	--	<0.5	16	3500	<1	--	--	<10	59	3.9	0.11	1100
		Feb-08		3700	<1	2	48	<2	2600	<0.5	290	5.6	31	3.4	6300	1	--	69	6300	<0.2	23	15	<0.1	13	<1	--	<0.5	16	3100	<1	--	--	<10	62	3.1	<0.1	1000
		May-08		4200	<1	1.9	46	<1	2400	<0.5	280	9.4	13	5	6200	<5	--	65	6000	<0.2	22	16	<0.1	12	<1	--	<0.5	15	2900	<5	--	--	<10	52	3.4	0.1	860
		May-09		660	<1	1.7	23	<2	2100	<0.5	220	<1	7.9	<1	3500	<1	--	48	3800	<0.2	35	11	<0.1	11	<1	--	<0.5	13	2300	<1	--	--	<10	63	5.8	0.17	620
		Nov-09		290	<1	6.1	25	<1	1900	<0.5	200	<10	<10	<2	8000	<5	--	45	3400	<0.2	50	<20	<0.1	13	1.8	--	<10	14	2300	<1	<1	--	<10	78	5.9	0.27	610
		May-10		360	<1	2.3	26	<1	1800	<0.5	--	<2	6.1	<2	5900	<1	--	46	3500	<0.2	41	8	<0.1	12	<1	--	<1	13	2300	<1	<1	--	<2	67	5.5	0.2	580
		May-10		200	<1	2.5	24	<1	1800	<0.5	--	<2	6.1	<2	5700	<1	--	46	3400	<0.2	39	8	<0.1	11	<1	--	<1	12	2200	<1	<1	--	<2	65	5.5	0.19	580

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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**	**-**
BRF-47 (cont)	47	Nov-10		--	<1	5.1	37	<1	--	<0.5	--	<2	6.7	2.5	--	2.7	--	--	--	<0.2	--	8.5	--	--	<1	--	<1	--	--	<1	<1	--	2.4	55	--	--	--
		May-11		490	<1	2.4	29	<1	1700	<0.5	210	<2	6.5	<2	5500	2.4	--	48	3300	<0.2	38	9.4	<0.1	11	<1	--	<1	11	2200	<1	<1	--	<2	59	4.3	--	580
		Nov-11		520	<1	3.5	37	<1	1800	<0.5	260	<2	7.1	<2	8200	<1	--	57	4000	<0.2	46	--	<0.1	16	<1	--	<1	14	3300	<1	<1	--	<2	120	6.4	--	810
		May-12		--	<1	3	32	<1	--	<0.5	--	<2	7.8	<2	--	<1	--	--	--	<0.2	--	10	--	--	<1	--	<1	--	--	<1	<1	--	<2	120	--	--	--
		Nov-12		--	<1	3.6	38	<1	--	<0.5	--	<2	7.7	<2	--	<1	--	--	--	<0.2	--	5.8	--	--	<1	--	<1	--	--	<1	<1	--	<2	130	--	--	--
		May-13		510	<1	3.6	34	<1	1800	<0.5	310	<2	9.4	<2	9900	<1	--	65	4400	<0.2	41	9.6	<0.1	17	<1	--	<1	14	3500	<1	<1	--	<2	120	12	<0.1	1000
		May-13		440	<1	3.6	34	<1	1700	<0.5	310	<2	8.8	<2	9700	<1	--	64	4300	<0.2	38	9	<0.1	18	<1	--	<1	14	3500	<1	<1	--	<2	120	12	0.15	1000
		Aug-13		173	<2	5.57	36.6	<2	1930	<1	305	<2	9.05	<2	11400	<2	--	58.5	4650	<0.2	66.6	3.82	<0.1	18.5	<2	--	<2	14.3	3480	<2	<50	--	<2	155	12.9	0.19	880
		Feb-14		<100	<2	4.13	40.6	<2	2080	<1	318	<2	7.4	<10	8740	<2	--	57.3	3780	<0.2	51.9	2.33	<0.1	24.7	<2	--	<5	14.3	3770	<2	<2	--	<20	113	10.8	--	930
		Aug-14		--	<2	**10.3**	49.2	<4	--	<1	--	2.24	6.46	<10	--	<2	--	--	--	<0.2	--	2.27	<0.1	--	<2	--	<5	--	--	<2	2.38	--	<20	138	--	0.28	--
		Oct-14		--	<2	9.33	46.1	<4	--	<1	--	<2	6.4	<10	--	<2	--	--	--	<0.2	--	2.91	<0.1	--	<2	--	<5	--	--	<2	<2	--	<20	123	15.9	0.66	939
		Feb-15		--	<2	4.85	38.8	<2	--	<1	--	<2	10.1	<10	--	<2	--	--	--	<0.2	--	3.84	--	--	<2	--	<5	--	--	<2	<2	--	<2	95.5	--	--	--
		Aug-15		--	<2	**11.1**	37.2	<2	--	<1	--	<2	8.42	<10	--	<2	--	--	--	<0.2	--	2.56	--	--	<2	--	<5	--	--	<2	--	--	<2	64	--	0.23	--
		Aug-15		--	<2	**11.1**	41.8	<2	--	<1	--	<2	8.17	<10	--	<2	--	--	--	<0.2	--	2.42	--	--	<2	--	<5	--	--	<2	--	--	<2	65.2	--	0.23	--
		Feb-16		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-48	48	May-99		18000	<1	6	130	<1	<200	1.4	400	27	140	<10	130000	14	--	72	21000	<0.2	--	**120**	--	22	5	--	<10	11	3800	<2	--	--	10	180	4	0.01	1800
		Jun-99		990	<1	2	30	<1	1500	0.7	380	2	9	<10	75000	<1	--	82	26000	<0.2	--	84	--	11	<1	--	<10	12	2600	<2	--	--	20	130	3	<0.1	1700
		Jul-99		4200	2	2	40	<1	1900	0.8	410	12	140	<10	110000	2	--	73	23000	<0.2	--	74	--	14	<1	--	<10	11	3600	<2	--	--	<10	120	3	<0.1	1900
		Aug-99		30000	3	9	190	<1	1800	1	400	35	130	20	170000	**37**	--	71	18000	0.2	--	--	--	--	<1	--	<10	--	3900	<2	--	--	70	180	3	0.1	1900
		Sep-99		8900	6	9	70	<1	2100	0.5	420	14	140	<10	140000	4	--	72	19000	<0.2	--	62	--	18	<1	--	<10	10	4400	<2	--	--	50	100	3	0.1	1900
		Oct-99		12000	3	5	40	<1	870	0.8	340	16	110	<10	120000	12	--	63	18000	<0.2	--	79	--	17	<1	--	<10	8.7	2600	<2	--	--	<10	120	3	<0.1	1800
		Nov-99		5200	<1	5	70	<1	1700	0.9	400	6	110	10	110	2	--	66	20000	<0.2	--	65	--	16	7	--	<10	10	3800	<2	--	--	<10	110	3	<0.1	1400
		Dec-99		2800	2	<1	40	<1	1300	0.54	380	4.4	150	<10	94000	<1	--	72	23000	<0.2	<20	94	--	13	4	--	<10	12	3400	<2	<50	69	<10	120	3.1	<0.1	1400
		Dec-99		3100	3	<1	50	<1	1300	0.55	380	6.4	150	<10	94000	<1	--	73	23000	<0.2	<20	93	--	12	4	--	<10	12	3400	<2	<50	80	<10	120	3	<0.1	1400
		May-00		4700	<1	2.9	52	<1	1700	0.32	370	13	78	<10	130000	<1	--	63	16000	<0.2	<20	56	--	16	2.4	12000	<10	12	4200	<2	130	75	12	76	4.3	<0.1	1400
		Nov-00		55	1.5	<1	35	1	2200	0.55	390	<1	89	<10	93000	<1	--	59	11000	<0.2	<20	49	--	24	<1	--	<10	9.6	5000	<2	<50	<5	<10	88	3.1	<0.1	1600
		May-01		220	<1	<1	<10	<1	<200	1	0.63	<1	84	<10	910	<1	--	0.11	83	<0.2	<20	38.7	--	21	<1	1700	<10	10	<50	<2	65	13	<10	<10	3.1	<0.1	1600
		May-04		1900	<0.6	2.9	40	<1	700	0.81	380	3.5	94.9	<10	110000	1.8	--	71	15000	<0.1	<20	43.8	<0.01	17	1	--	<10	10	4100	<0.1	<50	58	<10	<10	2.5	<0.1	1600
		Aug-06		8100	<3	8	110	<1	2000	1	440	7	60	<10	122000	2	--	71	8800	<0.1	<20	38	<0.01	28	5	--	30	10	6000	<2	--	--	<10	20	2.9	<0.1	1500
		Nov-06		1200	<3	4	40	<1	2000	0.1	440	1	53	<10	110000	<1	--	71	8600	<0.1	<20	31	0.01	35	<1	--	20	8.3	5800	<2	--	--	<10	<10	3.5	<0.1	1500
		Feb-07		8600	2.3	2.3	63	<2	2000	1	430	9.2	73	5.2	110000	2.9	--	79	14000	<0.2	<5	39	<0.1	22	1.3	--	<0.5	11	5600	<1	--	--	20	150	1.5	<0.1	1600
		May-07		680	<1	1.8	38	<1	2000	0.57	440	3.1	82	2.9	100000	<1	--	81	14000	<0.2	<5	38	<0.1	18	2.8	--	<0.5	11	5200	<1	--	--	<10	29	1.3	0.11	1600
		Aug-07		660	<1	1.4	25	<5	1900	<0.5	420	2.2	78	3.9	100000	<1	--	77	14000	<0.2	<5	32	<0.1	19	<1	--	<0.5	11	5200	<1	--	--	<10	28	1.8	<0.1	1700
		Nov-07		610	<1	1.2	32	<2	2000	<0.5	450	2.2	79	3.7	99000	<1	--	80	14000	<0.2	<5	35	<0.1	20	<1	--	<0.5	12	5400	<1	--	--	<10	30	4.1	0.31	2000
		Feb-08		1600	<1	1.3	31	<2	2000	<0.5	460	1.9	100	3.5	110000	<1	--	85	16000	<0.2	<5	33	<0.1	20	<1	--	<0.5	17	5200	<1	--	--	<10	33	2	0.23	1700
		May-08		10000	<1	2.9	71	<1	2000	1.7	460	11	73	7.4	120000	5.5	--	88	16000	<0.2	<5	43	<0.1	21	<1	--	<0.5	13	5200	<1	--	--	18	55	2.4	0.12	1700
		May-09		2600	<1	3	25	<2	2000	1.6	430	5.8	62	2.6	100000	2.4	--	80	14000	<0.2	<5	39	<0.1	19	1.3	--	1	12	4900	1	--	--	<10	35	3.6	0.16	1500

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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**	**-**
BRF-48 (cont)	48	May-09		2900	<1	2.1	28	<2	2000	<0.5	440	6.7	60	2.1	110000	1.5	--	87	14000	<0.2	6.7	40	<0.1	20	<1	--	<0.5	12	5200	<1	--	--	<10	36	4	0.16	1600
		Jun-09		--	--	--	--	--	--	1.4	--	--	62	--	--	--	--	--	--	--	--	32	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-09		1600	<1	2.6	36	<1	1900	<0.5	450	<20	76	2.1	100000	<5	--	83	13000	<0.2	<5	<20	<0.1	21	1	--	<10	12	6300	<1	<1	--	<10	26	3.4	0.21	1800
		May-10		900	<1	2.5	37	<1	2100	<0.5	--	7.7	41	<2	86000	1.9	--	87	9200	<0.2	<5	38	<0.1	24	1.6	--	<1	12	6200	<1	<1	--	<2	33	3.4	0.13	1700
		Nov-10		--	<1	1.2	37	<2	--	<0.5	--	<2	34	<2	--	<1	--	--	--	<0.2	--	20	--	--	<1	--	<1	--	--	<1	<1	--	<2	20	--	--	--
		Nov-10		--	<1	1.3	37	<2	--	<0.5	--	<2	34	<2	--	<1	--	--	--	<0.2	--	23	--	--	<1	--	<1	--	--	<1	<1	--	<2	18	--	--	--
		May-11		570	<1	1	35	<1	1300	<0.5	380	<2	17	<2	22000	<1	--	56	7000	<0.2	6.4	17	<0.1	11	<1	--	<1	14	2200	<1	<1	--	<2	10	3.6	--	1100
		Nov-11		--	<1	1	31	<1	--	<0.5	--	<2	34	<2	--	<1	--	--	--	<0.2	--	19	--	--	<1	--	<1	--	--	<1	<1	--	<2	16	--	--	--
		Nov-11		670	--	--	--	--	1800	--	470	--	--	--	85000	--	--	83	10000	--	5.1	--	<0.1	18	--	--	--	14	4800	--	--	--	--	--	2.4	--	1500
		May-12		--	<1	<1	29	<1	--	<0.5	--	<2	26	<2	--	<1	--	--	--	<0.2	--	18	--	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		Nov-12		--	<1	<1	30	<1	--	<0.5	--	<2	35	<2	--	<1	--	--	--	<0.2	--	18	--	--	<1	--	<1	--	--	<1	<1	--	<2	14	--	--	--
		Nov-12		--	<1	<1	40	<1	--	<0.5	--	<2	37	<2	--	<1	--	--	--	<0.2	--	19	--	--	<1	--	<1	--	--	<1	<1	--	<2	14	--	--	--
		May-13		970	<1	<1	32	<1	1200	<0.5	430	<2	42	<2	24000	1.1	--	71	18000	<0.2	<2	21	<0.1	13	<1	--	<1	15	3200	<1	<1	--	<2	18	2.9	0.1	1400
		Aug-13		286	<2	2.15	29.6	<2	1720	<1	494	<2	43.6	<2	75000	<2	--	81.8	13600	<0.2	<2	16.4	<0.1	15	<2	--	<2	13.6	4450	<2	<50	--	<2	<25	2	0.2	1490
		Feb-14		<100	<2	<2	22.4	<2	1100	<1	430	<2	17.6	<10	18800	<2	--	60	7410	<0.2	<50	8.88	<0.1	10.7	<2	--	<5	13.9	2360	<2	<2	--	<20	<50	4.71	--	1280
		Feb-14		<100	<2	<2	23.7	<2	1130	<1	425	2.17	17.9	<10	20600	<2	--	62.2	7370	<0.2	<50	8.96	<0.1	11.1	<2	--	<5	13.6	2330	<2	<2	--	<20	<50	4.74	--	1270
		Aug-14		--	<2	2.41	30.9	<4	--	<1	--	<2	33.1	<10	--	<2	--	--	--	<0.2	--	13.2	<0.1	--	<2	--	<5	--	--	<2	<2	--	<20	<50	--	0.23	--
		Aug-14		--	<2	2	28	<4	--	<1	--	<2	41.4	<10	--	<2	--	--	--	<0.2	--	16.4	<0.1	--	<2	--	<5	--	--	<2	<2	--	<20	<50	--	0.28	--
		Feb-15		--	<2	2.18	23.8	<2	--	<1	--	<2	36.8	<10	--	<2	--	--	--	<0.2	--	16.5	--	--	<2	--	<5	--	--	<2	<2	--	<2	<25	--	--	--
		Aug-15		--	<2	4.97	32	<2	--	<1	--	<2	39.9	<10	--	<2	--	--	--	<0.2	--	16	--	--	<2	--	<5	--	--	<2	--	--	<2	<25	--	0.16	--
		Feb-16		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-49	49	May-99		8400	<1	4	70	<1	<200	0.2	270	8	9	<10	10000	10	--	65	9100	<0.2	--	13	--	6.7	3	--	<10	9.4	2900	<2	--	--	10	20	2	0.3	960
		Jun-99		5500	<1	4	60	<1	3700	0.2	260	6	6	<10	7200	5	--	66	8500	<0.2	--	10	--	7.4	<1	--	<10	9.7	2700	<2	--	--	<10	20	2	0.3	910
		Jul-99		8800	3	4	70	<1	3800	0.2	250	12	17	<10	12000	8	--	63	8100	<0.2	--	10	--	7.4	<1	--	<10	9.5	2800	<2	--	--	10	20	2	0.5	950
		Aug-99		1600	2	2	40	<1	4000	<0.1	270	2	6	<10	1600	2	--	67	7900	<0.2	--	--	--	--	<1	--	<10	--	2800	<2	--	--	<10	<10	2	0.5	800
		Sep-99		19000	3	**12**	120	<1	4200	0.3	260	19	22	<10	22000	11	--	70	8500	<0.2	--	25	--	8.4	<1	--	<10	9.5	3200	<2	--	--	20	70	2	0.6	960
		Oct-99		6200	2	4	60	<1	3500	0.2	210	3	5	<10	7000	6	--	57	7000	<0.2	--	8	--	8.5	<1	--	<10	8.6	2700	<2	--	--	<10	10	2	0.4	800
		Nov-99		12000	<1	<1	100	<1	3900	0.4	240	4	12	20	13000	10	--	60	7400	<0.2	--	14	--	8.6	3	--	<10	9.6	2900	<2	--	--	<10	60	2	0.8	700
		Dec-99		2200	2	1.6	50	<1	3900	<0.1	240	4	3.7	<10	2100	<1	--	62	7600	<0.2	770	2.5	--	8.5	3	--	<10	9.2	3000	<2	<50	50	<10	10	2.4	0.5	720
		May-00		2500	<1	1.6	51	<1	3800	0.12	250	5	8	14	2400	<1	--	64	7900	<0.2	750	4.4	--	8.8	<1	8200	<10	10	3300	<2	120	42	<10	<10	2.8	0.61	800
		May-00		2100	<1	1.5	50	<1	3800	0.17	260	4	7.1	10	1800	<1	--	68	8100	<0.2	780	3	--	8.8	<1	7600	<10	10	3600	<2	120	40	<10	20	3.1	0.62	800
		Nov-00		600	2.7	1.6	38	<1	4200	0.65	240	<1	<1	<10	650	<1	--	64	7200	<0.2	790	<1	--	9.6	<1	--	<10	10	3400	<2	<50	12	<10	10	2.1	0.62	630
		May-01		66	<1	<1	<10	<1	<200	<0.1	0.44	<1	<1	<10	47	<1	--	0.12	<5	<0.2	<20	<1	--	9.2	<1	840	<10	9.6	<50	<2	<50	<5	<10	14	2	0.7	810
		May-04		980	<0.6	<0.1	30	<1	2600	1.3	140	0.8	3.8	<10	860	0.7	--	36	3500	<0.1	830	5.1	<0.01	13	0.4	--	<10	5.7	2100	<0.1	50	20	<10	<10	1.2	1.2	310
		Aug-06		600	<3	<1	50	<1	2300	0.1	120	<1	1	<10	890	<1	--	31	3500	<0.1	730	3	<0.01	12	2	--	<10	5.8	1900	<2	--	--	<10	<10	1.6	1.3	240
		Nov-06		1600	<3	2	70	<1	2300	<0.1	120	1	4	<10	1700	1	--	30	3200	<0.1	720	1	0.01	14	<1	--	<10	4	1900	<2	--	--	<10	<10	1.8	1.7	230

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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	-
BRF-49 (cont)	49	Feb-07		410	<1	3	52	<2	2400	1.3	120	1.2	5.1	2	500	<1	--	30	3100	<0.2	700	4.6	<0.1	12	1.5	--	<5	5.5	1900	<1	--	--	<10	<10	1.3	1.4	210
		May-07		<100	<1	5	48	<1	2100	1.2	120	<1	5.8	1.1	390	<1	--	29	3500	<0.2	680	2.6	<0.1	12	1.8	--	<0.5	7.3	1800	<1	--	--	<10	<10	1.1	1.5	210
		Aug-07		240	<1	2.4	48	<5	2200	1.2	120	<1	4.5	<1	2300	<1	--	30	3600	<0.2	680	2.2	<0.1	13	<1	--	<0.5	6.9	1900	<1	--	--	<10	<10	1.5	1.3	240
		Nov-07		<100	<1	2	42	<2	1800	1.4	100	1.1	3.6	1.2	330	<1	--	25	2800	<0.2	580	2.6	<0.1	11	<1	--	<0.5	4.9	1500	<1	--	--	<10	<10	2.9	1.8	230
		Feb-08		340	<1	1.3	50	<2	2200	1.2	120	<1	<10	1	410	<1	--	29	3200	<0.2	700	2.7	<0.1	13	<1	--	<0.5	6.2	1800	<1	--	--	<10	<30	1.9	1.3	220
		Feb-08		380	<1	1.4	49	<2	2300	1.2	120	<1	<10	1.1	410	<1	--	30	3100	<0.2	700	2.9	<0.1	14	<1	--	<0.5	6.4	1800	<1	--	--	<10	<30	2.1	1.3	220
		May-08		110	<1	1.4	43	<1	2200	1.8	120	<1	1.4	1.7	190	<1	--	30	3300	<0.2	690	3.5	<0.1	14	<1	--	<0.5	6.4	1900	<1	--	--	<10	<10	1.6	1.4	230
		May-09		180	<1	1.6	38	<2	2000	1.8	120	1	1.6	<1	280	<1	--	30	3000	<0.2	650	5.3	<0.1	14	<1	--	<0.5	6.7	1800	<1	--	--	<10	<10	3.8	1.6	230
		Jun-09		--	--	--	--	--	--	0.99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.4	--
		Nov-09		200	<1	3.3	47	<1	1900	0.84	130	<10	<10	<2	820	<5	--	31	4200	<0.2	620	<20	<0.1	14	<1	--	<10	9.3	1800	<1	<1	--	<10	13	5.8	1.6	250
		May-10		<100	<1	3.2	45	<1	1800	1.3	--	2.5	1.8	<2	1100	<1	--	36	4400	<0.2	560	5.1	<0.1	15	<1	--	<1	9.2	2300	<1	<1	--	<2	<10	5.2	1.4	290
		Nov-10		--	<1	4.6	68	<1	--	2	--	<2	2.1	<2	--	<1	--	--	--	<0.2	--	20	--	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		May-11		380	<1	5.7	64	<1	1900	<0.5	190	2.2	2.8	<2	750	<1	--	47	5400	<0.2	510	5.2	<0.1	19	<1	--	<1	7.6	3000	<1	<1	--	<2	<10	5.7	--	450
		May-11		430	<1	6.4	66	<1	1900	<0.5	190	2.3	2.7	<2	780	<1	--	47	5300	<0.2	510	5.2	<0.1	19	<1	--	<1	7.6	3000	<1	<1	--	<2	<10	5.7	--	450
		Nov-11		280	<1	5.6	71	<1	2000	<0.5	200	<2	2.2	<2	650	<1	--	48	5600	<0.2	510	3.1	<0.1	20	<1	--	<1	9.7	3500	<1	<1	--	<2	<10	6.3	--	450
		May-12		--	<1	3.2	66	<1	--	0.85	--	<2	3	<2	--	<1	--	--	--	<0.2	--	6	--	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		Nov-12		--	<1	3.1	74	<1	--	0.76	--	<2	3.8	<2	--	<1	--	--	--	<0.2	--	3.7	--	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		May-13		400	<1	3.3	72	<1	1900	0.77	280	<2	4.1	<2	1200	<1	--	64	9200	<0.2	410	6.2	<0.1	23	<1	--	<1	14	4500	<1	<1	--	<2	<10	38	1.2	740
		Aug-13		167	<2	2.88	77.6	<2	2430	<1	310	<2	5.15	<2	441	<2	--	67.1	10200	<0.2	506	<2	<0.1	22.4	<2	--	<2	12.9	4850	<2	<50	--	<2	<25	49.9	1.34	757
		Aug-13		<100	<2	2.72	74.4	<2	2320	<1	302	<2	4.79	<2	409	<2	--	65.6	9510	<0.2	464	<2	0.72	21.8	<2	--	<2	12.5	4720	<2	<50	--	<2	<25	49.9	1.29	917
		Feb-14		278	<2	<2	72.4	<2	2940	<1	381	<2	5.3	<10	441	<2	--	82.6	9390	<0.2	366	<2	<0.1	26.1	<2	--	<5	13.6	6250	<2	<2	--	<20	<50	88.4	--	808
		Aug-14		--	<2	2.66	85.2	<4	--	<1	--	<2	<20	<10	--	<2	--	--	--	<0.2	--	<20	<0.1	--	<20	--	<5	--	--	<2	<2	--	<20	<50	--	1.25	--
		Feb-15		--	<2	<2	<10	<2	--	<1	--	<2	<2	<10	--	<2	--	--	--	<0.2	--	<10	--	--	<2	--	<5	--	--	<2	<2	--	<2	<25	--	--	--
		Aug-15		--	<2	4.68	118	<2	--	<1	--	<2	11.7	<10	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<5	--	--	<2	--	--	<2	<25	--	1.01	--
		Feb-16		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-50	50	May-99		7200	<1	3	160	<1	<200	0.2	160	6	9	<10	7000	9	--	31	6200	<0.2	--	13	--	2.4	2	--	<10	4.5	180	<2	--	--	10	30	5	0.1	26
		Jun-99		2700	<1	3	160	<1	<200	<0.1	170	3	47	<10	3700	2	--	30	5700	<0.2	--	5	--	0.6	<1	--	<10	4.5	220	<2	--	--	<10	10	6	0.1	23
		Jul-99		7200	<1	2	250	<1	<200	0.2	220	6	9	<10	9100	4	--	38	5000	<0.2	--	7	--	0.6	<1	--	<10	4.6	260	<2	--	--	10	20	6	0.2	24
		Aug-99		1500	<1	<1	200	<1	<200	<0.1	190	<1	5	<10	3300	2	--	33	3900	<0.2	--	--	--	--	<1	--	<10	--	250	<2	--	--	<10	<10	6	0.2	24
		Sep-99		27000	<1	**12**	380	<1	<200	0.3	200	29	31	10	32000	14	--	36	6000	<0.2	--	31	--	0.7	<1	--	<10	4.6	260	<2	--	--	20	90	7	0.2	28
		Oct-99		39000	<1	**14**	490	<1	<200	0.8	160	40	32	30	52000	**40**	--	33	5700	<0.2	--	54	--	1.3	2	--	<10	4	220	<2	--	--	40	140	6	0.2	24
		Nov-99		4000	<1	<1	210	<1	160	0.2	160	1	6	10	5800	3	--	29	3400	<0.2	--	5	--	0.5	<1	--	<10	4.7	240	<2	--	--	<10	30	7	0.2	30
		Nov-99		3300	<1	<1	210	<1	130	0.2	160	2	5	10	5200	2	--	29	3400	<0.2	--	4	--	0.5	<1	--	<10	4.5	250	<2	--	--	<10	20	7	0.2	23
		Dec-99		6000	<1	3.1	220	<1	<200	<0.1	170	9.9	3.2	<10	7000	3	--	32	4300	<0.2	<20	4.2	--	1.5	2	--	<10	4.4	260	<2	<50	200	<10	20	6.5	0.2	35
		May-00		3300	<1	1.1	200	<1	<200	<0.1	170	5	5.9	<10	6800	1.6	--	31	4300	<0.2	<20	3.6	--	0.49	<1	9900	<10	4.3	270	<2	96	58	<10	12	8.2	0.17	24
		Nov-00		190	1.7	2.1	170	<1	<200	0.36	160	<1	<1	<10	4200	<1	--	30	3500	<0.2	<20	<1	--	0.57	<1	--	<10	4.6	250	<2	<50	6.2	<10	<10	6.6	0.15	20
		May-01		110	<1	<1	190	<1	<200	0.37	170	<1	6.8	13	4500	3.8	--	29	3300	<0.2	<20	<1	--	0.54	<1	6100	<10	4.6	3100	<2	<50	8.3	<10	13	6.7	0.16	14

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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	-
BRF-50 (cont)	50	May-04		280	<0.6	3	220	<1	200	<0.05	180	<0.1	6	<10	7000	0.2	--	31	3800	<0.1	<20	5.5	<0.01	1	4.5	--	<10	5.1	260	<0.1	<50	<5	<10	<10	6.9	0.15	23
		Aug-06		<200	<3	1	210	<1	<200	<0.1	170	1	19	<10	5900	<1	--	29	3900	<0.1	<20	3	<0.01	1	2	--	<10	6.7	260	<2	--	--	<10	<10	6.2	0.15	25
		Nov-06		4100	<3	2	220	<1	<200	<0.1	160	7	6	<10	8300	3	--	28	4000	<0.1	<20	7	<0.01	1.7	<1	--	<10	5.2	240	<2	--	--	<10	20	5.6	0.14	25
		Feb-07		<100	<1	1.3	210	<2	<200	<0.5	160	<1	3.8	1.7	4400	<1	--	28	3800	<0.2	<5	4.5	<0.1	<0.5	14	--	<0.5	5.9	250	<1	--	--	<10	11	2.4	0.12	30
		May-07		<100	<1	3.8	210	<1	<200	<0.5	170	<1	4.3	1.1	4200	<1	--	29	3900	<0.2	<5	3.6	<0.1	0.6	11	--	<0.5	5.6	260	<1	--	--	<10	<10	2.1	<0.1	32
		Aug-07		700	<1	3.8	200	<1	200	<0.5	170	1.6	3.8	<1	5700	<1	--	29	4100	<0.2	13	3.4	<0.1	1	<1	--	<0.5	6	300	<1	--	--	<10	<10	2.5	0.1	29
		Aug-07		540	<1	4	210	<1	<200	<0.5	170	1.4	3.7	1.2	6000	<1	--	30	4200	<0.2	<5	3.4	<0.1	0.82	<1	--	<0.5	6.3	270	<1	--	--	<10	<10	2.5	0.12	30
		Nov-07		470	<1	2.7	200	<2	<200	<0.5	180	2.5	4.1	<1	3700	<1	--	32	4400	<0.2	<5	4.6	<0.1	0.77	<1	--	<0.5	5.2	260	<1	--	--	<10	12	5	0.3	37
		Feb-08		2800	<1	2.8	130	<2	<200	<0.5	97	<1	<10	<1	7400	<1	--	18	2700	<0.2	<5	3	<0.1	1.2	<1	--	<0.5	5.6	170	<1	--	--	<10	<30	2.3	0.14	23
		May-08		370	<1	2.4	190	<1	<200	<0.5	180	1.1	2.2	1.2	5500	<1	--	30	4500	<0.2	<5	5.3	<0.1	0.7	<1	--	<0.5	5.8	250	<1	--	--	<10	<10	2.5	0.1	36
		May-08		260	<1	2.3	190	<1	<200	<0.5	180	1.7	2.2	1.1	5100	<1	--	30	4500	<0.2	<5	5.7	<0.1	0.64	<1	--	<0.5	5.5	250	<1	--	--	<10	11	2.5	<0.1	35
		May-09		370	<1	3.4	130	<2	<200	<0.5	120	1.2	1.5	<1	6200	<1	--	20	2800	<0.2	5.8	4.9	<0.1	1.2	<1	--	<0.5	5	220	<1	--	--	<10	<10	3.7	0.14	21
		Nov-09		150	<1	2.4	140	<1	<200	<0.5	140	<10	<10	<2	6700	<5	--	23	3900	<0.2	<5	<20	<0.1	0.88	<1	--	<10	4.6	230	<1	<1	--	<10	<10	5.3	0.17	30
		May-10		150	<1	3.6	140	<1	<200	<0.5	--	2.4	1.5	<2	6600	<1	--	25	3700	<0.2	<5	5.1	<0.1	0.93	<1	--	<1	4.4	240	<1	<1	--	<2	<10	3.5	0.16	28
		Nov-10		--	<1	3.1	<2	<1	--	<0.5	--	<2	1.8	<2	--	1.3	--	--	--	<0.2	--	5.2	--	--	<1	--	<1	--	--	<1	<1	--	<2	15	--	--	--
		May-11		2100	<1	3.4	240	<1	<200	<0.5	190	3.1	2.4	<2	8400	1.3	--	34	4500	<0.2	6.3	6.8	<0.1	1.1	<1	--	<1	5.6	280	<1	<1	--	2.8	<10	3.3	--	41
		Nov-11		520	<1	4.2	250	<1	220	<0.5	190	<2	2.2	<2	6400	<1	--	34	5100	<0.2	7.3	3.7	<0.1	0.62	<1	--	<1	5.9	300	<1	<1	--	<2	<10	3.2	--	42
		Nov-11		440	<1	4.5	240	<1	<200	<0.5	190	<2	2.2	<2	6100	1.3	--	34	5100	<0.2	5.2	3.7	<0.1	0.57	<1	--	<1	5.8	300	<1	<1	--	<2	<10	3.3	--	41
		May-12		--	<1	3.2	290	<1	--	<0.5	--	<2	1.3	<2	--	<1	--	--	--	<0.2	--	5.1	--	--	<1	--	<1	--	--	<1	<1	--	<2	12	--	--	--
		Nov-12		--	<1	2.4	320	<1	--	<0.5	--	<2	1.6	<2	--	<1	--	--	--	<0.2	--	2.5	--	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		May-13		<100	<1	2.7	360	<1	<200	<0.5	190	<2	<1	<2	10000	<1	--	31	4700	<0.2	<2	3.3	<0.1	0.97	<1	--	<1	7.5	350	<1	<1	--	<2	<10	3.2	<0.1	30
		Aug-13		<100	<2	<2	378	<2	124	<1	198	<2	<2	<2	8150	<2	--	30.6	4440	<0.2	<2	<2	<0.1	<1	<2	--	<2	6.54	315	<2	<50	--	<2	<25	2.97	<0.1	32.7
		Oct-14		--	<2	2.29	368	<4	--	<1	--	<2	<2	<10	--	<2	--	--	--	<0.2	--	<2	<0.1	--	<2	--	<5	--	--	<2	<2	--	<20	<50	3.58	0.22	40.4
		Feb-15		--	<2	<2	295	<2	--	<1	--	<2	2.77	<10	--	<2	--	--	--	<0.2	--	<10	--	--	<2	--	<5	--	--	<2	<2	--	<2	<25	--	--	--
		Feb-15		--	<2	<2	300	<2	--	<1	--	<2	2.71	<10	--	<2	--	--	--	<0.2	--	<10	--	--	<2	--	<5	--	--	<2	<2	--	<2	<25	--	--	--
		Aug-15		--	<2	2.27	395	<2	--	<1	--	<2	3.39	<10	--	<2	--	--	--	<0.2	--	2.26	--	--	<2	--	<5	--	--	<2	--	--	3.38	<25	--	0.12	--
		Feb-16		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-A	A	Nov-81		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Jan-82		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Feb-82		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Jul-82		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-95		900	1	1	150	<1	<500	3	38	2	48	<10	21000	**47**	--	12	12000	<0.2	--	6	--	2.4	1	--	<10	4	140	<2	--	--	<10	4400	2	<0.1	48
		Nov-95		<50	<1	<1	120	<1	<500	0.4	43	<1	23	<10	8000	15	--	12	7300	<0.2	--	<1	--	2.8	<1	--	<10	3.8	150	<2	--	--	<10	550	2	<0.1	49
		Jun-96		120	<1	1	120	<1	<500	2	49	<1	24	<10	7400	10	--	13	6400	<0.2	--	10	--	2.2	<1	--	<10	3.8	180	<2	--	--	<10	1200	3	<0.1	42
		Nov-96		<50	1	1	120	<1	<500	0.4	48	<1	27	<10	8200	2	--	13	8400	<0.2	--	2	--	2.7	1	--	<10	4.9	130	<2	--	--	<10	990	3	<0.1	53
		Nov-96		<50	2	1	120	<1	<500	0.3	49	<1	26	<10	8400	2	--	13	8600	<0.2	--	3	--	2.5	1	--	<10	4	190	<2	--	--	<10	990	3	<0.1	52
		Jun-97		<50	<1	<1	100	<1	<500	0.3	34	<1	30	<10	10000	4	--	13	11000	<0.2	--	<1	--	2.3	<1	--	<10	3.8	120	<2	--	--	<10	1900	3	<0.1	40

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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**	**-**
BRF-A (cont)	A	Oct-97		50	<1	<1	120	<1	<500	<0.1	45	<1	28	<10	8500	<1	--	14	9300	<0.2	--	<1	--	2.6	<1	--	<10	4	150	<2	--	--	<10	1000	3	<0.1	54
		May-98		270	<1	<1	100	<1	<200	1	35	1	32	<10	10000	**22**	--	12	8700	0.5	--	5	--	2.3	<1	--	<10	3.4	90	<2	--	--	<10	4400	3	<0.1	47
		Nov-98		170	<1	2	160	<1	<200	**7**	62	1	18	<10	6600	**41**	--	15	6000	<0.2	--	2	--	2.6	<1	--	<10	4.2	240	<1	--	--	<10	2600	2	<0.1	40
		May-99		200	<1	<1	100	**6**	400	2.3	48	3	15	<10	4700	**19**	--	13	5800	<0.2	--	2	--	2.7	2	--	<10	4.2	130	<2	--	--	<10	2700	2	<0.1	64
BRF-B	B	Nov-81		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Jan-82		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Feb-82		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Jul-82		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Apr-91		<50	--	7	330	--	<500	0.3	51	<1	<1	<10	690	<1	20	13	280	--	<20	<1	<0.01	4.7	<1	7800	--	18	840	--	--	--	70	650	3	--	11
		Jun-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-91		190	--	**13**	330	--	<500	2	54	1	--	<10	1300	8	--	14	280	--	--	<1	--	4.6	--	5200	--	19	910	--	--	--	--	590	3	--	15
		Nov-93		700	<1	<1	380	<1	<500	4	50	1	--	<10	2000	6	20	13	270	<0.2	--	2	<0.01	4.8	<1	--	<10	19	910	--	--	--	--	480	3	--	14
		May-94		200	<1	<1	400	<1	<500	1	58	1	<1	<10	1400	1	20	16	190	<0.2	--	<1	<0.01	4.9	<1	--	<10	20	1100	<50	--	--	<10	460	3	0.2	11
		Aug-94		--	--	<1	--	--	--	0.9	--	<1	<1	--	--	1	--	--	--	<0.2	--	<1	--	--	<1	--	--	--	--	<50	--	--	<10	--	--	0.1	--
		Dec-94		<50	1	<1	330	<1	<500	0.6	46	<1	<1	<10	700	<1	--	13	120	**6.3**	<20	<1	<0.01	--	<1	--	10	--	910	<2	--	--	<10	290	3	0.1	14
		May-95		<50	1	<1	400	<1	<500	0.7	55	<1	<1	<10	700	2	--	15	62	<0.2	--	2	--	4.9	<1	--	<10	20	1000	<2	--	--	<10	190	2	0.1	14
		Nov-95		100	<1	<1	350	<1	<500	0.9	49	<1	<1	<10	1500	2	--	13	230	<0.2	--	<1	--	4.8	<1	--	<10	20	820	<2	--	--	<10	640	3	0.1	15
		Jun-96		70	<1	<1	360	<1	<500	0.6	52	<1	<1	<10	790	2	--	14	92	<0.2	--	2	--	4.3	<1	--	<10	21	900	<2	--	--	<10	240	3	0.2	14
		Jun-96		<50	<1	<1	330	<1	<500	0.7	49	<1	<1	<10	730	1	--	13	78	<0.2	--	3	--	4.4	<1	--	<10	21	920	<2	--	--	<10	200	3	0.3	13
		Nov-96		140	2	<1	380	<1	<500	1	59	<1	<1	<10	1600	3	--	14	220	<0.2	--	<1	--	5.3	<1	--	<10	20	970	<2	--	--	<10	680	3	<0.1	15
		Jun-97		60	<1	<1	370	<1	<500	0.8	58	<1	2	<10	1900	2	--	15	320	<0.2	--	<1	--	4.7	<1	--	<10	21	970	<2	--	--	<10	520	3	<0.1	9
		Oct-97		60	<1	<1	360	<1	<500	0.3	52	<1	<1	<10	1300	2	--	14	310	<0.2	--	<1	--	5.1	<1	--	<10	21	960	<2	--	--	<10	1000	3	<0.1	16
		May-98		<50	<1	<1	360	<1	200	0.4	50	16	<1	<10	900	<1	--	13	190	0.3	--	24	--	4.8	<1	--	<10	21	890	<2	--	--	<10	440	3	<0.1	12
		Nov-98		60	<1	<1	390	<1	200	0.4	51	<1	<1	<10	750	2	--	14	120	<0.2	--	<1	--	5.1	<1	--	<10	22	1100	<1	--	--	<10	420	3	0.1	12
		May-99		<50	<1	<1	370	<1	400	0.3	52	<1	2	<10	960	<1	--	14	210	<0.2	--	<1	--	5.1	<1	--	<10	22	1000	<2	--	--	<10	490	3	0.1	15
BRF-BRC0.3	*BRC1*	Oct-90		50	--	1	30	--	<50	0.2	40	<1	--	<10	1100	<1	--	12	72	--	--	<1	0.35	1.6	<1	--	--	4.4	--	--	--	<5	--	80	3	--	21
BRF-BRC1.9	*BRC2*	Oct-90		150	--	2	30	--	<50	<0.1	41	<1	--	<10	230	<1	--	12	78	--	--	<1	0.31	1.7	<1	--	--	4.2	--	--	--	9	--	<10	3	--	20
BRF-C	C	Nov-81		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Jan-82		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Feb-82		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Jul-82		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-89		1200	--	<1	80	<1	<500	**10**	42	5	10	<10	18000	**43**	<10	10	4000	--	<20	15	--	2	<1	--	--	4.6	50	--	--	--	<10	870	4	--	72
		Feb-90		1700	--	<1	300	<1	<500	0.9	56	2	<1	<10	1500	2	<10	17	360	--	<20	3	--	4.2	<1	--	--	16	790	<50	--	8	<10	1400	3	--	13
		May-90		<50	--	1	80	<1	<500	**15**	44	8	19	<10	27000	**67**	<10	7.7	4100	--	<20	23	--	1.8	<1	--	--	4	60	--	--	--	<10	1400	3	--	88
		Aug-90		50	--	<1	90	<1	<500	2	53	2	5	40	1700	3	<10	7.9	3700	--	<20	12	--	2.1	<1	--	--	4	100	--	--	--	<10	70	<1	--	80
		Nov-90		<50	--	<1	90	--	<500	1	56	4	10	<10	3100	5	40	8.5	3100	--	<20	14	0.03	2.4	<1	--	--	4.2	<50	--	--	--	<10	110	4	--	60
		Feb-91		<50	--	<1	80	--	<500	0.5	62	2	5	10	2200	2	<10	9.1	3800	--	<20	10	0.02	2.2	<1	--	--	4.2	70	--	--	--	<10	60	5	--	65

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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	-
BRF-C (cont)	C	Apr-91		<50	--	3	90	--	<500	<0.1	59	<1	5	<10	960	<1	<10	9	3400	--	<20	2	0.03	2.4	1	4000	--	3.9	100	--	--	--	<10	20	4	--	62
		May-91		<50	--	<1	80	--	<500	2	87	2	7	<10	20000	4	<10	8.5	2700	--	<20	4	0.03	2.3	3	--	--	4.3	70	--	--	--	<10	250	5	--	74
		Jun-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Aug-91		<50	--	1	80	--	<500	2	49	2	7	<10	2000	7	<10	8.3	3400	--	<20	10	<0.01	2.1	1	4400	--	3.9	110	--	--	--	<10	460	4	--	65
		Nov-91		<50	--	**12**	60	--	<500	3	53	5	--	<10	5000	9	--	7.9	3800	--	--	11	--	2.3	--	3000	--	4	<50	--	--	--	--	410	4	--	73
		Nov-92		70	<1	4	60	<1	<500	**7**	45	31	--	90	30000	**27**	--	6.7	<1100	<0.2	<20	40	0.02	2.2	<1	--	<10	4.2	<50	<50	--	--	--	1000	3	--	70
		May-93		<50	<1	<1	70	<1	<500	--	52	1	--	<10	2800	3	--	7.4	4100	--	--	--	--	2.1	<1	--	--	4.1	90	--	--	--	--	1000	3	--	71
		May-93		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-93		<50	<1	<1	40	<1	<500	<0.1	41	<1	--	<10	800	<1	--	7.1	3400	--	--	3	--	2.1	--	--	--	3.9	100	--	--	--	--	<10	3	--	54
		May-94		<5	<1	<1	60	<1	<500	0.1	45	<1	--	<10	860	<1	<10	8	3900	--	--	4	--	2	<1	--	<10	3.8	50	--	--	--	--	20	3	--	48
		Dec-94		<50	<1	<1	50	<1	<500	0.1	39	<1	--	<10	680	<1	--	7.2	3500	--	--	7	--	2	--	--	--	3.7	60	--	--	--	<10	<10	2	--	57
		May-95		<50	<1	<1	70	<1	<500	0.2	39	<1	--	<10	1200	<1	--	6.9	3600	--	--	7	--	1.9	<1	--	--	4	60	--	--	--	--	20	2	--	46
		Nov-95		<50	<1	<1	60	<1	<500	0.1	36	<1	3	<10	630	2	--	6.3	3300	<0.2	--	4	--	2	<1	--	<10	3.6	<50	<2	--	--	<10	10	3	<0.1	49
		Jun-96		<50	<1	2	40	<1	<500	0.7	38	<1	5	<10	470	1	--	6.4	3300	<0.2	--	5	--	1.8	<1	--	<10	3.5	60	<2	--	--	<10	<10	3	0.1	43
		Nov-96		<50	<1	<1	50	<1	<500	<0.1	44	<1	3	<10	650	<1	<10	6.6	3700	<0.2	--	5	--	2.6	<1	--	<10	3.2	<50	<2	--	--	<10	10	3	<0.1	49
		Jun-97		<50	<1	<1	60	<1	<500	<0.1	55	<1	5	<10	820	<1	--	9	4100	<0.2	--	5	--	2.1	<1	--	<10	4.2	70	<2	--	--	<10	30	3	<0.1	46
		Oct-97		50	<1	<1	80	<1	<500	<0.1	66	<1	4	<10	660	<1	--	11	4600	<0.2	--	8	--	2.4	<1	--	<10	4.7	90	<2	--	--	<10	10	3	<0.1	77
		Oct-97		50	<1	<1	80	<1	<500	<0.1	65	<1	4	<10	720	<1	--	11	4600	<0.2	--	7	--	2.3	<1	--	<10	4.6	90	<2	--	--	<10	10	3	<0.1	75
		May-98		<50	<1	<1	100	<1	400	0.1	84	<1	4	<10	700	<1	--	14	5200	0.4	--	7	--	2.5	<1	--	<10	5	110	<2	--	--	<10	20	3	0.1	140
		May-98		<50	<1	<1	90	<1	360	0.1	81	<1	3	<10	630	<1	--	13	5000	0.3	--	7	--	2.4	<1	--	<10	4.9	120	<2	--	--	<10	10	3	0.1	140
		Nov-98		<50	<1	<1	120	<1	400	0.2	100	1	8	<10	640	8	--	17	6600	<0.2	--	8	--	2.8	<1	--	<10	5.7	170	<1	--	--	<10	<10	7	<0.1	160
		May-99		<50	<1	<1	120	**9**	600	0.1	120	<1	6	<10	900	<1	--	20	7100	<0.2	--	7	--	3.2	2	--	<10	6	250	<2	--	--	<10	10	4	<0.1	320
BRF-D	D	Nov-81		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Jul-82		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-89		1600	--	<1	60	<1	<500	**23**	170	3	1	<10	1700	**77**	39	47	99	--	<20	19	--	4.7	<1	--	--	18	690	--	--	--	<10	12000	2	--	300
		Mar-90		5500	--	<1	160	<1	<500	**33**	200	1	<1	20	6900	**200**	40	48	140	--	<20	23	--	4.5	<1	--	--	15	710	--	--	--	10	11000	3	--	390
		May-90		1800	--	<1	110	<1	<500	**9**	140	5	4	<10	3700	**37**	40	39	100	--	<20	33	--	6.9	<1	--	--	22	670	--	--	--	<10	3600	2	--	290
		Aug-90		320	--	1	30	<1	<500	**42**	140	3	<1	10	1500	**110**	30	34	74	--	<20	8	--	3.7	<1	--	--	14	480	--	--	--	<10	10000	3	--	170
		Nov-90		330	--	<1	30	--	<500	**6**	140	<1	1	<10	930	**17**	40	35	76	--	<20	5	<0.01	4.5	<1	--	--	22	640	--	--	--	30	1300	2	--	220
		Feb-91		12000	--	2	940	--	<500	**26**	170	34	8	20	22000	**160**	60	43	270	--	20	**110**	0.03	5.5	<1	--	--	20	800	--	--	24000	<10	7200	4	--	260
		Apr-91		<50	--	2	30	--	<500	0.5	140	<1	2	<10	84	1	30	31	100	--	<20	<1	0.02	3.5	<1	8200	--	12	410	--	--	--	<10	2800	2	--	190
		May-91		70	--	<1	30	--	<500	4	130	3	5	<10	680	8	30	30	68	--	<20	2	0.01	3.8	1	--	--	15	460	--	--	--	<10	1600	2	--	190
		Jun-91		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Aug-91		1100	--	<1	60	--	<500	**7**	140	5	2	500	2200	**28**	40	33	67	--	<20	47	<0.01	4.6	<1	11000	--	18	570	--	--	--	<10	1800	26	--	160
		Nov-91		700	--	**16**	10	--	<500	**11**	150	2	--	<10	2000	**100**	--	33	100	--	--	9	--	3.2	--	5800	--	9.5	460	--	--	--	--	10000	2	--	180
		Feb-92		510	--	<1	50	--	<500	3	130	3	--	<10	1200	7	--	34	67	--	--	7	--	4.1	--	9900	--	19	630	--	--	--	--	1600	1	--	220
		May-92		390	--	<1	40	--	<500	**21**	140	2	--	<10	1300	**58**	35	36	60	--	--	13	--	4.2	--	9700	--	15	500	--	--	--	--	6200	2	--	280

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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**	**-**
BRF-D (cont)	D	Aug-92		90	--	<1	30	--	<500	3	130	1	--	<10	400	9	--	30	35	--	--	<1	--	3.8	--	8900	--	18	460	--	--	--	--	1400	1	--	200
		Nov-92		230	<1	<1	30	<1	<500	**15**	140	<1	--	50	680	**65**	--	31	62	<0.2	<20	<1	--	3.1	3	--	<10	11	350	<50	--	--	--	6000	2	--	180
		May-93		80	<1	<1	20	<1	<500	--	150	<1	--	<10	360	**49**	--	35	55	--	--	--	--	3.4	<1	--	--	11	470	--	--	--	--	4900	2	--	240
		May-93		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-93		180	<1	<1	20	<1	<500	--	140	4	--	<10	280	5	--	32	27	<0.2	<20	4	--	3.6	--	--	--	15	540	--	--	--	--	870	2	--	160
		May-94		80	1	<1	20	<1	<500	**21**	170	--	--	<10	520	**51**	--	38	56	--	--	--	--	3.5	<1	--	<10	12	450	--	--	--	--	4700	2	--	190
		Nov-94		<50	2	<1	<10	<1	<500	2	<0.1	1	<1	<10	<10	7	--	<0.01	<5	<0.2	--	<1	--	--	<1	--	<10	--	<50	<50	--	--	<10	<10	2	<0.1	180
		May-95		50	2	<1	20	<1	<500	**8**	150	2	--	<10	380	**33**	--	36	53	--	--	2	--	3.6	<1	--	--	10	500	--	--	--	--	3600	2	--	180
		Nov-95		<50	<1	<1	30	<1	<500	**38**	150	<1	<1	<10	360	**76**	--	33	44	<0.2	--	3	--	3.2	<1	--	<10	9.5	380	<2	--	--	<10	8100	2	<0.1	160
		Jun-96		1000	<1	6	40	<1	<500	**14**	140	<1	2	<10	2200	**40**	--	34	70	<0.2	--	4	--	3.4	<1	--	<10	12	410	<2	--	--	<10	2700	2	0.2	190
BRF-E	E	Jul-82		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.2	--	--	0.11	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Aug-82		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.2	--	--	<0.01	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Oct-82		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.2	--	--	<0.01	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Sep-83		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Jan-85		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Dec-88		350	--	<1	120	--	<500	1	69	<1	2	20	940	**46**	1000	19	59	--	30	28	0.06	1.7	<1	--	--	13	--	--	--	--	<10	70	4	--	25
		Mar-89		320	--	1	110	--	<500	0.2	72	1	2	<10	740	4	<10	20	35	--	<20	<1	<0.01	1.1	<1	--	--	11	--	--	--	--	<10	<10	4	--	71
		Aug-89		120	--	1	70	--	<500	0.2	72	<1	<1	50	820	**36**	12	22	65	--	<20	3	<0.01	1.3	<1	--	--	12	--	--	--	--	40	6	--	25
		Nov-89		1700	--	<1	100	1	<500	0.3	75	3	<1	<10	450	3	<10	24	17	--	<20	5	--	1.2	<1	--	--	14	550	--	--	--	<10	140	4	--	31
		Feb-90		1700	--	<1	110	1	<500	0.4	76	2	<1	<10	430	5	<10	24	22	--	<20	5	--	1.4	<1	--	--	13	560	--	--	--	<10	100	4	--	35
		May-90		170	--	<1	110	<1	<500	0.6	70	<1	<1	<10	620	4	20	21	21	--	<20	4	--	1.5	<1	--	--	15	570	--	--	--	<10	50	4	--	34
		Jul-90		310	--	1	120	<1	<500	1	81	<1	<1	<10	490	6	20	23	<5	--	<20	4	--	1.4	<1	--	--	19	620	--	--	--	<10	20	<1	--	39
		Nov-90		<50	--	<1	130	--	<500	<0.1	78	<1	<1	<10	550	12	30	22	19	--	<20	4	<0.01	1.6	1	--	--	24	670	--	--	--	<10	20	5	--	52
		Feb-91		<50	--	<1	120	--	<500	<0.1	79	<1	1	<10	440	2	20	22	48	--	20	2	<0.01	1.5	<1	5600	--	19	630	--	--	--	<10	<10	6	--	46
		May-91		<50	--	<1	670	--	<500	0.4	74	<1	<1	<10	440	2	20	20	62	--	<20	<1	<0.01	1.5	2	--	--	18	670	--	--	--	<10	<10	5	--	39
		Aug-91		<50	--	<1	140	--	<500	0.2	82	<1	<1	<10	540	2	20	24	38	--	<20	7	<0.01	1.6	<1	6200	--	24	680	--	--	--	<10	20	24	--	50
		Nov-91		90	--	**39**	120	--	<500	0.2	77	2	--	<10	630	1	30	22	67	<0.2	--	<1	<0.01	1.5	--	6400	<10	25	730	--	--	--	--	<10	6	--	52
		Feb-92		50	--	<1	140	--	<500	0.5	83	2	--	<10	620	2	16	23	<5	<0.2	--	2	<0.01	1.5	--	5900	<10	21	670	--	--	--	--	<10	6	--	56
		May-92		<50	--	<1	130	--	<500	0.5	84	2	--	<10	1500	4	24	23	51	<0.2	--	4	<0.01	1.6	--	5700	<10	21	660	--	--	--	--	40	6	--	78
		Aug-92		<50	--	<1	130	--	<500	<0.1	81	2	--	<10	420	4	30	22	45	<0.2	--	3	<0.01	1.6	--	5900	<10	26	660	--	--	--	--	<10	6	--	67
BRF-F	F	Dec-88		330	--	<1	200	--	<500	<0.1	100	<1	3	<10	280	5	1500	30	8	--	<20	<1	0.06	7.6	<1	--	--	14	--	--	--	--	<10	<10	13	--	170
		Mar-89		<50	--	<1	80	--	13000	<0.1	480	1	3	<10	180	1	3600	120	2200	--	<20	20	0.06	16	6	--	--	32	--	--	--	--	<10	<10	9	--	920
		Aug-89		320	--	<1	60	--	12000	<0.1	490	<1	4	<10	650	2	3300	110	2600	--	20	23	<0.01	18	<1	--	--	32	--	--	--	--	<10	10	9	--	1620
BRF-F45	F45	Nov-92		100	<1	5	780	<1	<500	1	1600	53	--	90	140000	**75**	40	54	10000	0.2	--	53	0.05	4.8	<1	--	<10	8.6	1300	--	--	--	--	460	6	--	170
		Feb-93		190000	<1	**20**	1000	**8**	<500	2	1900	**240**	--	90	250000	**130**	<10	96	13000	<0.2	--	**170**	0.02	4.8	2	--	<10	7.6	1700	<50	<50	--	--	530	4	--	210
		May-93		42000	<1	3	530	<1	<500	<1	1300	26	--	40	56000	**50**	30	46	9800	<0.2	--	35	0.03	3.9	<1	--	<10	8.7	1100	--	--	--	--	110	5	--	350
		Aug-93		23000	<1	2	240	<1	<500	1	470	31	--	470	35000	**26**	20	31	6000	<0.2	--	41	<0.01	2.4	<1	--	<10	10	480	--	--	--	--	110	5	--	300

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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**	**-**
BRF-F45 (cont)	F45	Aug-93		63000	<1	2	470	<1	<500	0.4	730	45	--	40	91000	<1	20	47	7300	<0.2	--	54	<0.01	3.6	<1	--	<10	8.8	710	--	--	--	--	230	5	--	290
		Nov-93		27000	<1	2	280	<1	<500	0.2	490	40	--	<10	38000	15	<10	35	6400	<0.2	--	38	<0.01	2.2	<1	--	<10	9.8	480	--	--	--	--	80	5	--	360
		Mar-94		--	--	--	--	--	--	--	--	--	3	--	--	--	--	--	--	--	--	12	--	--	--	--	--	--	--	<50	--	--	<10	--	--	0.2	--
		May-94		53000	<1	6	360	<1	<500	0.6	510	48	15	20	6500	**31**	10	48	8200	<0.2	--	20	<0.01	3.7	<1	--	<10	10	630	<50	--	--	50	140	7	0.2	35
		Aug-94		--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	<2	--	--	<10	--	--	<0.1	--
		Nov-94		10000	4	2	140	<1	<500	0.1	360	18	5	<10	17000	<1	--	30	5700	<0.2	--	17	<0.01	--	<1	--	<10	--	380	<2	--	--	10	30	5	<0.1	280
		May-95		2800	2	1	70	<1	<500	<0.1	260	5	1	<10	5600	2	--	25	5500	<0.2	--	7	--	2	<1	--	<10	9	280	2	--	--	<10	10	6	<0.1	270
		Nov-95		810	<1	<1	90	<1	<500	<0.1	250	<1	<1	<10	3900	3	--	24	5100	<0.2	--	7	--	3.8	<1	--	<10	10	150	<2	--	--	<10	20	8	<0.1	300
		Jun-96		9000	<1	3	110	<1	<500	0.3	300	10	6	<10	14000	10	--	27	5500	<0.2	--	14	--	1.9	<1	--	<10	9.1	300	<2	--	--	<10	20	5	0.2	250
		Nov-96		170	2	2	80	<1	<500	<0.1	230	2	<1	<10	2800	2	--	23	4700	<0.2	--	<1	--	2.4	<1	--	<10	8.6	250	<2	--	--	<10	<10	5	<0.1	220
		Jun-97		290	<1	<1	70	<1	<500	<0.1	220	4	2	<10	2800	1	--	24	4400	<0.2	--	<1	--	1.8	<1	--	<10	9.2	270	<2	--	--	<10	60	5	<0.1	200
		Oct-97		520	<1	2	80	<1	<500	<0.1	220	4	<1	<10	4000	<1	--	23	4700	<0.2	--	2	--	1.8	<1	--	<10	9.1	240	<2	--	--	<10	<10	9	<0.1	220
		May-98		470	<1	<1	70	<1	500	<0.1	240	2	<1	<10	4400	<1	--	24	5800	<0.2	--	4	--	1.5	<1	--	<10	10	230	<2	--	--	<10	40	5	<0.1	370
		Nov-98		230	1	2	80	<1	300	<0.1	220	2	1	<10	1500	<1	--	23	4200	<0.2	--	12	--	1.8	<1	--	<10	9.1	240	1	--	--	<10	<10	5	0.5	290
		May-99		1300	<1	<1	80	**10**	500	<0.1	240	4	<1	<10	4500	1	--	25	5700	<0.2	--	2	--	2.1	2	--	<10	11	<50	<2	--	--	<10	<10	5	<0.1	400
		Nov-99		7200	<1	<1	140	<1	430	<0.1	250	5	6	10	12000	5	--	24	4900	<0.2	--	19	--	1.7	2	--	<10	9.2	310	<2	--	--	<10	40	--	--	--
		Jun-00		480	<1	1.7	78	<1	630	<0.1	230	2.1	<1	<10	3200	<1	--	25	6300	<0.2	<20	1.8	--	1.6	<1	5800	<10	11	320	<2	58	20	<10	10	5	0.1	350
		Jun-00		480	<1	1.5	80	<1	630	<0.1	230	2	<1	<10	3300	<1	--	26	6500	<0.2	<20	1.2	--	1.6	<1	6000	<10	11	330	<2	59	20	<10	10	5.2	0.1	350
		Nov-00		3300	2.8	1.6	93	<1	430	<0.1	220	6.5	5	<10	6100	<1	--	23	4900	<0.2	<20	7	--	2	9.5	--	<10	9.3	290	<2	<50	78	<10	18	5.1	0.12	270
		May-01		1000	<1	<1	70	<1	520	0.69	220	3.1	3.7	<10	3600	<1	--	23	5200	<0.2	<20	<1	--	1.6	<1	6100	<10	9.7	280	<2	<50	22	<10	<10	5.1	<0.1	310
		Nov-01		--	<1	<1	81	<1	460	<0.1	220	5.2	<1	<10	2900	<1	--	24	4800	<0.1	<20	38	<0.01	1.4	<1	--	<10	8.8	290	<2	<50	13	<10	520	4.9	0.11	270
		May-02		810	<1	<1	81	<1	790	<0.1	240	3	2.6	<10	5000	2	--	26	6300	<0.1	<20	2.7	0.02	1.3	<1	--	<10	9.2	320	<2	<50	19	<10	33	4.8	<0.1	310
		Nov-02		2900	<1	5	90	<1	700	0.5	230	7	<1	<10	5300	**16**	--	24	5500	<0.1	<20	3.7	0.01	2.2	<1	--	<10	10	300	<2	<50	27	<10	<10	4.7	<0.1	300
		May-03		3000	<1	5	100	<1	800	<0.1	260	9	3	10	6200	<1	--	27	7200	<0.1	<20	4	<0.01	1.9	<1	8100	<10	12	330	<2	1300	70	<10	20	3.9	<0.1	380
		Nov-03		2400	<0.6	0.6	80	<1	800	0.1	260	3.9	1.9	<10	5800	0.6	--	26	6700	<0.1	<20	9.1	<0.01	0.7	1.3	9200	<10	11.3	330	<0.1	50	35	<10	<10	4.6	<0.1	420
		May-04		3100	<0.6	1.1	100	<1	620	0.13	250	7.8	2.8	10	7200	1.6	--	27	6400	<0.1	<20	12.6	0.08	2.6	1	--	<10	12	320	<0.1	--	--	<10	<10	5.6	<0.1	430
		Nov-04		1400	<3	3	90	<1	800	<0.1	260	6	1	<10	5000	<1	--	26	6400	<0.1	<20	4	<0.01	2.4	2	--	<10	9.8	320	<2	<50	54	<10	<10	4.4	<0.1	450
		May-05		12000	<3	3	150	<1	600	<0.1	280	19	8	<10	15000	2	--	27	6100	<0.1	<20	19	<0.01	2.1	<1	--	<10	13	340	<2	--	--	<10	<10	6.3	<0.1	371
		Nov-05		130	<3	1	70	<1	600	<0.1	220	1	<1	<10	3400	<1	--	24	4800	<0.1	<20	1	0.02	3.3	<1	--	<10	7.1	280	<2	--	--	<10	<10	4.7	<0.1	300
		May-06		4600	<3	1	100	<1	800	<0.1	260	7	3	<10	6700	1	--	27	6500	0.2	<20	6	<0.01	0.3	<1	--	<10	13	340	<2	--	--	<10	<10	4	0.1	404
		Jul-06		--	--	--	--	--	--	--	--	1	<1	--	--	--	--	--	--	<0.1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-06		<200	<3	1	80	<1	1000	<0.1	260	1	<1	<10	3700	<1	--	27	6600	<0.1	20	<1	<0.01	2.6	<1	--	<10	10	340	<2	--	--	<10	<10	5.1	<0.1	440
		Feb-07		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-07		<100	<1	5.6	84	<1	3200	<0.5	380	5.4	2.2	2	4300	<1	--	42	9800	<0.2	12	8	<0.1	1.9	32	--	<0.5	26	520	<1	--	--	<10	<10	4.8	<0.1	840
		Nov-07		<100	<1	3	71	<2	2200	<0.5	340	2.3	1.6	1.8	4600	<1	--	36	8700	<0.2	<5	6.4	<0.1	1.7	<1	--	<0.5	19	390	<1	--	--	<10	<10	5.4	<0.1	700
		May-08		120	<1	5.6	62	<1	4200	<0.5	400	3.1	2	2.3	4900	<1	--	46	10000	<0.2	5	12	<0.1	1.9	9.8	--	<0.5	31	520	<1	--	--	<10	<10	5.3	<0.1	910
		Nov-08		130	<1	3.5	52	<1	3600	<0.5	360	4.6	2.4	3.4	4400	<1	--	41	9400	<0.2	<5	12	<0.1	1.9	1.5	--	<0.5	26	450	<1	--	--	<10	<10	6.4	<0.1	420

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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	-
BRF-F45 (cont)	F45	Feb-09		130	<1	3.9	49	<2	3200	<0.5	370	<1	2	<1	4400	<1	--	40	10000	<0.2	<5	11	<0.1	1.6	1	--	<0.5	26	440	<1	--	--	<10	<10	6.3	<0.1	790
		May-09		<100	<1	3.4	43	<2	3300	<0.5	370	1.6	2.1	<1	4000	<1	--	42	9400	<0.2	11	9.3	<0.1	2.1	3.5	--	<0.5	29	500	<1	--	--	<10	13	6.9	0.15	860
		Aug-09		180	<1	1.3	43	<1	3500	<0.5	380	<2	<1	<2	4200	<1	--	42	9200	<0.2	<2	2.3	<0.1	2.1	2.7	--	<1	31	520	<1	--	--	<2	18	6.6	<0.1	920
BRF-F45R	F45R	Nov-08		2700	<1	4.9	110	<5	12000	<0.5	440	4.7	4.2	13	3500	2.7	--	140	7000	<0.2	21	13	<0.1	3.4	1	--	<0.5	48	1900	<1	--	--	<10	19	8.2	<0.1	1500
		Feb-09		3100	<1	6.2	67	<2	13000	<0.5	470	<1	2.6	4.6	4300	1.1	--	160	7800	<0.2	31	13	<0.1	3.7	<1	--	0.52	55	2300	<1	--	--	<10	<10	8.5	0.11	800
		May-09		950	<1	7.2	48	<2	15000	<0.5	520	<1	2.4	1.7	6000	<1	--	190	7700	<0.2	60	12	<0.1	4.1	<1	--	<0.5	64	3000	<1	--	--	<10	<10	8.8	0.13	1800
		Aug-09		550	<1	5.6	44	<1	16000	<0.5	500	<2	<1	2.5	7200	<1	--	190	5500	<0.2	56	7.2	<0.1	4.1	<1	--	<1	65	3100	<1	--	--	<2	16	8.6	0.13	2000
		Nov-09		330	<1	4.1	45	<2	16000	<0.5	500	<2	1.6	<2	8200	<1	--	200	6000	<0.2	70	4.9	<0.1	4	<1	--	<1	64	3200	<1	--	--	<2	<10	9	0.16	2000
		Nov-09		290	<1	4	46	<2	16000	<0.5	500	<2	1.6	<2	8000	<1	--	190	6800	<0.2	70	4.8	<0.1	4	<1	--	<1	63	3100	<1	--	--	<2	<10	8.7	0.16	2000
		Feb-10		300	<1	5.9	38	<5	16000	<0.5	490	<10	<10	<2	8600	<5	--	190	5700	<0.2	84	11	<0.1	4.2	<1	--	<10	67	3300	<1	<1	--	<10	<10	8.6	0.13	2100
		May-10		120	<1	5.2	39	<5	17000	<0.5	--	<2	1.8	6.2	6800	<1	--	200	6900	<0.2	87	12	<0.1	4.6	<1	--	<1	68	3600	<1	<1	--	<2	<10	8.7	<0.1	2100
		Nov-10		340	<1	6	52	<2	14000	<0.5	480	<2	2.9	<2	2900	<1	--	170	8400	<0.2	52	18	<0.1	5.7	29	--	<1	62	2800	<1	<1	--	<2	<10	8.6	--	1800
		Nov-10		470	<1	5.9	50	<2	14000	<0.5	480	<2	2.8	<2	3000	<1	--	170	8300	<0.2	53	16	<0.1	5.5	29	--	<1	61	2800	<1	<1	--	<2	<10	8.4	--	2100
		May-11		140	<1	4.9	35	<1	17000	<0.5	530	<2	<1	<2	7300	<1	--	210	5900	<0.2	130	9.9	<0.1	5.6	<1	--	<1	69	3900	<1	<1	--	<2	<10	8.6	--	2000
		Nov-11		360	<1	4.8	35	<5	17000	<0.5	540	<2	2	2.4	9200	<1	--	210	5900	<0.2	120	9	<0.1	6.2	<1	--	<1	72	4100	<1	<1	--	<2	<10	8.8	--	2100
		May-12		--	<1	8.1	36	<10	--	<0.5	--	<2	1.9	<2	--	<1	--	--	--	<0.2	--	17	--	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		Nov-12		--	<1	8.8	30	<10	--	<0.5	--	<2	2	<2	--	<1	--	--	--	<0.2	--	16	--	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		Nov-12		--	<1	6.9	32	<5	--	<0.5	--	<2	1.7	<2	--	<1	--	--	--	<0.2	--	14	--	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		May-13		<100	<1	8.9	34	<1	18000	<0.5	530	<2	1.3	<2	11000	<1	--	220	5300	<0.2	180	12	<0.1	7.1	<1	--	<1	74	4400	<1	<1	--	<2	<10	22	0.32	2200
		Aug-13		--	<2	3.66	37.6	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	<0.1	--	<2	--	<2	--	--	<2	<50	--	<2	<25	8.88	0.15	2350
		Feb-14		<100	<2	4.89	37.6	<2	19400	<1	597	<5	<10	<10	12600	<2	--	222	4670	<0.2	176	<10	<0.1	7.24	<10	--	<5	67.4	4120	<2	<50	--	<20	<50	8.88	--	1900
		Feb-14		<100	<2	4.38	37.6	<2	19500	<1	602	<5	<10	<10	12500	<2	--	222	4630	<0.2	175	<10	<0.1	7.18	<10	--	<5	67.7	4220	<2	<50	--	<20	<50	8.85	--	1910
		Aug-14		153	<2	8.78	35.8	<2	20100	1.2	587	<5	<10	<10	13400	<2	--	224	4920	<0.2	172	<10	<0.1	7.38	<10	--	<5	72.6	4340	<2	<50	--	<20	<50	9.18	--	2100
		Feb-15		--	<2	4.32	34.7	<2	--	<1	--	<5	<10	<10	--	<2	--	--	--	<0.2	--	<10	--	--	<10	--	<5	--	--	<2	<50	--	<20	<50	--	--	--
		Aug-15		--	<2	4.45	35.2	<40	--	<5	--	<5	<2	<10	--	<2	--	--	--	<0.2	--	<10	--	--	<10	--	<5	--	--	<2	--	--	<2	<25	--	0.13	--
		Feb-16		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-G	G	Dec-88		510	--	<1	60	--	<500	<0.1	73	1	<1	<10	490	9	830	9.6	220	--	<20	5	0.12	1.4	<1	--	--	3.4	--	--	--	--	<10	<10	12	--	19
		Mar-89		300	--	<1	50	--	<500	<0.1	77	<1	2	<10	530	3	<10	15	56	--	<20	<1	0.47	1.5	<1	--	--	3.1	--	--	--	--	<10	<10	10	--	39
		Aug-89		190	--	<1	20	--	<500	<0.1	82	<1	<1	<10	520	<1	<10	11	270	--	<20	3	<0.01	1.2	<1	--	--	2.8	--	--	--	--	<10	10	11	--	10
		Nov-89		1200	--	<1	30	<1	<500	<0.1	68	3	<1	<10	190	3	<10	12	290	--	<20	7	--	1.2	<1	--	--	3.5	140	--	--	--	<10	50	12	--	17
		Feb-90		1900	--	<1	50	<1	880	0.2	88	3	<1	<10	380	1	80	22	90	--	<20	5	--	1.7	<1	--	--	4.5	360	**50**	--	7	<10	60	10	--	110
		May-90		150	--	<1	50	<1	<500	0.3	68	<1	<1	10	300	2	<10	11	95	--	<20	2	--	1.1	<1	--	--	3.2	190	--	--	--	<10	<10	12	--	29
		Aug-90		140	--	<1	50	<1	<500	0.3	70	<1	2	<10	320	2	<10	9.7	260	--	<20	1	--	0.77	<1	--	--	2.8	180	--	--	--	<10	10	11	--	17
		Nov-90		1100	--	<1	50	--	<500	<0.1	80	<1	<1	<10	2100	3	50	13	180	--	<20	3	0.13	1	<1	--	--	3.2	230	--	--	--	10	230	12	--	62
		Feb-91		190	--	<1	40	--	<500	<0.1	78	<1	<1	10	360	<1	<10	14	260	--	<20	<1	0.03	0.94	<1	--	--	2.8	210	--	--	--	<10	<10	13	--	25
		May-91		<50	--	<1	40	--	<500	0.2	75	<1	<1	<10	230	<1	<10	11	140	--	<20	<1	0.04	0.86	2	--	--	2.9	170	--	--	--	<10	<10	12	--	32
		Aug-91		<50	--	<1	30	--	<500	<0.1	79	<1	<1	<10	400	<1	<10	11	220	--	<20	3	0.02	0.8	<1	4400	--	2.7	150	--	--	--	<10	10	4	--	20

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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	-
BRF-G (cont)	G	Nov-91		750	--	<1	30	--	<500	<0.1	83	2	--	<10	750	2	20	17	160	<0.2	--	9	0.09	0.82	--	3700	<10	2.9	240	--	--	--	--	10	12	--	81
		Nov-91		880	--	<1	30	--	<500	<0.1	84	2	--	<10	830	1	20	16	150	0.3	--	6	0.1	0.91	--	3800	<10	2.8	310	--	--	--	--	20	12	--	81
		Feb-92		<50	--	1	50	--	670	0.1	110	<1	--	<10	200	<1	160	24	120	<0.2	--	1	0.08	1	--	4500	<10	4.6	250	--	--	--	--	<10	12	--	180
		May-92		390	--	<1	50	--	<500	0.2	90	4	--	<10	2300	2	61	17	150	<0.2	--	12	0.05	1	--	4400	<10	3.3	210	--	--	--	--	50	13	--	140
		Aug-92		140	--	<1	40	--	<500	<0.1	71	2	--	<10	280	2	<10	11	210	<0.2	--	<1	0.01	0.77	--	4300	<10	3.2	140	--	--	--	--	<10	13	--	25
		Dec-92		270	<1	1	30	<1	<500	0.1	92	<1	--	<10	260	2	10	17	120	<0.2	--	<1	0.04	0.74	<1	--	<10	3.2	180	--	--	--	--	<10	12	--	84
		May-93		<50	<1	<1	40	<1	<500	<0.1	87	<1	--	<10	40	<1	<10	12	210	<0.2	--	<1	0.08	0.8	<1	--	<10	3.1	170	--	--	--	--	<10	13	--	51
		Nov-93		70	<1	<1	40	<1	<500	<0.1	84	2	--	<10	240	<1	<10	13	180	<0.2	--	3	0.02	0.9	<1	--	<10	3.2	130	--	--	--	--	<10	12	--	26
		Mar-94		--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	<50	--	--	<10	--	--	0.2	--
		May-94		<50	<1	<1	40	<1	<500	<0.1	87	<1	<1	<10	100	<1	20	15	150	<0.2	--	--	0.01	0.9	<1	--	<10	3.4	210	<50	--	--	<10	<10	13	<0.1	95
		Aug-94		--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	<2	--	--	<10	--	--	<0.1	--
		Nov-94		50	2	<1	40	<1	600	<0.1	100	2	<1	<10	110	<1	--	20	160	<0.2	--	<1	<0.01	--	1	--	<10	--	240	<2	--	--	<10	<10	13	<0.1	85
		May-95		150	1	<1	60	<1	1600	<0.1	140	<1	<1	<10	210	1	--	30	78	<0.2	--	<1	--	0.9	<1	--	<10	4	300	<2	--	--	<10	<10	12	<0.1	210
		Nov-95		<50	<1	1	70	<1	1600	0.2	130	<1	<1	<10	100	<1	--	27	100	<0.2	--	<1	--	0.9	3	--	<10	4.2	340	<2	--	--	<10	10	<1	<0.1	210
		Jun-96		60	<1	2	60	<1	1100	<0.1	150	<1	<1	<10	110	<1	--	33	65	<0.2	--	3	--	1	<1	--	<10	4.5	300	<2	--	--	<10	<10	12	0.2	250
		Nov-96		60	<1	2	40	<1	1100	<0.1	110	1	<1	<10	140	2	--	22	110	<0.2	--	<1	--	0.8	<1	--	<10	3.8	240	<2	--	--	<10	<10	12	<0.1	130
		Nov-96		<50	<1	<1	40	<1	<500	<0.1	24	1	<1	<10	40	1	--	2.8	32	<0.2	--	2	--	4.3	<1	--	<10	4.4	140	<2	--	--	<10	<10	11	<0.1	17
		Jun-97		<50	<1	<1	90	<1	4800	<0.1	230	2	<1	<10	<10	<1	--	55	<5	<0.2	--	<1	--	1.2	<1	--	<10	6.8	460	<2	--	--	<10	10	11	<0.1	380
		Jun-97		<50	<1	<1	60	<1	2500	<0.1	160	<1	<1	<10	90	2	--	36	62	<0.2	--	<1	--	1	<1	--	<10	5	350	<2	--	--	<10	<10	12	<0.1	230
		Oct-97		80	<1	<1	30	<1	500	<0.1	95	<1	<1	<10	130	<1	--	17	99	<0.2	--	3	--	0.9	<1	--	<10	4.2	200	<2	--	--	<10	<10	12	<0.1	82
		Oct-97		<50	<1	<1	20	<1	<500	<0.1	19	4	<1	10	50	<1	--	2.3	5	<0.2	--	6	--	2.9	<1	--	<10	4.2	180	<2	--	--	<10	<10	11	<0.1	32
		May-98		<50	<1	<1	100	<1	6100	<0.1	250	4	<1	<10	90	<1	--	60	61	<0.2	--	4	--	1.3	<1	--	<10	8.2	530	<2	--	--	<10	20	10	<0.1	740
		May-98		<50	<1	<1	30	<1	1400	<0.1	78	2	<1	<10	10	<1	--	3.1	<5	<0.2	--	5	--	2.4	<1	--	<10	4.8	210	<2	--	--	<10	<10	11	0.01	170
		Nov-98		<50	<1	<1	40	<1	400	<0.1	74	<1	<1	<10	<10	<1	--	19	<5	<0.2	--	<1	--	0.8	<1	--	<10	3.5	160	1	--	--	<10	<10	12	<0.1	42
		Nov-98		90	<1	<1	50	<1	1700	<0.1	120	<1	<1	<10	50	2	--	27	43	<0.2	--	<1	--	0.9	<1	--	<10	4.7	290	<1	--	--	<10	10	12	<0.1	180
		May-99		39	<1	<1	40	**19**	1900	<0.1	83	<1	<1	<10	10	3	--	7.6	<5	<0.2	--	<1	--	2.5	<1	--	<10	5.4	110	<2	--	--	<10	<10	10	<0.1	310
		May-99		<50	<1	<1	50	**19**	4600	<0.1	200	<1	<1	<10	240	5	--	50	110	<0.2	--	<1	--	1.7	6	--	<10	8.7	<50	<2	--	--	<10	<10	10	<0.1	670
		Nov-99		<50	<1	<1	30	<1	<200	<0.1	72	<1	<1	<10	30	<1	--	12	91	<0.2	--	<1	--	0.8	<1	--	<10	3.7	160	<2	--	--	<10	10	4	0.2	250
		Jun-00		58	<1	<1	56	<1	2600	<0.1	150	3.6	<1	11	170	<1	--	37	80	<0.2	30	1.4	--	1	1.3	4500	<10	6.2	370	<2	<50	<5	<10	14	11	0.11	340
		Nov-00		<50	<1	<1	48	<1	2000	<0.1	130	<1	<1	<10	150	<1	--	30	79	<0.2	32	<1	--	1	<1	--	<10	5.3	300	<2	<50	<5	<10	<10	11	0.12	260
		May-01		<50	<1	<1	36	<1	500	<0.1	85	<1	<1	<10	180	<1	--	15	200	<0.2	<20	<1	--	0.81	<1	660	<10	3.9	180	<2	<50	<5	<10	<10	12	0.1	84
		Nov-01		<50	<1	<1	43	<1	910	<0.1	100	<1	<1	<10	160	<1	--	19	110	<0.1	<20	3	0.02	0.8	<1	--	<10	4.1	220	<2	<50	7	<10	<10	12	0.1	110
		May-02		<50	<1	<1	58	<1	2000	<0.1	140	<1	<1	<10	61	3	--	31	30	<0.1	<20	<1	0.05	0.91	<1	--	<10	4.9	330	<2	<50	7.5	<10	17	10	<0.1	290
		Nov-02		230	<1	<1	40	<1	700	0.18	89	<1	<1	<10	30	<1	--	18	58	<0.1	<20	<1	0.01	0.93	<1	--	<10	3.8	210	<2	<50	<5	<10	<10	10	0.11	100
		May-03		<50	<1	<1	60	<1	3100	<0.1	190	<1	<1	10	160	<1	--	43	80	<0.1	30	<1	0.01	1.1	3	4900	<10	7.9	410	<2	970	<5	<10	20	8.3	<0.1	450
		Nov-03		<50	<0.6	<0.1	40	<1	1800	<0.05	140	<0.1	0.2	<10	60	<0.1	--	29	66	<0.1	30	5.8	<0.01	<0.1	1	0	<10	5.8	320	<0.1	<50	<5	<10	<10	10	<0.1	300
		May-04		<50	<0.6	<0.1	50	<1	2100	<0.05	160	0.6	0.2	<10	130	<0.1	--	37	45	<0.1	20	9	0.04	2.1	0.8	--	<10	6.8	370	0.1	--	--	<10	<10	9.4	0.1	380

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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	-
BRF-G (cont)	G	Nov-04		<50	<3	<1	40	<1	400	<0.1	90	<1	<1	<10	160	<1	--	15	210	<0.1	<20	<1	0.01	1.2	<1	--	<10	3	180	<2	<50	<5	<10	<10	10	0.12	70
		May-05		<50	<3	<1	50	<1	2500	<0.1	180	<1	<1	<10	80	<1	--	38	78	<0.1	<20	<1	0.01	1.6	<1	--	<10	8.4	360	<2	--	--	<10	<10	8.5	<0.1	426
		Nov-05		<50	<3	<1	30	<1	1200	<0.1	120	<1	<1	<10	30	<1	--	24	72	<0.1	<20	<1	0.01	2.7	<1	--	<10	1.3	250	<2	--	--	<10	<10	9.9	0.1	200
		May-06		<200	<3	<1	40	<1	700	<0.1	98	<1	<1	<10	70	<1	--	19	130	<0.1	<20	<1	<0.01	1	<1	--	<10	4.7	240	<2	--	--	<10	<10	10	0.1	115
		Nov-06		<200	<3	<1	40	<1	<200	<0.1	81	<1	<1	<10	230	<1	--	9.2	340	<0.1	<20	<1	<0.01	1.7	<1	--	<10	1.6	150	<2	--	--	<10	<10	11	<0.1	26
		Feb-07		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-07		<100	<1	1.7	42	<1	900	<0.5	120	<1	<1	1.4	<100	<1	--	25	34	<0.2	7.9	2.3	<0.1	1.1	7	--	<0.5	5.6	260	<1	--	--	<10	<10	7.3	<0.1	190
		Nov-07		<100	<1	<1	40	<2	760	<0.5	110	<1	<1	1.7	150	<1	--	20	59	<0.2	18	2.3	<0.1	0.98	<1	--	<0.5	4.9	220	<1	--	--	<10	<10	8.1	<0.1	140
		May-08		<100	<1	<1	48	<1	1300	<0.5	130	<1	<1	2.4	100	<1	--	29	53	<0.2	10	3.9	<0.1	1.1	<1	--	<0.5	6	280	<1	--	--	<10	<10	7.4	<0.1	210
		Nov-08		<100	<1	<1	39	<1	1000	<0.5	110	<1	<1	1.2	<100	<1	--	22	39	<0.2	14	3	<0.1	1	<1	--	<0.5	5	220	<1	--	--	<10	<10	9.4	<0.1	170
		May-09		<100	<1	1	65	<2	3300	<0.5	210	<1	<1	<1	100	<1	--	51	51	<0.2	100	5.3	<0.1	1.7	3.7	--	<0.5	12	480	<1	--	--	<10	<10	7.9	<0.1	520
		Nov-09		<100	<1	<1	56	<1	2400	<0.5	180	<2	<1	<2	<100	<1	--	42	140	<0.2	63	2.1	<0.1	1.2	2.3	--	<1	7.7	380	<1	--	--	<2	12	7.9	0.14	410
		Feb-10		<100	<1	<1	29	<5	<200	<0.5	72	<10	<10	<2	<100	<5	--	13	26	<0.2	<5	1.4	<0.1	0.9	<1	--	<10	4.1	160	<1	<1	--	<10	<10	9.1	<0.1	46
		May-10		<100	<1	<1	35	<1	<200	<0.5	--	<2	<1	<2	<100	<1	--	15	67	<0.2	<5	1.7	0.1	0.92	<1	--	<1	4.1	170	<1	<1	--	<2	<10	9.1	<0.1	51
		Nov-10		<100	<1	<1	39	<1	<200	<0.5	81	<2	<1	<2	<100	<1	--	10	620	<0.2	2.5	2.7	<0.1	1.1	1.8	--	<1	4.6	160	<1	<1	--	<2	<10	9.8	--	28
		May-11		<100	<1	<1	57	<1	1600	<0.5	160	<2	<1	<2	<100	<1	--	37	<10	<0.2	6.9	47	0.12	0.99	<1	--	<1	6.4	330	<1	<1	--	<2	<10	7.4	--	340
		Nov-11		<100	<1	<1	30	<1	380	<0.5	74	<2	<1	<2	<100	<1	--	14	41	<0.2	<5	1.4	<0.1	0.82	<1	--	<1	4.3	170	<1	<1	--	<2	<10	9.2	--	38
		Nov-11		260	<1	<1	30	<1	<200	<0.5	80	<2	<1	<2	<100	<1	--	15	42	<0.2	6.5	1.5	<0.1	1	<1	--	<1	4.6	180	<1	<1	--	<2	<10	9.3	--	37
		May-12		--	<1	<1	38	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	2.8	--	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		Nov-12		--	<1	<1	31	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	2.6	--	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		May-13		<100	<1	<1	45	<1	960	<0.5	130	<2	<1	<2	<100	<1	--	28	4.6	<0.2	<2	4.4	<0.1	0.84	<1	--	<1	6.1	290	<1	<1	--	<2	<10	7.8	--	240
		Aug-13		--	<2	<2	36.7	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	<0.1	--	<2	--	<2	--	--	<2	<50	--	<2	<25	8.79	<0.1	62.7
		Feb-14		<100	<2	<2	31.3	<2	56.1	<1	81.9	<5	<10	<10	<100	<2	--	9.58	64.4	<0.2	<50	<10	0.15	<1	<10	--	<5	4.68	148	<2	<50	--	<20	<50	8.83	--	33.8
		Aug-14		<100	<2	<2	33.1	<2	106	<1	85.7	<5	<10	<10	<100	<2	--	12.3	79.5	<0.2	<50	<10	0.14	<1	<10	--	<5	4.92	169	<2	<50	--	<20	<50	8.58	--	34.8
		Aug-14		<100	<2	<2	32.5	<2	59.6	<1	83.7	<5	<10	<10	<100	<2	--	12	76.1	<0.2	<50	<10	0.13	<1	<10	--	<5	4.69	164	<2	<50	--	<20	<50	8.62	--	34.5
		Feb-15		--	<2	<2	29.4	<2	--	<1	--	<5	<10	<10	--	<2	--	--	--	<0.2	--	<10	--	--	<10	--	<5	--	--	<2	<50	--	<20	<50	--	--	--
		Aug-15		--	<2	2.85	36.1	<2	--	<1	--	<5	<2	<10	--	<2	--	--	--	<0.2	--	<10	--	--	<10	--	<5	--	--	<2	--	--	7.98	<25	--	<0.1	--
		Feb-16		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-H	H	Dec-88		80	--	<1	40	--	<500	<0.1	100	<1	<1	<10	<10	<1	1200	9.6	57	--	<20	<1	0.08	1	<1	--	--	8.1	--	--	--	--	<10	<10	15	--	23
		Mar-89		<50	--	<1	130	--	<500	<0.1	62	2	2	<10	190	2	120	20	40	--	<20	<1	<0.01	5	<1	--	--	110	--	--	--	--	<10	<10	16	--	27
		Aug-89		100	--	<1	20	--	<500	<0.1	140	<1	<1	<10	420	<1	14	14	780	--	<20	4	<0.01	2.2	<1	--	--	10.3	--	--	--	--	<10	20	6	--	88
		Nov-91		570	--	<1	130	--	980	<0.1	180	2	--	<10	940	1	30	73	150	<0.2	--	3	<0.01	2.3	--	5000	<10	23	2200	--	--	--	--	10	10	--	470
		Feb-92		340	--	<1	140	--	720	<0.1	210	3	--	<10	690	<1	28	86	160	<0.2	--	<1	0.01	2.4	--	8200	<10	25	2300	--	--	--	--	<10	11	--	290
		May-92		150	--	<1	100	--	2600	<0.1	240	4	--	<10	920	<1	61	54	610	<0.2	--	3	<0.01	3	--	7000	<10	54	2600	--	--	--	--	20	11	--	790
		Aug-92		1600	--	<1	100	--	2300	<0.1	250	1	--	<10	2700	2	50	73	500	<0.2	--	<1	<0.01	3.4	--	9700	<10	57	2400	--	--	--	--	20	10	--	615
		Nov-96		150	<1	2	40	<1	2700	0.4	230	4	--	<10	520	2	--	79	250	--	--	<1	--	3.2	<1	--	--	71	2800	--	--	--	--	<10	11	--	600
		Jun-97		<50	<1	<1	50	<1	3400	<0.1	280	5	--	<10	480	<1	--	86	320	--	--	<1	--	2.8	<1	--	--	52	2900	--	--	--	--	<10	11	<0.1	610

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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	-
		Dec-88		780	--	<1	60	--	<500	<0.1	74	2	<1	10	670	6	730	24	<5	--	<20	<1	0.21	0.88	<1	--	--	4.1	--	--	--	--	50	<10	2	--	6
		Mar-89		960	--	<1	60	--	<500	0.2	77	3	2	<10	1000	2	20	26	12	--	<20	4	0.18	1	<1	--	--	3.9	--	--	--	--	<10	<10	4	--	3
		Aug-89		200	--	<1	30	--	<500	<0.1	73	<1	<1	<10	340	<1	12	26	<5	--	<20	1	0.17	0.82	<1	--	--	3.4	--	--	--	--	<10	10	2	--	8
		Nov-91		1300	--	<1	10	--	<500	<0.1	69	2	--	10	1500	1	10	23	61	<0.2	--	1	0.2	0.81	--	5200	<10	3.5	350	--	--	--	--	10	4	--	<1
		Feb-92		2600	--	1	20	--	<500	<0.1	58	2	--	<10	3500	3	<10	20	57	<0.2	--	3	0.15	0.82	--	6300	<10	3.6	<50	--	--	--	--	<10	3	--	10
		May-92		1900	--	1	50	--	<500	<0.1	150	4	--	<10	4400	4	15	50	660	<0.2	--	4	0.16	1.6	--	8600	<10	3.6	760	--	--	--	--	20	3	--	<1
		Aug-92		420	--	<1	50	--	<500	<0.1	63	1	--	<10	370	1	<10	21	6	<0.2	--	<1	0.2	0.88	--	7100	<10	3.9	130	--	--	--	--	20	3	--	3
		Dec-92		7100	<1	2	70	<1	<500	<0.1	75	<1	--	<10	7400	3	<10	21	190	<0.2	--	3	0.14	0.67	<1	--	<10	3.6	130	--	--	--	--	<10	3	--	2
		May-93		1500	<1	<1	60	<1	<500	<0.1	75	<1	--	<10	1400	<1	<10	21	29	<0.2	--	2	0.14	0.8	<1	--	<10	3.5	150	--	--	--	--	<10	3	--	6
		Nov-93		3900	<1	<1	80	<1	530	<0.1	73	2	--	<10	4600	2	<10	21	170	<0.2	--	2	0.09	0.7	<1	--	<10	3.6	80	--	--	--	--	<10	4	--	7
		Nov-93		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Mar-94		--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	<50	--	--	<10	--	--	0.2	--
		May-94		1200	<1	2	60	<1	<500	<0.1	72	<1	<1	<10	1200	1	10	24	17	<0.2	--	--	0.16	0.8	<1	--	<10	3.7	170	<50	--	--	<10	<10	4	<0.1	7
		Aug-94		--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	<2	--	--	<10	--	--	<0.1	--
		Nov-94		2100	1	<1	50	<1	<500	<0.1	67	<1	<1	<10	2200	<1	--	23	32	<0.2	--	<1	0.17	--	<1	--	<10	--	150	<2	--	--	<10	<10	4	<0.1	3
		May-95		3300	1	1	60	<1	<500	<0.1	74	2	<1	<10	3800	1	--	25	45	<0.2	--	2	--	0.8	<1	--	<10	4	150	<2	--	--	<10	<10	4	<0.1	10
		Nov-95		2200	<1	<1	130	<1	<500	<0.1	82	1	<1	<10	3200	2	--	22	23	<0.2	--	2	--	0.7	<1	--	<10	3.8	190	<2	--	--	<10	10	5	<0.1	19
		Nov-95		1700	<1	<1	60	<1	<500	<0.1	72	3	<1	<10	2300	2	--	21	13	<0.2	--	3	--	0.6	<1	--	<10	3.7	190	<2	--	--	<10	<10	4	<0.1	4
BRF-I	I	Jun-96		13000	<1	<1	110	<1	<500	<0.1	71	2	3	20	13000	6	--	24	190	<0.2	--	7	--	0.8	<1	--	<10	3.5	150	<2	--	--	10	20	4	0.2	3
		Nov-96		9200	<1	2	80	<1	<500	<0.1	72	5	2	<10	8000	9	--	24	96	<0.2	--	3	--	1.2	<1	--	<10	3.6	140	<2	--	--	<10	10	4	<0.1	4
		Nov-96		310	<1	<1	40	<1	<500	<0.1	70	2	<1	<10	230	2	--	23	<5	<0.2	--	<1	--	0.7	1	--	<10	3.6	110	<2	--	--	<10	<10	4	<0.1	4
		Jun-97		920	<1	<1	50	<1	<500	<0.1	69	<1	<1	<10	940	<1	--	23	<5	<0.2	--	<1	--	0.9	<1	--	<10	3.8	140	<2	--	--	<10	<10	4	<0.1	3
		Jun-97		950	<1	<1	50	<1	<500	<0.1	71	<1	<1	<10	1000	<1	--	24	5	<0.2	--	<1	--	0.9	<1	--	<10	3.8	150	<2	--	--	<10	<10	4	<0.1	3
		Jun-97		2100	<1	<1	60	<1	<500	<0.1	71	3	1	<10	2300	<1	--	24	44	<0.2	--	<1	--	0.9	<1	--	<10	3.7	160	<2	--	--	<10	70	5	<0.1	3
		Oct-97		12000	<1	4	130	1	<500	<0.1	74	9	2	10	15000	7	--	25	520	<0.2	--	11	--	1	<1	--	<10	3.7	150	<2	--	--	<10	20	4	<0.1	12
		Oct-97		100	<1	<1	50	<1	<500	<0.1	69	1	<1	<10	80	<1	--	23	<5	<0.2	--	2	--	0.9	<1	--	<10	3.8	140	<2	--	--	<10	<10	4	<0.1	12
		May-98		2900	<1	<1	60	<1	<200	<0.1	66	3	<1	<10	2700	<1	--	22	48	<0.2	--	4	--	0.8	<1	--	<10	3.6	90	<2	--	--	<10	<10	4	<0.1	2
		May-98		70	<1	<1	50	<1	<200	<0.1	65	<1	<1	<10	80	<1	--	22	<5	<0.2	--	4	--	0.8	<1	--	<10	3.7	110	<2	--	--	<10	<10	4	<0.1	2
		Nov-98		70	<1	<1	50	<1	<200	<0.1	62	3	<1	<10	70	<1	--	22	<5	<0.2	--	1	--	0.8	<1	--	<10	3.9	150	<1	--	--	<10	<10	5	<0.1	<1
		Nov-98		380	<1	<1	60	<1	<200	0.2	65	1	<1	<10	400	<1	--	22	<5	<0.2	--	<1	--	0.8	<1	--	<10	3.9	160	<1	--	--	<10	<10	5	<0.1	<1
		Nov-98		370	<1	<1	50	<1	<200	0.2	66	1	<1	<10	360	4	--	22	<5	<0.2	--	<1	--	0.8	<1	--	<10	3.9	150	<1	--	--	<10	<10	5	<0.1	<1
		May-99		130	<1	<1	50	**9**	<200	<0.1	67	<1	<1	<10	90	<1	--	23	<5	<0.2	--	<1	--	0.9	<1	--	<10	3.9	90	<2	--	--	<10	<10	5	<0.1	3
		May-99		<50	<1	<1	50	<1	<200	<0.1	66	<1	<1	<10	20	<1	--	24	<5	<0.2	--	<1	--	1	<1	--	<10	3.9	<50	<2	--	--	<10	<10	5	<0.1	3
		Nov-99		300	<1	3	60	<1	<200	<0.1	66	<1	<1	<10	190	<1	--	23	<5	<0.2	--	<1	--	0.8	<1	--	<10	4	170	<2	--	--	<10	10	--	--	--
		Jun-00		1100	<1	<1	61	<1	<200	<0.1	66	1.3	<1	<10	590	<1	--	23	10	<0.2	<20	<1	--	0.87	<1	8300	<10	3.8	170	<2	<50	23	<10	16	5.3	0.1	5
		Nov-00		2200	3.9	<1	59	<1	<200	<0.1	64	<1	<1	<10	1300	<1	--	22	19	<0.2	<20	<1	--	0.96	<1	--	<10	3.7	160	<2	<50	38	<10	<10	5.5	<0.1	8
		May-01		980	<1	<1	56	<1	<200	<0.1	68	<1	<1	10	740	<1	--	23	10	<0.2	<20	<1	--	0.96	<1	9100	<10	3.7	170	<2	<50	11	<10	10	6	<0.1	4.8

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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	-
BRF-I (cont)	I	May-01		1100	<1	<1	60	<1	<200	<0.1	72	<1	<1	<10	750	<1	--	25	10	<0.2	<20	<1	--	1	<1	8600	<10	3.6	180	<2	<50	15	<10	10	5.9	0.1	4.4
		Nov-01		3500	<1	<1	71	<1	<200	<0.1	71	<1	1.2	<10	2400	<1	--	24	48	<0.1	<20	<1	0.22	0.71	<1	--	<10	3.3	170	<2	<50	56	<10	65	6.5	0.1	7
		May-02		1100	<1	<1	61	<1	<200	<0.1	72	<1	<1	<10	710	2	--	25	9.7	<0.1	<20	<1	0.16	0.71	<1	--	<10	3.2	180	<2	<50	18	<10	14	7.1	<0.1	3
		Nov-02		4500	<1	2	70	<1	<200	<0.1	68	5	<1	10	2800	<1	--	23	34	<0.1	<20	2.3	0.16	1.5	<1	--	<10	3.4	160	<2	<50	39	<10	<10	6.5	0.1	3
		Nov-02		4300	<1	3	70	<1	<200	0.13	70	4	<1	<10	2900	<1	--	23	37	<0.1	<20	2.1	0.15	1.6	<1	--	<10	3.5	170	<2	<50	43	<10	<10	6.5	0.1	3
		May-03		1000	<1	<1	70	<1	<200	<0.1	72	<1	<1	<10	630	<1	--	24	10	<0.1	<20	<1	0.17	1	<1	7300	<10	4.1	170	<2	610	14	<10	<10	7.9	0.1	5.2
		Nov-03		1200	<0.6	<0.1	60	<1	<200	<0.05	71	<0.1	0.2	<10	670	<0.1	--	23	7	<0.1	<20	2.2	0.16	<0.1	0.2	8400	<10	3.5	180	<0.1	<50	18	<10	<10	8.8	<0.1	3.4
		Nov-03		1200	<0.6	<0.1	50	<1	<200	0.9	71	<0.1	0.2	<10	670	<0.1	--	22	7	<0.1	<20	2.2	0.16	<0.1	<0.2	0	<10	3.5	180	<0.1	<50	24	<10	<10	8.8	<0.1	3.2
		May-04		1400	<0.6	<0.1	60	<1	<200	<0.05	69	1.6	0.3	<10	740	0.3	--	22	11	<0.1	<20	2.2	0.18	1.5	0.1	--	<10	3.8	170	<0.1	--	--	<10	<10	9.1	<0.1	4.1
		Nov-04		3100	<3	1	70	<1	<200	<0.1	73	2	<1	<10	1600	<1	--	23	23	<0.1	<20	<1	0.16	1.9	<1	--	<10	2.4	170	<2	<50	63	<10	<10	10	<0.1	7
		Nov-04		2400	<3	<1	70	<1	200	<0.1	75	1	<1	<10	1500	<1	--	24	21	<0.1	<20	<1	0.16	1.9	<1	--	<10	2.2	170	<2	<50	26	<10	<10	10	<0.1	6
		May-05		1000	<3	<1	60	<1	200	<0.1	67	<1	1	<10	630	<1	--	21	10	<0.1	<20	<1	0.15	1.5	<1	--	<10	5.3	160	<2	--	--	<10	<10	10	0.1	2
		Nov-05		2200	<3	<1	60	<1	<200	<0.1	69	<1	<1	<10	1600	<1	--	22	19	<0.1	<20	5	0.15	2.4	<1	--	<10	<0.1	150	<2	--	--	<10	<10	11	0.1	2.9
		May-06		1800	<3	<1	70	<1	<200	<0.1	73	1	<1	<10	920	<1	--	24	13	<0.1	<20	<1	0.16	1.5	<1	--	<10	4.2	180	<2	--	--	<10	<10	13	0.1	2.4
		May-06		1900	<3	<1	70	<1	<200	<0.1	76	1	<1	<10	920	<1	--	25	13	<0.1	<20	<1	0.16	1.4	<1	--	<10	4.2	180	<2	--	--	<10	<10	12	0.1	2.4
		Nov-06		1400	<3	<1	70	<1	<200	<0.1	71	<1	<1	<10	870	<1	--	23	13	<0.1	<20	<1	0.15	1.6	<1	--	<10	1.2	180	<2	--	--	<10	10	13	<0.1	2.3
		Feb-07		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-07		210	<1	<1	60	<1	<200	<0.5	70	<1	<1	<1	100	<1	--	22	<10	<0.2	<5	2.2	--	0.92	1	--	0.51	3.9	170	<1	--	--	<10	<10	10	<0.1	<5
		Nov-07		1100	<1	<1	65	<2	<200	<0.5	73	1.4	<1	1.3	630	<1	--	23	<10	<0.2	<5	1.8	<0.1	1.2	<1	--	<0.5	4.1	180	<1	--	--	<10	<10	13	0.15	<5
		May-08		1400	<1	<1	64	<1	<200	<0.5	71	1	<1	1.7	660	<1	--	24	<10	<0.2	<5	2.5	0.16	1.1	<1	--	<0.5	5.7	180	<1	--	--	<10	<10	12	<0.1	<5
		May-08		1300	<1	<1	63	<1	<200	<0.5	71	<1	<1	1.6	620	<1	--	24	<10	<0.2	<5	2.4	0.16	1.1	<1	--	<0.5	4.7	170	<1	--	--	<10	10	12	<0.1	<5
		Nov-08		1100	<1	<1	64	<1	<200	<0.5	69	1.4	<1	1.2	600	<1	--	23	<10	<0.2	<5	2.5	0.12	1.1	<1	--	<0.5	3.8	170	<1	--	--	<10	<10	16	<0.1	<5
		May-09		2000	<1	<1	66	<2	<200	<0.5	72	<1	<1	<1	960	<1	--	26	14	<0.2	<5	2.1	<0.1	1.7	<1	--	<0.5	4.6	180	<1	--	--	<10	49	15	<0.1	<5
		May-09		1600	<1	<1	64	<2	<200	<0.5	72	<1	<1	<1	800	<1	--	25	10	<0.2	<5	2.2	<0.1	1.5	1.1	--	<0.5	4.4	180	<1	--	--	<10	<10	15	<0.1	<5
		Nov-09		2500	<1	<1	69	<1	<200	<0.5	73	2	<1	<2	1600	<1	--	24	27	<0.2	<2	1.7	0.16	1.4	<1	--	<1	4.1	170	<1	--	--	2.9	36	15	0.12	<5
		Feb-10		650	<1	<1	63	<1	<200	<0.5	71	<10	<10	<2	410	<5	--	24	<10	<0.2	<5	1.2	0.15	0.91	<1	--	<10	4	180	<1	<1	--	<10	<10	17	<0.1	<5
		May-10		170	<1	<1	67	<1	<200	<0.5	--	<2	<1	<2	200	<1	--	25	<10	<0.2	<5	1.4	<0.1	0.87	<1	--	<1	3.9	180	<1	<1	--	<2	<10	17	<0.1	<5
		May-10		160	<1	<1	67	<1	<200	<0.5	--	<2	<1	<2	180	<1	--	25	<10	<0.2	<5	1.4	0.13	0.83	<1	--	<1	4	180	<1	<1	--	<2	<10	17	<0.1	<5
		Nov-10		--	<1	<1	59	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	1.8	--	--	1.2	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		Nov-10		<100	--	--	--	--	<200	--	71	--	--	--	<100	--	--	25	<10	--	<2	--	0.21	1	--	--	--	4.4	190	--	--	--	--	--	16	--	<5
		May-11		<100	--	--	--	--	<200	--	78	--	--	--	<100	--	--	26	<10	--	<5	--	0.25	0.78	--	--	--	4.3	180	--	--	--	--	--	19	--	<5
		May-11		--	<1	<1	61	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	1.2	--	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		Nov-11		<100	<1	<1	65	<1	<200	<0.5	74	<2	<1	<2	<100	<1	--	25	<10	<0.2	<5	1.1	0.22	0.91	<1	--	<1	4.1	190	<1	<1	--	<2	<10	20	--	<5
		May-12		--	<1	<1	66	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	2	--	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		Nov-12		--	<1	<1	67	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	2.4	--	--	<1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		May-13		940	<1	<1	67	<1	<200	<0.5	78	<2	<1	<2	600	<1	--	25	11	<0.2	<2	2.5	0.38	0.95	<1	--	<1	4.4	200	<1	<1	--	<2	<10	21	--	<5
		Aug-13		--	<2	<2	69.4	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	0.23	--	<2	--	<2	--	--	<2	<50	--	<2	<25	20.7	<0.1	4.37

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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	-
BRF-I (cont)	I	Aug-13		--	<2	<2	69.3	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	0.21	--	<2	--	<2	--	--	<2	<50	--	<2	<25	20.8	<0.1	4.34
		Feb-14		<100	<2	<2	70.3	<2	<50	<1	85.2	<5	<10	<10	<100	<2	--	26.6	<15	<0.2	<50	<10	0.22	<1	<10	--	<5	4.48	197	<2	<50	--	<20	<50	20.9	--	4.24
		Aug-14		<100	<2	<2	70.9	<2	<50	<1	79.8	<5	<10	<10	<100	<2	--	26.3	<15	<0.2	<50	<10	0.24	<1	<10	--	<5	4.47	196	<2	<50	--	<20	<50	20.7	--	4.22
		Feb-15		--	<2	<2	66.2	<2	--	<1	--	<5	<10	<10	--	<2	--	--	--	<0.2	--	<10	--	--	<10	--	<5	--	--	<2	<50	--	<20	<50	--	--	--
		Aug-15		--	<2	2.47	70.8	<2	--	<1	--	<5	<2	<10	--	<2	--	--	--	<0.2	--	<10	--	--	<10	--	<5	--	--	<2	--	--	8.54	<25	--	<0.1	--
		Feb-16		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-J	J	Nov-91		1600	--	<1	50	--	<500	0.1	90	3	--	<10	1700	2	<10	21	82	<0.2	--	4	0.02	1.8	--	5100	<10	3.9	410	--	--	--	--	10	4	--	61
		Feb-92		900	--	<1	80	--	<500	<0.1	94	<1	--	<10	1100	5	<10	21	64	<0.2	--	4	0.05	1.6	--	7300	<10	4	310	--	--	--	--	<10	3	--	70
		May-92		200	--	<1	70	--	<500	<0.1	100	<1	--	<10	670	<1	10	21	38	<0.2	--	1	<0.01	1.2	--	6100	<10	4.1	330	--	--	--	--	<10	3	--	120
		May-92		110	--	<1	70	--	<500	<0.1	100	2	--	<10	960	<1	<10	21	38	<0.2	--	2	<0.01	1.1	--	6000	<10	3.8	330	--	--	--	--	20	3	--	92
		Aug-92		140	--	<1	80	--	<500	<0.1	100	<1	--	<10	230	1	<10	21	31	<0.2	--	2	0.01	1	--	6100	<10	4.5	340	--	--	--	--	<10	3	--	110
		Nov-92		60	<1	1	80	<1	<500	<0.1	110	<1	--	60	70	<1	<10	22	33	<0.2	<20	<1	<0.01	0.9	<1	--	<10	4.2	350	<50	--	--	--	<10	3	--	130
		Nov-92		70	<1	1	80	<1	<500	<0.1	110	<1	--	<10	70	<1	<10	21	32	<0.2	<20	<1	<0.01	0.96	<1	--	<10	4.2	330	<50	--	--	--	<10	3	--	130
		Feb-93		160	<1	1	80	<1	<500	<0.1	140	<1	--	<10	300	2	<10	25	53	<0.2	--	<1	<0.01	0.9	<1	--	<10	4.4	370	<50	<50	--	--	<10	3	--	140
		May-93		140	<1	<1	80	<1	<500	<0.1	130	<1	--	<10	80	<1	<10	23	20	<0.2	--	1	<0.01	1.1	<1	--	<10	4.3	360	--	--	--	--	<10	3	--	170
		Aug-93		140	<1	<1	100	<1	<500	<0.1	130	1	--	<10	40	<1	<10	27	--	0.2	--	<1	<0.01	1.1	<1	--	<10	4.3	360	--	--	--	--	<10	3	--	160
		Aug-93		120	<1	<1	90	<1	<500	<0.1	130	1	--	<10	34	<1	<10	26	--	0.2	--	<1	<0.01	1.1	<1	--	<10	4.2	370	--	--	--	--	<10	3	--	160
		Aug-93		920	<1	<1	90	<1	<500	<0.1	120	<1	--	<10	990	2	<10	26	57	<0.2	--	2	<0.01	1.4	<1	--	<10	4.2	390	--	--	--	--	20	3	--	130
		Aug-93		830	<1	<1	100	<1	<500	<0.1	120	<1	--	<10	820	1	<10	25	63	<0.2	--	1	<0.01	1.3	<1	--	<10	4.2	380	--	--	--	--	<10	3	--	130
		Nov-93		<50	<1	<1	80	<1	<500	<0.1	120	<1	--	<10	<10	<1	<10	24	37	<0.2	--	<1	<0.01	1	<1	--	<10	4.2	440	--	--	--	--	<10	3	--	160
		Mar-94		--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	<50	--	--	<10	--	--	0.2	--
		May-94		<50	<1	1	90	<1	<500	0.1	130	<1	<1	<10	30	1	<10	24	44	<0.2	--	--	<0.01	1.1	<1	--	<10	4.3	340	<50	--	--	<10	<10	3	<0.1	150
		Aug-94		--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	<2	--	--	<10	--	--	<0.1	--
		Nov-94		<50	1	<1	70	<1	<500	<0.1	120	<1	<1	<10	190	<1	--	22	44	<0.2	<20	<1	<0.01	--	<1	--	<10	--	320	<2	--	--	<10	<10	3	0.1	110
		May-95		60	1	<1	80	<1	<500	<0.1	120	<1	<1	<10	60	<1	--	23	51	<0.2	--	<1	--	0.9	<1	--	<10	4	390	<2	--	--	<10	<10	4	<0.1	120
		May-95		<50	2	<1	70	<1	<500	<0.1	120	<1	<1	<10	60	<1	--	23	49	<0.2	--	<1	--	0.9	<1	--	<10	4	370	<2	--	--	<10	<10	4	<0.1	120
		Nov-95		<50	<1	<1	60	<1	<500	<0.1	110	<1	<1	<10	<10	<1	--	21	34	<0.2	--	1	--	0.9	<1	--	<10	4.3	350	<2	--	--	<10	<10	6	<0.1	130
		Jun-96		50	<1	<1	70	<1	<500	<0.1	110	<1	<1	<10	60	1	--	21	51	<0.2	--	2	--	0.9	<1	--	<10	4.3	320	<2	--	--	<10	<10	6	0.2	110
		Nov-96		<50	1	<1	80	<1	<500	<0.1	120	<1	<1	<10	40	<1	--	20	58	<0.2	--	<1	--	1.3	<1	--	<10	3.6	280	<2	--	--	<10	<10	5	<0.1	100
		Jun-97		90	<1	<1	70	<1	<500	<0.1	110	<1	<1	<10	60	<1	--	21	51	<0.2	--	<1	--	0.9	<1	--	<10	4.3	320	<2	--	--	<10	<10	5	<0.1	84
		Oct-97		120	<1	<1	60	<1	<500	<0.1	110	<1	<1	<10	50	<1	--	20	58	<0.2	--	<1	--	1	<1	--	<10	4.4	330	<2	--	--	<10	<10	6	0.1	89
		May-98		<50	<1	<1	60	<1	500	<0.1	100	<1	<1	<10	50	2	--	18	50	<0.2	--	2	--	0.9	<1	--	<10	4.3	240	<2	--	--	<10	<10	4	0.1	96
		Nov-98		<50	<1	<1	80	<1	400	<0.1	110	<1	<1	<10	60	<1	--	20	67	<0.2	--	<1	--	1.1	<1	--	<10	4.6	330	<1	--	--	<10	<10	5	<0.1	87
		May-99		<50	<1	<1	70	<1	600	<0.1	100	<1	<1	<10	20	<1	--	20	41	<0.2	--	<1	--	1.1	<1	--	<10	4.7	290	<2	--	--	<10	<10	4	<0.1	120
		May-99		<50	<1	<1	70	**10**	500	<0.1	100	<1	<1	<10	20	<1	--	20	37	<0.2	--	<1	--	1.1	<1	--	<10	4.6	240	<2	--	--	<10	<10	4	<0.1	120
		Nov-99		<50	<1	<1	80	<1	570	<0.1	100	<1	<1	<10	20	<1	--	20	94	<0.2	--	<1	--	0.9	<1	--	<10	4.7	330	<2	--	--	<10	10	--	--	--
		Jun-00		<50	<1	<1	85	<1	530	<0.1	100	<1	<1	<10	20	<1	--	21	82	<0.2	<20	<1	--	0.92	<1	5900	<10	4.6	340	<2	<50	<5	<10	11	3.5	0.1	110

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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	-
BRF-J (cont)	J	Nov-00		<50	1.7	<1	81	<1	590	<0.1	110	2.3	<1	<10	81	<1	--	21	96	<0.2	<20	<1	--	0.99	<1	--	<10	4.5	350	<2	<50	<5	<10	<10	3.7	0.11	120
		Nov-00		<50	2.4	<1	80	<1	550	<0.1	110	<1	<1	<10	67	<1	--	20	96	<0.2	<20	3	--	1	<1	--	<10	4.6	350	<2	<50	<5	<10	<10	3.6	0.1	130
		May-01		<50	<1	<1	70	<1	500	<0.1	93	2	<1	<10	120	<1	--	18	50	<0.2	<20	<1	--	0.13	<1	5000	<10	4.3	290	<2	<50	5.3	<10	<10	3.5	0.12	140
		Nov-01		<50	<1	<1	91	<1	590	<0.1	120	<1	<1	<10	54	<1	--	22	100	<0.1	<20	<1	<0.01	0.88	<1	--	<10	4.1	370	<2	<50	7.1	<10	<10	3.4	0.11	130
		May-02		<50	<1	<1	91	<1	550	<0.1	120	<1	<1	<10	39	2	--	23	84	<0.1	<20	<1	<0.01	0.84	<1	--	<10	4.1	390	<2	<50	6.8	<10	13	3	0.1	160
		May-02		<50	<1	<1	92	<1	550	<0.1	120	<1	<1	<10	48	2	--	23	84	<0.1	<20	<1	<0.01	0.81	<1	--	<10	4.2	390	<2	<50	7.1	<10	18	3.1	0.1	160
		Nov-02		2400	<1	<1	90	<1	800	<0.1	130	<1	<1	<10	130	<1	--	23	72	<0.1	<20	<1	<0.01	1.2	<1	--	<10	5.6	410	<2	<50	<5	<10	<10	3.1	0.11	150
		May-03		<50	<1	<1	90	<1	600	<0.1	120	<1	<1	<10	<10	<1	--	22	57	<0.1	<20	<1	<0.01	1	<1	6000	<10	5.4	360	<2	780	<5	<10	<10	2.8	0.11	140
		May-03		<50	<1	<1	90	<1	600	<0.1	120	<1	<1	<10	<10	<1	--	22	56	<0.1	<20	<1	<0.01	1.1	<1	5800	<10	5.5	360	<2	780	<5	<10	<10	2.8	0.11	140
		Nov-03		<50	<0.6	<0.1	80	<1	600	<0.05	130	<0.1	0.2	<10	20	<0.1	--	22	78	<0.1	<20	3.8	<0.01	<0.1	0.4	5900	<10	4.8	390	<0.1	<50	<5	<10	<10	3.4	<0.1	190
		May-04		<50	<0.6	<0.1	100	<1	500	<0.05	140	<0.1	0.2	<10	<10	0.9	--	23	72	<0.1	<20	3.9	0.01	1.6	0.3	--	<10	5	400	<0.1	--	--	<10	<10	3.4	<0.1	200
		May-04		<50	<0.6	<0.1	100	<1	500	<0.05	130	3.9	0.2	<10	<10	0.2	--	23	71	<0.1	<20	4	0.01	1.4	0.3	--	<10	4.5	390	<0.1	--	--	<10	<10	3.2	<0.1	200
		Nov-04		<50	<3	1	100	<1	800	<0.1	140	<1	<1	<10	10	<1	--	23	86	<0.1	<20	<1	<0.01	1.3	<1	--	<10	3.3	380	<2	<50	<5	<10	<10	3	<0.1	270
		May-05		<50	<3	<1	90	<1	700	<0.1	130	<1	1	<10	<10	<1	--	22	61	<0.1	<20	<1	<0.01	1.5	<1	--	<10	7	370	<2	--	--	<10	<10	2.8	0.11	232
		May-05		<50	<3	<1	90	<1	700	<0.1	130	<1	<1	<10	30	<1	--	23	66	<0.1	<20	<1	<0.01	2	<1	--	--	6.9	370	<2	--	--	<10	<10	2.8	0.11	231
		Nov-05		90	<3	<1	100	<1	800	<0.1	150	<1	<1	<10	60	<1	--	23	110	<0.1	<20	<1	<0.01	2.6	<1	--	<10	1.6	410	<2	--	--	<10	<10	3.3	0.11	230
		Nov-05		50	<3	<1	100	<1	800	<0.1	150	<1	<1	<10	50	<1	--	23	110	<0.1	<20	<1	<0.01	2.5	<1	--	<10	1.6	400	<2	--	--	<10	<10	3.2	0.11	230
		May-06		<200	<3	<1	120	<1	930	<0.1	160	<1	<1	<10	<30	<1	--	26	91	<0.1	<20	<1	0.03	1.3	<1	--	<10	5.3	420	<2	--	--	<10	<10	3	0.1	271
		Nov-06		<200	<3	<1	110	<1	800	<0.1	150	<1	<1	<10	<30	<1	--	26	99	<0.1	<20	<1	0.01	1.8	1	--	<10	3.4	430	<2	--	--	<10	<10	4	<0.1	270
		Nov-06		<200	<3	<1	110	<1	800	<0.1	160	<1	<1	<10	<30	<1	--	26	100	<0.1	<20	<1	0.02	1.7	1	--	<10	3.3	440	<2	--	--	<10	<10	3.8	<0.1	270
		Feb-07		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-07		<100	<1	1.6	110	<1	830	<0.5	160	<1	<1	1.6	<100	<1	--	26	89	<0.2	<5	2.9	<0.1	1	7.2	--	<0.5	6.2	450	<1	--	--	<10	<10	3.6	0.14	260
		May-07		<100	<1	<1	110	<1	830	<0.5	160	<1	<1	1.6	<100	<1	--	27	90	<0.2	<5	2.7	<0.1	1.2	4.8	--	0.53	6.2	440	<1	--	--	<10	<10	3	<0.1	280
		Nov-07		<100	<1	<1	110	<2	840	<0.5	170	<1	<1	<1	<100	<1	--	27	120	<0.2	<5	2.9	<0.1	1	<1	--	<0.5	6.1	450	<1	--	--	<10	12	3.8	0.12	320
		Nov-07		<100	<1	<1	110	<2	860	<0.5	170	<1	<1	<1	<100	<1	--	27	120	<0.2	<5	2.5	<0.1	1.2	<1	--	<0.5	6.2	450	<1	--	--	<10	<10	3.6	<0.1	280
		May-08		<100	<1	<1	100	<1	1000	<0.5	170	<1	<1	1.6	<100	<1	--	27	87	<0.2	<5	4.9	<0.1	1.1	<1	--	<0.5	7.5	470	<1	--	--	<10	<10	3.8	<0.1	310
		Nov-08		<100	<1	<1	94	<1	1100	<0.5	170	<1	<1	1.7	<100	<1	--	27	140	<0.2	<5	4.6	<0.1	1.2	<1	--	<0.5	6.5	460	<1	--	--	<10	<10	4.7	<0.1	300
		Nov-08		<100	<1	<1	94	<1	1000	<0.5	170	<1	<1	<1	<100	<1	--	27	140	<0.2	<5	4.5	<0.1	1.2	<1	--	<0.5	6.7	460	<1	--	--	<10	15	4.5	<0.1	300
		May-09		110	<1	<1	94	<2	1200	<0.5	190	<1	<1	<1	<100	<1	--	31	100	<0.2	<5	4.6	<0.1	1.2	<1	--	<0.5	7.7	490	<1	--	--	<10	<10	5.2	<0.1	390
		Nov-09		<100	<1	<1	87	<1	1300	<0.5	200	<2	<1	<2	<100	<1	--	32	110	<0.2	<2	1.8	<0.1	1.1	<1	--	<1	8.4	510	<1	--	--	<2	<10	5.9	0.13	440
		Feb-10		810	<1	<1	120	<1	700	<0.5	140	<10	<10	<2	440	<5	--	34	22	<0.2	<5	3	<0.1	1.5	1.4	--	<10	6.4	360	<1	<1	--	<10	<10	4.6	0.1	290
		Mar-10		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-10		<100	<1	<1	68	<1	1200	<0.5	--	<2	<1	<2	<100	<1	--	39	<10	<0.2	<5	3.8	<0.1	1.2	<1	--	1.5	7.8	420	<1	<1	--	<2	<10	5.2	<0.1	420
		Nov-10		<100	<1	<1	61	<1	1100	<0.5	180	<2	<1	<2	<100	<1	--	40	41	<0.2	<2	5.1	<0.1	1.2	5.6	--	<1	7.5	390	<1	<1	--	<2	<10	5.2	--	430
		May-11		<100	<1	<1	55	<1	1200	<0.5	180	<2	<1	<2	<100	<1	--	41	<10	<0.2	5.5	3	0.13	1.3	5.2	--	<1	8.1	400	<1	<1	--	<2	<10	5.5	--	400
		May-11		<100	<1	<1	54	<1	1100	<0.5	170	<2	<1	<2	<100	<1	--	40	<10	<0.2	<5	3.1	0.14	1.1	4.9	--	<1	9.1	400	<1	<1	--	<2	<10	5.7	--	410
		Nov-11		<100	<1	<1	50	<1	1600	<0.5	190	<2	<1	<2	<100	<1	--	42	50	<0.2	5.6	3.4	<0.1	1.3	5.9	--	<1	9.4	420	<1	<1	--	<2	<10	6.3	--	460

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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**	**-**
BRF-J (cont)	J	May-12		--	<1	<1	48	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	5.6	--	--	8.1	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		May-12		--	<1	<1	50	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	5.3	--	--	7.9	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		Nov-12		--	<1	<1	43	<1	--	<0.5	--	<2	<1	<2	--	<1	--	--	--	<0.2	--	6	--	--	5	--	<1	--	--	<1	<1	--	<2	<10	--	--	--
		May-13		<100	<1	<1	50	<1	920	<0.5	150	<2	<1	<2	<100	<1	--	37	<2	<0.2	<2	4.4	<0.1	1.1	2.9	--	<1	7.4	370	<1	<1	--	<2	<10	5	--	320
		May-13		<100	<1	<1	53	<1	940	<0.5	150	<2	<1	<2	<100	<1	--	38	<2	<0.2	<2	4.3	<0.1	1.3	2.6	--	<1	7.5	370	<1	<1	--	<2	<10	4.9	--	330
		Aug-13		--	<2	<2	52	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	<0.1	--	2.68	--	<2	--	--	<2	<50	--	<2	<25	5.03	<0.1	403
		Feb-14		<100	<2	<2	50.4	<2	2010	<1	244	<5	<10	<10	<100	<2	--	36.5	141	<0.2	<50	<10	<0.1	1.37	<10	--	<5	11.4	501	<2	<50	--	<20	<50	5.71	--	475
		Aug-14		<100	<2	2.95	46.1	<2	1630	<1	201	<5	<10	<10	<100	<2	--	41	<15	<0.2	<50	<10	<0.1	1.71	<10	--	<5	10.2	426	<2	<50	--	<20	<50	5.34	--	397
		Feb-15		--	<2	<2	52.5	<2	--	<1	--	<2	<2	<10	--	<2	--	--	--	<0.2	--	<2	--	--	<2	--	<5	--	--	<2	<2	--	<2	<25	--	--	--
		Aug-15		--	<2	3.91	48.7	<2	--	<5	--	<5	<2	<10	--	<2	--	--	--	<0.2	--	<10	--	--	<10	--	<5	--	--	<2	--	--	7.81	<25	--	<0.1	--
		Aug-15		--	<2	3.9	47.9	<2	--	<5	--	<5	<2	<10	--	<2	--	--	--	<0.2	--	<10	--	--	<10	--	<5	--	--	<2	--	--	8.5	<25	--	<0.1	--
		Feb-16		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-K	K	Nov-90		4000	--	<1	130	--	<500	0.2	140	2	13	<10	6400	8	20	25	1300	--	<20	7	0.01	2.8	1	--	--	6.3	730	--	--	--	<10	120	3	--	160
		Feb-91		2600	--	<1	110	--	<500	<0.1	140	2	<1	10	5200	4	10	24	1800	--	<20	2	0.02	2.6	<1	--	--	5.5	570	--	--	--	<10	<10	4	--	220
		May-91		1600	--	<1	120	--	<500	<0.1	130	1	1	<10	4700	2	<10	22	1600	--	<20	<1	0.03	1.8	<1	--	--	5.1	530	--	--	--	<10	<10	4	--	180
		Aug-91		2900	--	1	100	--	<500	<0.1	150	2	3	<10	5700	5	10	23	1900	--	<20	6	<0.01	3.4	<1	8500	--	5.3	620	--	--	--	<10	10	11	--	190
		Nov-91		3000	--	**23**	100	--	<500	<0.1	140	4	--	<10	4300	3	--	23	2000	--	--	2	--	1.6	--	3200	--	5.2	710	--	--	--	--	10	4	--	180
BRF-L	L	May-91		60	--	<1	140	--	<500	0.5	100	<1	3	<10	270	1	10	42	48	--	<20	<1	0.03	3.8	3	--	--	7.1	2000	--	--	--	<10	<10	26	--	82
		Aug-91		<50	--	<1	140	--	<500	<0.1	91	<1	<1	<10	270	2	10	47	<5	--	<20	2	0.03	3.8	<1	9000	--	6.2	2000	--	--	--	<10	20	27	--	85
		Nov-91		<50	--	<1	90	--	<500	<0.1	95	1	--	<10	270	<1	--	46	23	--	--	<1	--	3.3	--	5400	--	6	1900	--	--	--	--	<10	26	--	95
BRF-M	M	Nov-89		1500	--	1	170	<1	<500	<0.1	61	6	2	<10	460	2	17	42	7	--	<20	21	--	4.7	<1	--	--	9.9	2300	--	--	--	<10	80	11	--	60
		Mar-90		1600	--	<1	140	<1	<500	0.1	71	<1	<1	<10	180	8	20	44	46	--	<20	12	--	3.8	<1	--	--	7.4	2400	--	--	--	10	130	12	--	78
		May-90		50	--	2	180	<1	<500	**26**	62	14	<1	<10	260	9	20	38	<5	--	<20	66	--	6.3	<1	--	--	8.8	2500	--	--	--	<10	30	2	--	57
		Aug-90		50	--	1	170	<1	<500	**6**	72	1	<1	40	330	6	20	41	5	--	<20	12	--	4.5	<1	--	--	9.3	2400	--	--	--	<10	50	10	--	70
		Nov-90		<50	--	<1	160	--	<500	0.1	71	1	8	<10	150	6	20	42	<5	--	<20	7	0.4	4.6	<1	--	--	8.5	2300	--	--	--	<10	10	21	--	72
		Feb-91		170	--	<1	100	--	<500	0.2	68	<1	<1	<10	410	8	20	39	23	--	<20	18	0.35	3.9	<1	9200	--	7.7	1800	--	--	--	<10	10	13	--	78
		May-91		240	--	<1	150	--	<500	0.4	65	<1	2	<10	490	4	20	39	25	--	<20	<1	0.47	4.7	<1	--	--	8.7	2400	--	--	--	<10	<10	10	--	65
BRF-MW-3H	MW-3H/P-3	May-13		<100	<1	<1	160	<1	590	<0.5	31	<2	<1	<2	<100	<1	--	24	3.3	<0.2	<2	<1	<0.1	5.8	<1	--	<1	83	1900	<1	<1	--	<2	10	11	--	56
		Aug-13		--	<2	<2	181	<2	--	<1	--	<2	<2	<2	--	<2	--	--	--	<0.2	--	<2	<0.1	--	<2	--	<2	--	--	<2	<50	--	<2	<25	10.8	0.51	57.1
		Feb-14		<100	<2	<2	184	<2	614	<1	33.1	<5	<10	<10	<100	<2	--	24.7	<15	<0.2	<50	<10	0.29	5.77	<10	--	<5	79.6	1920	<2	<50	--	<20	<50	10.7	--	55.9
		Aug-14		<100	<2	<2	194	<2	654	<1	33.6	<5	<10	<10	<100	<2	--	26	<15	<0.2	<50	<10	<0.1	6.09	<10	--	<5	87.9	2040	<2	<50	--	<20	<50	10.6	--	55.8
		Feb-15		--	<2	<2	180	<2	--	<1	--	<5	<10	<10	--	<2	--	--	--	<0.2	--	<10	--	--	<10	--	<5	--	--	<2	<50	--	<20	<50	--	--	--
		Aug-15		--	<2	<2	195	<2	--	<1	--	<5	<2	<10	--	<2	--	--	--	<0.2	--	<10	--	--	<10	--	<5	--	--	<2	--	--	8.1	<25	--	0.53	--
		Feb-16		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-N	N	Nov-89		1600	--	<1	170	<1	<500	<0.1	150	3	1	<10	270	2	<10	42	320	--	<20	6	--	2.8	<1	--	--	9.7	1100	--	--	--	<10	70	25	--	66
		Feb-90		1900	--	<1	170	<1	<500	0.3	150	4	<1	<10	270	9	<10	46	500	--	<20	5	--	3	<1	--	--	8.2	960	--	--	--	<10	90	27	--	66
		May-90		50	--	<1	140	<1	<500	5	140	<1	<1	<10	560	4	10	38	540	--	<20	5	--	2.7	<1	--	--	10	870	--	--	--	<10	10	26	--	57

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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	-
BRF-N (cont)	N	Aug-90		60	--	<1	150	<1	<500	0.2	140	<1	2	<10	110	1	<10	36	520	--	<20	2	--	2.1	<1	--	--	8.9	970	--	--	--	<10	<10	26	--	76
		Nov-90		140	--	<1	160	--	<500	0.1	140	8	<1	<10	460	2	20	38	480	--	<20	11	0.01	3.3	<1	--	--	8.6	940	--	--	--	<10	<10	26	--	69
		Feb-91		<50	--	2	150	--	<500	<0.1	87	<1	<1	10	190	<1	40	33	180	--	<20	<1	0.02	21	<1	--	--	8.7	740	--	--	--	<10	<10	22	--	60
		May-91		<50	--	<1	190	--	<500	0.3	100	<1	<1	<10	1500	1	30	36	150	--	<20	<1	0.03	6.9	2	--	--	8.2	920	--	--	--	<10	<10	24	--	55
		Aug-91		<50	--	<1	200	--	<500	0.3	120	<1	<1	<10	300	5	20	41	220	--	<20	5	0.03	5.7	1	7400	--	8.3	1000	--	--	--	<10	30	26	--	61
		Nov-91		<50	--	<1	170	--	<500	<0.1	130	1	--	<10	1500	<1	--	43	230	--	--	<1	--	4.3	--	4700	--	8	1200	--	--	--	--	10	26	--	66
		Feb-92		<50	--	<1	200	--	<500	<0.1	110	3	--	<10	210	2	--	41	160	--	--	2	--	0.1	--	7500	--	7.5	1000	--	--	--	--	<10	25	--	60
		May-92		60	--	<1	190	--	<500	0.1	120	<1	--	<10	180	1	26	47	120	--	--	5	--	4.9	--	8000	--	7.3	1100	--	--	--	--	37	20	--	90
		Aug-92		<50	--	<1	190	--	<500	<0.1	120	2	--	<10	10	1	20	40	120	--	--	2	--	4.6	--	7300	--	8.4	1100	--	--	--	--	<10	27	--	59
		Nov-92		<50	<1	<1	190	1	<500	0.4	130	<1	--	30	130	1	--	46	140	<0.2	<20	<1	--	3.9	2	--	<10	7.8	1100	**70**	--	--	--	80	25	--	58
		May-93		<50	<1	<1	180	<1	<500	<0.1	120	--	--	<10	<10	<1	20	42	89	--	--	2	--	3.9	<1	--	--	6.7	1000	--	--	--	--	<10	20	--	70
		Nov-93		80	<1	<1	220	<1	<500	<0.1	160	4	--	<10	110	<1	10	50	160	<0.2	--	5	--	3.6	<1	--	<10	7.8	1300	--	--	--	--	<10	23	--	57
		May-94		<50	<1	2	210	<1	<500	<0.1	120	--	--	<10	90	3	--	54	85	--	--	--	--	3.7	<1	--	<10	7.4	1200	--	--	--	--	20	24	--	61
		Nov-94		<50	2	<1	<10	<1	<500	0.2	<0.1	2	<1	<10	<10	<1	--	<0.01	<5	<0.2	--	1	--	--	<1	--	<10	--	<50	**80**	--	--	<10	<10	23	<0.1	63
		May-95		60	1	1	160	<1	<500	0.5	94	<1	--	<10	180	3	--	34	99	--	--	2	--	4.3	<1	--	--	5.9	900	--	--	--	--	80	16	--	42
BRF-O	O	Nov-90		7000	--	3	80	--	710	0.1	310	6	3	10	10000	6	30	31	300	--	<20	13	0.01	6.3	<1	--	--	11	550	--	--	--	10	30	5	--	630
		Feb-91		<50	--	<1	90	--	760	<0.1	290	<1	<1	<10	220	<1	20	30	210	--	<20	2	0.01	7.2	<1	--	--	11	680	--	--	--	<10	<10	4	--	590
		May-91		<50	--	<1	630	--	850	0.2	290	<1	<1	77	1300	<1	20	29	230	--	<20	<1	<0.01	7.2	4	--	--	11	630	--	--	--	<10	100	5	--	560
		Aug-91		<50	--	3	60	--	950	<0.1	300	<1	<1	<10	200	<1	10	33	300	--	<20	<1	0.01	2.3	3	7400	--	9.5	510	--	--	--	<10	10	4	--	620
		Nov-91		<50	--	**62**	70	--	650	0.1	300	3	--	<10	240	<1	--	34	370	--	--	<1	--	1.4	--	4400	--	9.4	530	--	--	--	--	10	4	--	660
		Feb-92		<50	--	2	80	--	<500	<0.1	320	6	--	<10	150	<1	--	35	360	--	--	2	--	1.4	--	7100	--	9.7	470	--	--	--	--	<10	4	--	290
		Feb-92		<50	--	<1	60	--	<500	<0.1	310	6	--	<10	130	<1	--	34	350	--	--	2	--	1.3	--	7100	--	9.6	510	--	--	--	--	<10	4	--	300
		May-92		50	--	<1	50	--	770	<0.1	290	<1	--	<10	210	<1	--	35	360	--	--	2	--	1.4	--	6500	--	9.1	480	--	--	--	--	<10	4	--	750
		Aug-92		100	--	<1	50	--	800	<0.1	320	<1	--	<10	110	<1	--	33	380	--	--	<1	--	1.4	--	7200	--	10	480	--	--	--	--	20	4	--	640
		Nov-92		<50	<1	1	50	<1	800	0.1	300	1	--	30	20	<1	--	35	440	<0.2	<20	<1	--	1.2	2	--	<10	9.9	450	<50	--	--	--	20	4	--	555
		May-93		<50	<1	<1	50	<1	500	--	330	<1	--	<10	80	<1	--	37	520	--	--	--	--	1.4	<1	--	--	9.5	500	--	--	--	--	<10	4	--	670
		May-93		<50	<1	<1	40	<1	500	--	310	<1	--	<10	80	<1	--	35	4800	--	--	--	--	1.4	<1	--	--	9.5	520	--	--	--	--	<10	4	--	670
		Nov-93		<50	<1	<1	40	1	910	<0.1	320	<1	--	<10	<10	<1	--	37	510	--	--	<1	--	1.4	--	--	--	9.8	470	--	--	--	--	<10	4	--	660
		May-94		<50	<1	<1	60	<1	<500	<0.1	310	<1	--	<10	30	<1	10	45	670	--	--	<1	--	1.5	<1	--	<10	9.6	570	--	--	--	--	<10	4	--	530
		Nov-94		<50	1	<1	<10	<1	<500	<0.1	<0.1	1	<1	<10	<10	3	--	<0.01	<5	<0.2	--	<1	--	--	<1	--	<10	--	<50	<50	--	--	<10	<10	4	<0.1	610
		May-95		<50	2	<1	70	<1	1000	0.1	330	<1	--	<10	190	1	--	39	750	--	--	3	--	1.3	<1	--	--	10	540	--	--	--	--	<10	4	--	490
		Nov-95		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-95		60	<1	<1	40	<1	1000	<0.1	310	9	<1	<10	60	<1	--	38	600	<0.2	--	<1	--	1.3	<1	--	<10	9.8	530	<2	--	--	<10	<10	4	<0.1	540
		Jun-96		<50	<1	1	40	<1	1000	<0.1	330	<1	1	<10	80	<1	--	38	640	<0.2	--	3	--	1.3	<1	--	<10	9.7	490	<2	--	--	<10	<10	4	0.1	570
		Nov-96		<50	3	<1	40	<1	1000	<0.1	330	<1	--	<10	50	<1	--	40	700	--	--	<1	--	1.5	6	--	--	9.5	560	--	--	--	--	<10	4	--	590
		Jun-97		340	<1	<1	40	<1	900	<0.1	330	4	--	30	470	<1	--	41	740	--	--	2	--	1.4	<1	--	--	9.9	510	--	--	--	--	20	4	<0.1	450
BRF-P	P	Nov-90		18000	--	5	210	--	<500	0.4	87	25	20	<10	21000	**17**	80	7.4	270	--	<20	23	0.03	64	2	--	--	45	670	--	--	--	20	60	5	--	26

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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**	**-**
BRF-P (cont)	P	Feb-91		9600	--	4	190	--	<500	1	57	12	4	10	10000	12	80	8.6	240	--	<20	25	0.03	35	<1	--	--	57	570	--	--	--	<10	30	4	--	27
		May-91		11000	--	4	290	--	<500	0.7	59	17	8	<10	12000	11	60	11	200	--	<20	16	0.02	17	2	--	--	51	490	--	--	--	<10	30	4	--	27
		Aug-91		3700	--	<1	260	--	<500	<0.1	56	5	7	10	4200	3	50	9.8	140	--	<20	6	0.01	14	<1	5400	--	44	510	--	--	--	10	20	4	--	27
		Nov-91		3200	--	**31**	360	--	<500	0.1	47	21	--	<10	3100	3	40	9.8	150	--	<20	42	--	8	<1	7500	--	46	490	--	--	--	--	20	4	--	29
BRF-PZ 2AC	PZ 2AC	May-99		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	0.1	72
BRF-Q	Q	May-91		500	--	2	100	--	<500	1	110	<1	<1	<10	100	2	10	31	340	--	<20	<1	0.05	2.5	1	--	--	13	1100	--	--	--	<10	<10	5	--	170
		Aug-91		2400	--	1	80	--	<500	<0.1	130	2	3	<10	5900	4	10	30	350	--	<20	4	0.19	4.1	4	7600	--	7.6	820	--	--	--	<10	20	4	--	200
		Nov-91		5200	--	**19**	60	--	<500	<0.1	140	8	--	<10	9000	4	--	32	470	--	--	2	--	2.4	--	6400	--	9.3	1100	--	--	--	--	10	4	--	160
		Feb-92		430	--	1	80	--	<500	<0.1	120	6	--	<10	2000	<1	--	32	370	--	--	2	--	2	--	5600	--	8.6	970	--	--	--	--	<10	6	--	200
		May-92		230	--	<1	70	--	<500	<0.1	110	<1	--	<10	1300	<1	--	32	280	--	--	2	--	2.1	--	4000	--	7	<80	--	--	--	--	<10	3	--	170
		Aug-92		<50	--	<1	80	--	<500	<0.1	110	<1	--	<10	860	<1	--	29	200	--	--	<1	--	2.3	--	4800	--	7.8	860	--	--	--	--	<10	3	--	170
		Aug-92		<50	--	<1	80	--	<500	<0.1	110	1	--	<10	860	<1	--	29	210	--	--	1	--	2.2	--	4900	--	8.2	840	--	--	--	--	<10	3	--	350
		Nov-92		60	<1	<1	50	<1	<500	0.1	100	<1	--	20	600	<1	--	26	130	<0.2	<20	<1	--	2	3	--	<10	3.7	500	<50	--	--	--	<10	2	--	--
		May-93		<50	<1	<1	50	<1	<500	--	130	<1	--	<10	160	<1	--	33	240	--	--	--	--	2	<1	--	--	5.1	680	--	--	--	--	<10	2	--	290
		Nov-93		80	<1	<1	50	<1	<500	<0.1	120	<1	--	<10	520	<1	--	31	170	<0.2	--	2	--	2.3	2	--	<10	5.2	590	--	--	--	--	<10	2	--	220
		May-94		80	<1	1	50	<1	<500	<0.1	130	--	--	<10	480	3	--	36	250	--	--	--	--	1.9	1	--	<10	4.4	670	--	--	--	--	<10	2	--	210
		Nov-94		190	4	<1	50	<1	<500	<0.1	97	<1	<1	<10	510	<1	--	27	140	<0.2	--	<1	--	--	2	--	<10	--	510	2	--	--	<10	<10	2	0.2	190
		May-95		<50	2	<1	60	<1	<500	<0.1	110	<1	--	<10	330	<1	--	31	190	--	--	<1	--	1.9	1	--	--	4	570	--	--	--	--	<10	2	--	160
		Nov-95		70	<1	<1	50	<1	<500	0.5	120	1	<1	<10	620	<1	--	33	150	<0.2	--	<1	--	2.2	<1	--	<10	4.2	490	<2	--	--	<10	<10	13	0.2	230
		Jun-96		<50	<1	<1	30	<1	<500	0.1	100	<1	<1	<10	190	<1	--	28	210	<0.2	--	<1	--	1.8	<1	--	<10	4.6	520	<2	--	--	<10	<10	3	0.3	160
		Nov-96		60	1	<1	50	<1	<500	<0.1	110	<1	--	<10	1100	<1	--	29	260	--	--	2	--	2.6	<1	--	--	5	600	--	--	--	--	<10	2	--	160
		Jun-97		<50	<1	<1	30	<1	<500	<0.1	140	<1	--	<10	420	<1	--	36	120	--	--	<1	--	1.9	<1	--	--	3.7	550	--	--	--	--	<10	2	<0.1	190
BRF-R	R	Nov-90		120000	--	**14**	100	--	1500	**18**	410	48	620	120	280000	**110**	100	98	57000	--	20	**280**	0.03	6.3	3	--	--	9.7	1500	--	--	--	60	670	5	--	1400
		Feb-91		25000	--	9	330	--	1400	**18**	410	38	<1	90	93000	**52**	80	77	53000	--	<20	**220**	<0.01	5.7	2	--	--	9.6	2000	--	--	--	130	500	4	--	1300
		May-91		18000	--	<1	1600	--	1500	**16**	370	18	400	<10	66000	**25**	40	71	38000	--	<20	**200**	0.11	5.2	4	--	--	9.2	1600	--	--	--	<10	340	4	--	2100
		Aug-91		18000	--	8	100	--	1800	**8**	370	17	410	20	72000	**23**	60	61	43000	--	20	**200**	--	11	<1	36000	--	8.9	1500	--	--	--	50	300	4	--	1300
		Nov-91		18000	--	**18**	280	--	1400	**9**	370	18	--	<10	62000	**17**	--	68	43000	--	--	**160**	--	4.7	--	35000	--	9.1	1800	--	--	--	--	260	4	--	1100
		Feb-92		11000	--	4	80	--	670	**12**	390	23	--	<10	60000	14	--	75	50000	--	--	**170**	--	4.7	--	28000	--	9.4	1600	--	--	--	--	160	4	--	1200
		May-92		1100	--	1	360	--	<500	<0.1	48	3	--	<10	1300	1	--	9.1	110	--	--	5	--	5.9	--	8700	--	47	390	--	--	--	--	20	3	--	20
		Aug-92		1700	--	<1	20	--	1300	**10**	360	<1	--	<10	35000	6	--	60	40000	--	--	**140**	--	5.3	--	13000	--	11	1400	--	--	--	--	180	3	--	1300
		Nov-92		1500	<1	<1	10	1	1400	**9**	380	<1	--	30	35000	5	--	54	42000	<0.2	<20	89	--	4.9	<1	--	<10	9.6	1400	<50	--	--	--	190	4	--	1000
		May-93		1400	<1	<1	10	<1	700	--	360	<1	--	<10	28000	4	--	63	40000	--	--	--	--	4.6	<1	--	--	9.5	1400	--	--	--	--	130	3	--	1200
		Nov-93		1200	<1	<1	<10	3	1200	**9**	370	<1	--	<10	31000	3	--	59	39000	--	--	**140**	--	5.1	--	--	--	9.7	1600	--	--	--	--	150	3	--	1200
		May-94		2400	<1	2	20	<1	600	**7**	370	2	--	<10	43000	5	20	70	48000	--	--	100	--	5.5	<1	--	<10	9.9	2000	--	--	--	--	170	4	--	1000
		Nov-94		1800	5	<1	10	2	1400	**7**	380	3	350	<10	34000	4	--	54	38000	<0.2	--	**130**	--	--	<1	--	10	--	1600	<2	--	--	<10	150	4	0.2	1200
		May-95		2600	4	<1	40	2	1400	**8**	390	4	--	<10	36000	5	--	59	43000	--	--	**140**	--	5.6	<1	--	--	10	1800	--	--	--	--	170	4	--	1000
		Nov-95		2200	2	<1	20	3	1200	**7**	360	9	330	<10	32000	7	--	53	35000	<0.2	--	**160**	--	5.7	<1	--	<10	9.9	1600	<2	--	--	<10	140	3	0.1	940

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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**	**-**
BRF-R (cont)	R	Jun-96		80	<1	2	20	2	1200	**7**	340	<1	290	<10	30000	8	--	50	33000	<0.02	--	**130**	--	4.9	<1	--	<10	9.5	1600	<2	--	--	<10	130	3	0.2	960
		Nov-96		1800	2	1	20	<1	1300	<0.1	360	1	--	<10	31000	7	--	59	40000	--	--	100	--	6.3	<1	--	--	10	1800	--	--	--	--	140	4	--	1100
		Jun-97		2400	<1	<1	20	<1	1100	5	370	8	--	<10	36000	3	--	55	36000	--	--	**120**	--	5.3	<1	--	--	9.9	1800	--	--	--	--	120	3	<0.1	850
BRF-S	S	Nov-90		110000	--	<1	880	--	<500	2	38	63	77	120	220000	**160**	50	23	6400	--	50	68	0.01	2.4	2	--	--	8	60	--	--	--	70	540	4	--	47
		Feb-91		58000	--	4	600	--	<500	2	29	57	32	90	120000	**73**	50	16	3000	--	<20	63	0.01	2.9	<1	--	--	5.8	220	--	--	--	120	240	4	--	60
		May-91		190000	--	4	1400	--	1100	**6**	39	**180**	94	0.2	260000	**200**	40	36	5500	--	<20	**180**	0.05	2.6	3	--	--	5.8	750	--	--	--	0.3	750	5	--	53
		Aug-91		26000	--	<1	230	--	<500	0.2	22	4	28	20	43000	5	60	8.7	1200	--	20	7	<0.01	14	10	580	--	5.1	80	--	--	--	40	180	5	--	52
		Nov-91		83000	--	3	580	--	<500	2	28	59	--	60	120000	**79**	--	18	2500	--	--	81	--	1.6	--	38000	--	4.7	<50	--	--	--	--	360	4	--	60
		Feb-92		31000	--	7	260	--	<500	1	24	34	--	20	50000	**27**	--	10	1100	--	--	42	--	0.93	--	44000	--	4.8	100	--	--	--	--	60	4	--	64
		May-92		11000	--	3	190	--	<500	1	24	18	--	<10	18000	**21**	--	6.9	940	--	--	27	--	4.4	--	23000	--	4.7	60	--	--	--	--	70	4	--	62
		Aug-92		1900	--	<1	60	--	<500	0.3	19	<1	--	<10	2400	3	--	4.8	440	--	--	9	--	0.87	--	9600	--	5	<50	--	--	--	--	<10	3	--	28
		Nov-92		19000	<1	3	140	<1	<500	2	23	13	--	<10	25000	**18**	--	7.1	740	<0.2	--	13	--	0.76	<1	--	<10	4.7	70	--	--	--	--	70	4	--	64
		May-93		1300	<1	<1	<10	<1	<500	--	22	1	--	<10	2000	2	--	4.6	440	--	--	--	--	0.5	<1	--	--	4.6	<50	--	--	--	--	<10	4	--	55
		Nov-93		4200	<1	<1	60	<1	<500	0.5	20	2	--	<10	5000	2	--	5.4	440	--	--	5	--	0.4	--	--	--	4.8	<50	--	--	--	--	<10	4	--	52
		May-94		1100	<1	2	60	<1	<500	0.6	23	1	--	<10	1300	1	<10	5.6	500	--	--	6	--	0.6	1	--	<10	4.8	<50	--	--	--	--	<10	4	--	45
		Nov-94		10000	1	<1	100	<1	<500	0.8	18	16	4	<10	14000	10	--	5.9	520	<0.2	--	21	--	--	<1	--	<10	--	60	<2	--	--	10	30	4	<0.1	49
		May-95		2700	<1	<1	80	<1	<500	1	22	4	--	<10	3900	**40**	--	5.7	510	--	--	12	--	0.5	<1	--	--	4.8	60	--	--	--	--	20	4	--	48
		Nov-95		4000	<1	<1	60	<1	<500	0.9	18	5	2	<10	4900	4	--	5	400	<0.2	--	12	--	0.6	<1	--	<10	4.8	<50	<2	--	--	<10	10	4	<0.1	57
		Jun-96		4800	<1	2	90	1	<500	1	19	8	5	<10	14000	12	--	6	540	<0.2	--	14	--	0.4	<1	--	<10	4.9	<50	<2	--	--	10	30	4	<0.1	50
		Nov-96		6700	<1	1	80	<1	<500	0.7	19	4	--	<10	7400	4	--	5.2	470	--	--	14	--	1.3	<1	--	--	4.9	<50	--	--	--	--	20	4	--	50
		Jun-97		6400	<1	2	60	<1	<500	0.5	20	9	--	<10	8100	5	--	5.7	500	--	--	18	--	0.5	<1	--	--	5.1	<50	--	--	--	--	40	4	--	35
		May-11		1400	<1	<1	58	<1	<200	0.69	20	2.4	1.8	<2	1400	1.1	--	4.6	580	<0.2	<5	5.5	<0.1	1.1	1.6	--	<1	6.5	45	<1	<1	--	3.2	18	8.1	--	28
		Nov-11		130	<1	<1	55	<1	<200	<0.5	21	<2	1.1	<2	100	<1	--	4.7	690	<0.2	<5	3.3	<0.1	0.71	<1	--	<1	6.5	49	<1	<1	--	<2	<10	8.6	--	27
		Nov-11		150	<1	<1	56	<1	<200	<0.5	21	<2	1	<2	<100	<1	--	4.9	690	<0.2	<5	3.2	<0.1	0.83	<1	--	<1	6.7	50	<1	<1	--	<2	<10	8.7	--	27
		May-12		--	<1	1.2	59	<1	--	0.55	--	<2	--	--	--	<1	--	--	--	<0.2	--	4.5	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	<0.1	--
		Nov-12		--	<1	<1	56	<1	--	<0.5	--	<2	--	--	--	<1	--	--	--	<0.2	--	4.4	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	<0.1	--
		May-13		--	<1	<5	50	<1	--	<0.5	--	<2	--	--	--	<1	--	--	--	<0.2	--	3.5	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	<0.1	--
		May-13		--	<1	<1	48	<1	--	<0.5	--	<2	--	--	--	<1	--	--	--	<0.2	--	2.6	<0.1	--	<1	--	<1	--	--	<1	--	--	--	--	--	<0.1	--
		Aug-13		<100	<2	<2	60.4	<2	90.2	<1	23.2	<2	<2	<2	<100	<2	--	4.88	797	<0.2	<2	4.78	<0.1	<1	<2	--	<2	7.07	51.6	<2	--	--	<2	<25	8.64	<0.1	33
		Feb-14		--	<2	<2	59.3	<2	--	<1	--	<5	--	--	--	<5	--	--	--	<0.2	--	<10	<0.1	--	<10	--	<5	--	--	<2	--	--	--	--	--	<0.1	--
		Aug-14		--	<2	<2	61	<2	--	<1	--	<5	--	--	--	<5	--	--	--	<0.2	--	<10	0.23	--	<10	--	<5	--	--	<2	--	--	--	--	--	<0.1	--
		Aug-14		--	<2	<2	66	<2	--	<1	--	<5	--	--	--	<5	--	--	--	<0.2	--	<10	0.35	--	<10	--	<5	--	--	<2	--	--	--	--	--	<0.1	--
		Feb-16		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-UT0.15	*NNC2*	Oct-90		120	--	<1	40	--	<50	0.1	58	<1	--	<10	620	<1	--	14	190	--	--	<1	0.23	2.1	<1	--	--	5.3	--	--	--	<5	--	<10	3	--	67
		Nov-96		1900	<1	1	40	<1	<500	<0.1	34	2	--	<10	2300	<1	--	9.2	350	--	--	14	--	2.4	<1	--	--	3.4	50	--	--	--	--	<10	3	--	52
		Jun-97		2200	<1	<1	70	<1	<500	<0.1	29	2	--	<10	4800	1	--	7.4	660	<0.2	--	<1	--	2.2	<1	--	--	2.5	<50	--	--	--	--	10	2	--	25

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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**	**-**
BRF-UT0.38	*NNC1*	Oct-90		80	--	<1	30	--	<50	<0.1	43	<1	--	<10	270	<1	--	12	110	--	--	<1	0.35	1.6	<1	--	--	4.5	--	--	--	9	--	<10	3	--	37
		Nov-96		1400	<1	1	50	<1	<500	<0.1	36	<1	--	<10	3100	<1	--	10	500	--	--	7	--	2.8	3	--	--	3.8	120	--	--	--	--	<10	3	--	53
		Jun-97		510	<1	<1	40	<1	<500	<0.1	32	<1	--	<10	1200	<1	--	7.8	380	--	--	2	--	2.2	<1	--	--	2.8	70	--	--	--	--	10	2	--	30
BRF-WB0.4	*WBR1*	Oct-90		290	--	**39**	40	--	80	<0.1	62	<1	--	<10	450	<1	--	17	72	--	--	<1	0.32	2.2	1	--	--	6.2	--	--	--	11	--	10	5	--	50
		Nov-96		2900	<1	2	20	<1	<500	3	43	2	--	<10	3100	3	--	5.4	78	--	--	3	--	2.3	2	--	--	2	60	--	--	--	--	10	3	--	17
		Jun-97		1600	<1	<1	30	<1	<500	0.1	45	2	--	<10	2300	2	--	7.8	74	--	--	<1	--	1.6	<1	--	--	2.5	60	--	--	--	--	10	4	--	12
		Nov-01		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-01		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.43	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-02		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.43	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-02		880	<1	3.6	50	<1	<200	<0.1	66	<1	<1	<10	720	4	--	12	62	<0.1	<20	<1	0.9	1.6	<1	--	<10	4.7	150	<2	<50	16	<10	<10	6.1	0.15	45
		May-03		440	<1	<1	40	<1	<200	<0.1	54	<1	<1	<10	330	<1	--	8.9	33	<0.1	<20	<1	0.69	1.4	<1	4000	<10	3.6	100	<2	480	14	<10	<10	3.7	0.11	18
		Nov-03		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.92	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-04		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.92	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-04		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.81	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-05		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.76	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-05		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-06		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-06		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Feb-07		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-07		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.47	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-07		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-08		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-08		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-09		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-09		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Feb-10		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-10		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.83	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-10		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-11		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.88	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-11		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.93	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-12		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-12		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.47	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-13		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.56	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Feb-14		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.84	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Aug-14		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
*BRF-WB0.95**	*NA*	Nov-07		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-08		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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	-
BRF-WB0.95 (cont)*	*NA*	Nov-08		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.36	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-09		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-09		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.93	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Feb-10		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-10		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-10		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.92	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-11		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.76	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-11		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.73	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-12		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-12		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.33	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-13		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.44	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Aug-13		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.73	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Feb-14		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.69	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Aug-14		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.83	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BRF-WB1.2	*WBR2*	Oct-90		320	--	4	50	--	110	<0.1	50	<1	--	<10	460	<1	--	17	41	--	--	<1	0.46	2.2	<1	--	--	5.2	--	--	--	8	--	<10	5	--	27
		Nov-96		3200	<1	2	20	<1	<500	<0.1	39	4	--	<10	3600	3	--	5.2	98	--	--	<1	--	2.4	<1	--	--	2.3	60	--	--	--	--	10	4	--	15
		Jun-97		2100	<1	<1	30	<1	<500	0.1	44	2	--	<10	2300	2	--	6.6	90	--	--	<1	--	1.8	<1	--	--	2.9	70	--	--	--	--	10	4	--	9
BRF-WB1.65	*WBR3*	Oct-90		320	--	1	60	--	<50	<0.1	45	<1	--	<10	530	<1	--	18	75	--	--	<1	0.43	1.2	<1	--	--	2	--	--	--	9	--	<10	3	--	6
		Nov-96		3100	<1	2	30	<1	<500	<0.1	35	2	--	<10	3300	3	--	7.5	77	--	--	<1	--	2.1	4	--	--	2	70	--	--	--	--	20	3	--	15
		Nov-96		3000	<1	2	<10	<1	<500	<0.1	28	2	2	<10	3400	4	--	2.6	15	<0.2	--	<1	--	1.6	<1	--	<10	1.1	<50	<2	--	--	<10	<10	3	<0.1	14
		Jun-97		1000	<1	<1	40	<1	<500	<0.1	33	<1	--	<10	1100	<1	--	8.4	72	--	--	<1	--	1.3	<1	--	--	2.2	60	--	--	--	--	20	4	--	6
		Nov-01		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.36	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-02		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.67	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-02		330	<1	2.6	60	<1	<200	1.2	43	<1	<1	<10	310	<1	--	12	48	<0.1	<20	<1	1.1	1.3	<1	--	<10	3.3	80	<2	<50	6	<10	<10	5.3	0.11	12
		May-03		310	<1	<1	50	<1	<200	<0.1	32	<1	<1	<10	250	<1	--	9.5	34	<0.1	<20	<1	0.82	1.1	<1	3900	<10	2.9	<50	<2	360	6	<10	<10	3.6	<0.1	7.4
		Nov-03		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.77	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-04		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.61	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-04		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.99	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-05		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.69	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-05		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.34	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-06		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-06		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Feb-07		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-07		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-07		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.27	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-08		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-08		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Well ID	Historical Well ID Ref.	Date	Program	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)	Sodium, total (mg/L)	Strontium, total (ug/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**	**-**
BRF-WB1.65 (cont)	*WBR3*	May-09		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-09		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.72	--	--	--	--	--	--	--	--	--	--	--	--	--
		Feb-10		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-10		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.81	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-10		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.76	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-11		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.7	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-11		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.6	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-12		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Nov-12		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.18	--	--	--	--	--	--	--	--	--	--	--	--	--
		May-13		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.42	--	--	--	--	--	--	--	--	--	--	--	--	--
		Aug-13		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.37	--	--	--	--	--	--	--	--	--	--	--	--	--
		Feb-14		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.69	--	--	--	--	--	--	--	--	--	--	--	--	--
		Aug-14		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.76	--	--	--	--	--	--	--	--	--	--	--	--	--

~ Action Level
* historical location unknown
^ nitrate MCL (MCL has not been established for nitrite)
^^ nitrite MCL (more conservative MCL of nitrate and nitrite)
-- 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 that measured values exceed EPA MCLs exceed EPA MCLs or Action Levels
Italics indicate surface water sample locations. MCLs do not apply to these samples.
MCL - Maximum Contaminant Level
mg/L - milligrams per liter
NA - not available
Ref. - reference
TDEC - Tennessee Department of Environment and Conservation; MCLs established in Rules of TDEC Solid Waste Management Appendix III
ug/L - microgram per liter
Well ID - well identification

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, field (NTU)
BRF-1	1	Apr-87	--	280	--	--	4.7	6.3	646	15.9	370	--	--
		Jun-87	--	284	--	--	0.5	6.8	835	16	--	--	--
		Nov-92	--	224	--	30	1.1	5.8	475	14.6	240	95	--
		May-93	--	112	--	-18	0.8	5.8	347	17.5	210	58	--
		Nov-93	--	111	--	256	1.1	5.6	345	16.3	180	25	--
		May-94	--	92	--	250	0.7	5.5	214	16.9	130	90	--
		Dec-94	--	159	--	69	0.6	5.7	358	16.9	170	29	--
		May-95	--	195	--	143	0.9	5.9	413	18.6	250	23	--
		Nov-95	--	164	--	209	0.6	5.6	336	15.9	130	66	--
		Jun-96	--	120	--	123	0.4	5.4	274	78.6	120	66	--
		Nov-96	--	148	--	231	0.9	5.5	340	15.4	140	60	--
		Jun-97	--	124	--	122	--	5.9	302	16.5	140	61	--
		May-99	--	125	--	435	0.5	5.7	375	19.5	170	56	--
		Jun-99	--	189	--	265	0.7	5.8	413	22.5	160	36	--
		Jul-99	--	182	--	222	0.2	5.6	356	18.6	140	46	--
		Aug-99	--	184	--	347	0.4	5.3	331	20.1	150	52	--
		Sep-99	--	181	--	290	0.9	5.4	356	16.3	160	25	--
		Oct-99	--	124	--	269	0.7	5.5	303	15.7	140	75	--
		Nov-99	--	247	--	231	2.3	6.1	468	17.2	260	56	--
		Dec-99	--	260	--	212	3	6.2	515	14.5	53	250	--
		May-00	--	190	--	244	1.4	5.7	449	18.4	190	130	--
		Nov-00	--	218	--	270	0	6.1	456	14.9	250	68	--
		May-01	--	226	--	343	2.5	6	436	14.9	240	48	--
		Aug-06	--	265	--	181	0.1	6.1	550	17.1	280	110	--
		Aug-06	--	--	--	--	--	--	--	--	280	170	--
		Nov-06	--	275	--	170	2.7	6.3	560	16.8	290	110	--
		Feb-07	--	273	--	171	0.7	6	589	16.2	290	160	--
		May-07	--	298	--	140	1.8	6.4	559	18.1	290	140	--
		Aug-07	--	270	--	181	0.7	6.3	560	17.1	250	110	--
		Nov-07	--	265	--	172	0.7	6.4	555	17.3	260	86	--
		Feb-08	--	282	--	200	1	6.2	558	15.8	240	130	--
		May-08	--	278	--	152	0.8	6.2	560	18	260	53	--
		May-09	--	276	--	172	0.5	6.4	547	16.3	250	58	--
		Nov-09	--	246	--	240	0.5	5.9	437	14.9	230	42	67
		Nov-09	--	--	--	--	--	--	--	--	240	38	--
		May-10	--	274	--	146	0.3	6.2	518	16.8	240	66	67.3
		Nov-10	--	287	--	124	0.3	5.8	511	14.3	--	--	59
		May-11	--	282	--	180	0.6	5.8	540	15.9	260	56	46.7
		Nov-11	--	249	--	144	0.2	6.1	526	14.2	240	67	53.1
		May-12	--	250	--	162	0.7	6.1	508	16.1	--	70	24.3
		May-12	--	--	--	--	--	--	--	--	--	69	--
		May-12	--	--	--	--	--	--	--	--	--	69	--
		Nov-12	--	231	--	179	0.3	6.2	466	14.7	--	54	178
		Nov-12	--	--	--	--	--	--	--	--	--	49	--
		May-13	--	228	--	175	0.5	6.1	479	17.7	220	62	119
		Aug-13	--	248	--	162	0.4	6	470	17.6	--	51.2	25.7
		Feb-14	--	225	--	161	1.1	6.3	484	13.3	182	32	91
		Aug-14	--	243	--	161	0.1	6.2	475	18	--	67.2	76
		Feb-15	--	156	--	143	0.1	6.1	469	13.4	--	49.2	79
		Aug-15	--	226	--	--	--	--	--	--	--	131	45
		Feb-16	--	227	--	142	0.1	6.3	478	12.7	--	--	23
BRF-10-51	10-51	May-11	--	262	--	331	0.3	6.2	540	16.4	310	29	--
		Nov-11	--	275	--	235	0.1	6.3	545	17.2	300	3.1	9.9
		May-12	--	282	--	281	0.2	6.3	554	18	--	13	20.1
		Nov-12	--	--	--	--	--	--	--	--	--	2.4	--
		Nov-12	--	288.5	--	268	0.2	6.4	551	17.1	--	2.5	12
		May-13	--	299	--	325	0.2	6.6	571	16.4	--	6.8	10
		Aug-13	--	302	--	290	0.3	6.4	572	20	--	5.1	13.4
		Feb-14	--	300.5	--	287	0.4	6.3	563	15.4	--	3.8	10.1
		Feb-14	--	--	--	--	--	--	--	--	--	2.7	--
		Aug-14	--	268	--	316	0.1	5.9	585	18.1	--	4.6	8.4
		Feb-16	--	313	--	319	0.1	6.4	610	15.3	--	--	23
BRF-10-52	10-52	May-11	--	--	--	--	--	--	--	--	400	38	--
		May-11	--	--	--	--	--	--	--	--	390	40	--
		May-11	--	418	--	112	0.2	6.3	760	16.2	--	--	--
		May-11	--	--	--	--	--	--	--	--	--	--	--
		Nov-11	--	404	--	115	0.1	6.4	776	16.8	380	58	35.5
		May-12	--	393.5	--	105	0.3	6.5	579	20	--	52	33.1
		May-12	--	--	--	--	--	--	--	--	--	55	--

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, field (NTU)
BRF-10-52 (cont)	10-52	Nov-12	--	384	--	93	0.1	6.5	739	16.9	--	38	36.6
		May-13	--	402	--	116	0.3	6.7	754	16.8	--	32	8
		Aug-13	--	403.5	--	124	0.4	6.5	750	19.9	--	41	21.5
		Aug-13	--	--	--	--	--	--	--	--	--	39	--
		Feb-14	--	408	--	124	0.2	6.5	740	15.8	--	34.8	13.1
		Aug-14	--	341	--	120	0.1	6.1	764	18.6	--	23.3	13.6
		Feb-16	--	421	--	126	0.1	6.5	771	15.2	--	--	11.3
BRF-2	2	Apr-87	--	280	--	--	4.5	6.5	253	15.8	490	--	--
		Jun-87	--	264	--	--	0.5	6.3	600	16	--	--	--
		Aug-09	--	385	--	84	0.8	7.2	1142	17.8	--	--	--
BRF-20H	20H	Feb-08	--	232	--	525	2.6	6.4	1818	17.2	1500	4	--
BRF-22	22	Feb-91	--	--	--	90	1.4	6.6	362	14.2	230	--	--
		Aug-91	--	110	--	-74	0.5	6.6	455	22.1	300	--	--
		Nov-91	--	206	--	-69	0.9	6.7	441	21.3	240	--	--
		Dec-91	--	190	--	-52	1	6.6	400	17.5	--	--	--
BRF-23	23	Feb-91	--	--	--	111	2.6	6.5	296	13.8	190	--	--
		Aug-91	--	112	--	-68	0.3	6.4	301	24.3	180	--	--
		Nov-91	--	118	--	-22	1.9	6.6	306	19.9	190	--	--
		Dec-91	--	115	--	11	1	6.4	306	18.8	--	--	--
BRF-25	25	Feb-91	--	--	--	16	0.8	7.4	459	9	310	--	--
		Jun-91	--	186	--	-85	0.6	7.2	510	18.2	280	--	--
		Nov-91	--	200	--	-86	2.4	7.6	510	14.8	320	--	--
		Dec-91	--	257	--	-51	0.2	7.4	379	14	--	--	--
BRF-26	26	Feb-91	--	--	--	-148	0.4	7.1	491	18.5	330	--	--
		Jun-91	--	226	--	-128	0.3	7	584	19.8	280	--	--
		Nov-91	--	253	--	-89	0.4	7.2	604	17.7	350	12000	--
		Dec-91	--	236	--	-117	0.3	7.2	618	16	--	--	--
BRF-27	27	Feb-91	--	--	--	-118	0.7	7.1	478	17.5	310	--	--
		Jun-91	--	196	--	-96	0.4	7.2	527	19.3	210	--	--
		Nov-91	--	198	--	-90	0.5	7.2	504	16.5	300	52	--
		Dec-91	--	196	--	-99	0.4	7.3	492	16.5	--	--	--
BRF-28	28	Feb-91	--	--	--	196	0.8	6	748	10.8	650	--	--
		Aug-91	--	218	--	-82	0.4	6.3	457	24.8	250	--	--
		Nov-91	--	170	--	-7	0.6	6.6	467	14.5	270	13	--
		Dec-91	--	83	--	57	0.5	6.2	787	13.8	--	--	--
BRF-29	29	Apr-91	--	132	--	336	2	5.1	267	14.9	170	--	--
		Jun-91	--	221	--	368	3	6.5	439	16.6	2200	--	--
		Nov-91	--	287	--	323	1.1	6.4	600	16.9	300	1400	--
		Nov-92	--	269	--	215	2.1	6.5	565	17.8	260	2600	--
		May-93	--	182	--	356	5.9	6.9	446	16.2	440	1300	--
		May-93	--	227	--	327	4.3	6.8	500	16.8	--	--	--
		Nov-93	--	246	--	387	2.3	6.5	567	19.2	430	1700	--
		May-94	--	220	--	634	4.2	6.9	406	18	300	620	--
		Nov-94	--	280	--	243	2.4	6.7	600	17.8	330	1500	--
		May-95	--	234	--	199	4.9	6.8	480	17.8	250	1300	--
		Nov-95	--	235	--	479	5.6	6.5	505	19.3	300	350	--
		Jun-96	--	229	--	399	4.2	6.9	490	19	360	1600	--
		Nov-96	--	253	--	488	7.1	6.5	552	17.2	300	<1	--
		Nov-96	--	259	--	469	4.6	6.4	561	18.4	460	1300	--
		Jun-97	--	233	--	200	3.1	6.7	498	16.2	360	1400	--
		Nov-02	--	227	--	598	4.6	6.8	496	18.8	300	15	--
BRF-30	30	Apr-91	--	153	--	231	1.8	5.7	580	20.5	390	--	--
		Jun-91	--	110	--	314	1.1	5.9	415	17.2	260	--	--
		Nov-91	--	109	--	302	0.5	6	369	18.3	220	700	--
		Nov-02	--	242	--	570	1	6.1	736	17.1	490	23	--
BRF-31	31	Apr-91	--	76	--	148	0.8	5.8	354	19.7	220	--	--
		Jun-91	--	76	--	266	1.6	5.9	360	16.9	210	--	--
		Nov-91	--	80	--	261	0.6	5.9	354	17	150	2400	--
		Nov-92	--	82	--	220	0.6	5.8	353	16.9	180	310	--
		May-93	--	76	--	128	0.2	5.9	350	16.6	240	150	--
		Nov-93	--	81	--	336	0.1	5.7	330	18.2	270	1200	--
		May-94	--	86	--	350	0.2	6	294	16.9	240	1100	--
		Dec-94	--	85	--	238	0.2	5.9	312	17	190	750	--
		May-95	--	89	--	283	0.2	5.9	321	17.9	190	520	--
		Nov-95	--	92	--	378	0.2	5.8	326	17	270	280	--
		Jun-96	--	96	--	260	0.5	5.9	360	18.4	290	400	--
		Nov-96	--	97	--	301	0.2	5.7	336	16.5	180	490	--
		Jun-97	--	100	--	260	0.1	6	399	17.8	270	86	--

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, field (NTU)
BRF-32	32	Apr-91	--	200	--	235	1.1	7	480	15.3	300	--	--
		Jun-91	--	202	--	387	1.8	6.6	593	15.3	2100	--	--
		Nov-91	--	220	--	330	1	6.9	454	17.1	270	91	--
BRF-41	41	May-91	--	301	--	-222	0.5	7.5	580	15.2	360	--	--
		Aug-91	--	291	--	-58	0.5	7.4	586	15.4	330	--	--
BRF-43	43	May-91	--	259	--	116	3.2	7.3	550	16	350	--	--
		Aug-91	--	325	--	29	0.5	7.3	657	16	420	--	--
BRF-44	44	May-91	--	290	--	179	6.1	9	740	19.2	440	--	--
		Aug-91	--	241	--	212	0.9	8.2	666	18.3	420	--	--
		Sep-91	--	227	--	264	4.7	7.64	966	16.7	580	--	--
BRF-46	46	Nov-93	--	362	--	399	1.3	6.9	783	15.6	500	75	--
		May-94	--	362	--	355	3	6.9	645	17.6	340	26	--
		Aug-94	--	368	--	358	--	6.7	769	--	--	--	--
		Nov-94	--	366	--	315	1.3	6.8	799	16	480	9	--
		May-95	--	338	--	248	2.2	6.9	713	16.8	430	19	--
		Nov-95	--	366	--	458	2.3	6.6	776	15.3	430	37	--
		Jun-96	--	374	--	325	4.1	7	742	19.5	360	31	--
		Nov-96	--	371	--	528	4.1	6.6	810	15.6	460	20	--
		Jun-97	--	358	--	271	--	6.8	777	17.5	470	25	--
		Oct-97	--	387	--	524	5.9	6.9	800	16.1	430	50	--
		May-98	--	371	--	351	4.2	6.9	694	19.7	460	25	--
		Nov-98	--	378	--	375	2.6	6.8	683	19	430	13	--
		May-99	--	310	--	480	3.7	6.7	743	19.2	420	2	--
		Nov-02	--	380	--	553	6.4	6.8	824	14.8	480	31	--
BRF-47	47	May-99	--	--	--	--	--	--	--	--	1500	<1	--
		Jun-99	--	192	--	375	3.6	6.4	1732	17.8	1400	6	--
		Jul-99	--	200	--	364	0.7	6.4	1728	24.7	1600	510	--
		Aug-99	--	202	--	312	0.5	6.2	2015	22.9	1500	17000	--
		Sep-99	--	200	--	281	0.6	6.2	2017	16.7	1500	170	--
		Oct-99	--	216	--	236	1.7	6.3	1173	20.2	1500	13	--
		Nov-99	--	189	--	316	1.7	6.4	1785	18.5	1500	270	--
		Dec-99	--	176	--	434	4.4	6.5	1712	15.9	16	1400	--
		May-00	--	174	--	482	--	6.4	1571	19.3	1500	12	--
		Nov-00	--	168	--	449	--	6.4	1626	17.2	1400	19	--
		May-01	--	170	--	554	3.7	6.3	1409	15	1400	11	--
		May-04	--	147	--	269	1.7	6.2	1800	26.9	1400	300	--
		Aug-06	--	139	--	248	4.5	6.4	1950	20	1800	62	--
		Nov-06	--	138	--	212	4.8	6.3	1978	18.7	1800	74	--
		Feb-07	--	129	--	283	1.9	6	2067	15.5	1700	260	--
		May-07	--	141	--	295	3.2	6.3	1956	22.9	1400	210	--
		Aug-07	--	135	--	214	4	6.1	1932	20	1700	71	--
		Nov-07	--	137	--	326	1.5	6.2	1866	23.6	1600	44	--
		Feb-08	--	141	--	295	1.7	6.2	1789	20.5	1500	100	--
		May-08	--	133	--	245	1.2	6.2	1658	21.7	1500	47	--
		May-09	--	133	--	242	0.5	6.4	1347	16.9	1100	4	--
		Nov-09	--	224	--	202	0.5	6.3	1292	16.6	1000	17	--
		May-10	--	151	--	220	0.4	6.2	1286	17.1	1100	12	35
		May-10	--	--	--	--	--	--	--	--	1100	14	--
		Nov-10	--	172	--	200	0.3	6	1260	17.7	--	--	100
		May-11	--	137	--	250	0.3	6	1308	16.5	1000	18	42
		Nov-11	--	154	--	213	0.1	6.2	1632	17.8	1300	23	23.3
		May-12	--	149	--	208	0.1	6.1	1675	17.4	--	11	22
		Nov-12	--	166	--	214	0.2	6.2	1367	17.5	--	40	59.1
		May-13	--	146	--	253	0.2	5.9	1799	16.8	1500	24	37
		May-13	--	--	--	--	--	--	--	--	1500	22	--
		Aug-13	--	158	--	195	0.5	6.1	1687	19.3	--	16.9	18
		Feb-14	--	172	--	325	0.1	5.5	1694	16	1440	14	21
		Aug-14	--	204	--	184	0.1	6.2	1806	19.2	--	30	27.4
		Oct-14	--	--	--	186	0.1	6.1	1802	18.6	1480	37.3	46
		Feb-15	--	156	--	214	0.1	6	1854	15	--	12.8	35
		Aug-15	--	166	--	--	--	--	--	--	--	10.3	33
		Aug-15	--	--	--	--	--	--	--	--	--	11.6	--
		Feb-16	--	163	--	235	0.1	6.1	1800	16.1	--	--	4.9
BRF-48	48	May-99	--	--	--	360	0.2	6.2	2124	15.5	2200	580	--
		Jun-99	--	104	--	337	0.6	5.4	1993	23.3	2000	47	--
		Jul-99	--	104	--	318	0.2	5.6	2402	19.9	2400	62	--
		Aug-99	--	114	--	310	0.4	5.5	2625	21	2300	1100	--
		Sep-99	--	118	--	244	1.9	5.7	2653	19.9	2200	130	--
		Oct-99	--	122	--	246	1	5.7	2346	20.1	2000	200	--

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, field (NTU)
BRF-48 (cont)	48	Nov-99	--	62	--	247	0.8	5.7	2325	18	2200	96	--
		Dec-99	--	84	--	255	0.6	5.7	2359	17.2	64	2200	--
		Dec-99	--	--	--	--	--	--	--	--	71	2200	--
		May-00	--	124	--	277	0.6	5.6	2340	20.1	2300	140	--
		Nov-00	--	66	--	341	--	5.7	2292	16.6	2100	69	--
		May-01	--	78	--	389	2.8	5.8	2124	16	2300	28	--
		May-04	--	148	--	212	0.6	5.8	2420	21.6	2400	140	--
		Aug-06	--	124	--	214	2.8	6	2489	18.5	2400	330	--
		Nov-06	--	120	--	193	6.9	6.1	2574	17.5	2500	360	--
		Feb-07	--	122	--	240	1	5.7	2624	16.4	2400	100	--
		May-07	--	151	--	193	0.6	6	2115	19.9	2600	20	--
		Aug-07	--	151	--	214	0.5	6	2622	21.2	2500	61	--
		Nov-07	--	152	--	316	0.7	6.1	2516	20	2400	18	--
		Feb-08	--	174	--	217	0.8	6	2597	19.2	2300	65	--
		May-08	--	158	--	203	0.5	5.9	2587	19	2500	180	--
		May-09	--	--	--	--	--	--	--	--	2500	57	--
		May-09	--	158	--	203	0.6	6.1	2591	20.6	2500	90	--
		Jun-09	--	--	--	259	0.8	5.8	2597	22.8	--	--	--
		Nov-09	--	174	--	223	0.6	5.8	2582	16.2	2500	140	--
		May-10	--	114	--	222	1.2	5.7	2648	19.5	2600	35	44
		Nov-10	--	186	--	206	0.5	5.7	2155	18.7	--	--	48
		Nov-10	--	--	--	--	--	--	--	--	--	--	--
		May-11	--	166	--	230	0.7	5.9	1945	17.4	1700	28	13
		Nov-11	--	210	--	203	1	6	2512	17.8	--	--	40.1
		Nov-11	--	--	--	--	--	--	--	--	2300	70	--
		May-12	--	216	--	190	0.3	6	2300	17.1	--	25	26.8
		Nov-12	--	202	--	205	0.4	5.9	2044	16.8	--	27	27.9
		Nov-12	--	--	--	--	--	--	--	--	--	31	--
		May-13	--	172	--	244	0.5	5.8	2248	17.7	2000	64	67.8
		Aug-13	--	205	--	192	0.7	5.9	2548	20.6	--	32.2	29
		Feb-14	--	177	--	251	0.1	5.9	2056	13.1	1900	14.4	58
		Feb-14	--	--	--	--	--	--	--	--	1910	12.8	--
		Aug-14	--	240	--	190	0.1	5.9	2638	20.7	--	31	22.5
		Aug-14	--	--	--	--	--	--	--	--	--	30	--
		Feb-15	--	232	--	210	0.1	5.8	2529	12.9	--	29.2	45
		Aug-15	--	268	--	--	--	--	--	--	--	58.8	125
		Feb-16	--	241	--	225	0.1	5.9	2719	13.3	--	--	79
BRF-49	49	May-99	--	--	--	460	0.6	6	1947	14.4	1200	230	--
		Jun-99	--	182	--	376	0	6.66	1381	19.11	1200	170	--
		Jul-99	--	192	--	402	0.1	6.8	1569	17.5	1300	170	--
		Aug-99	--	180	--	382	0.2	6.8	1677	17.7	1200	46	--
		Sep-99	--	184	--	248	0.4	6.7	1692	17.8	1100	360	--
		Oct-99	--	192	--	261	0.5	6.6	1495	18	1200	150	--
		Nov-99	--	178	--	325	0.6	6.8	1503	17.8	1200	170	--
		Dec-99	--	190	--	333	0.4	6.8	1509	16.8	28	1100	--
		May-00	--	183	--	403	0.8	6.5	1620	17.3	1200	27	--
		May-00	--	--	--	--	--	--	--	--	1400	22	--
		Nov-00	--	190	--	408	0.8	6.8	1523	17.1	1300	8	--
		May-01	--	194	--	234	0.1	6.9	1446	16.1	1300	18	--
		May-04	--	239	--	318	0.3	6.8	883	17.1	690	19	--
		Aug-06	--	229	--	204	0.4	6.9	860	18.9	620	12	--
		Nov-06	--	227	--	206	0.3	6.9	875	18	620	26	--
		Feb-07	--	225	--	226	0.3	6.7	899	16.2	550	14	--
		May-07	--	228	--	226	0.7	6.9	815	22.2	560	2	--
		Aug-07	--	222	--	159	0.2	6.9	853	18.6	580	4.1	--
		Nov-07	--	224	--	289	0.2	7	838	18	570	2.5	--
		Feb-08	--	217	--	189	0.3	6.9	828	17.3	550	9.2	--
		Feb-08	--	--	--	--	--	--	--	--	540	10	--
		May-08	--	218	--	178	0.3	7	828	18	250	1.8	--
		May-09	--	209	--	218	0.2	7.1	819	16.1	560	2.5	--
		Jun-09	--	--	--	278	0.2	6.7	843	16.5	--	--	--
		Nov-09	--	247	--	188	0.3	6.9	881	17	590	9.6	11.3
		May-10	--	260	--	207	0.2	6.7	1022	17.4	770	6.1	13
		Nov-10	--	265	--	220	0.2	6.5	1096	17.5	--	--	7.8
		May-11	--	256	--	226	0.3	6.6	1213	16.8	920	8.8	21
		May-11	--	--	--	--	--	--	--	--	950	8.9	--
		Nov-11	--	--	--	--	--	--	--	--	950	5.1	--
		May-12	--	265	--	173	0.2	6.5	1363	16.8	--	4.3	5.2

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, field (NTU)
BRF-49 (cont)	49	Nov-12	--	271	--	192	0.2	6.67	1514	17.5	--	8.8	20.9
		May-13	--	297	--	228	0.2	6.6	1733	16.3	1400	12	12.8
		Aug-13	--	289.5	--	218	0.4	6.6	1767	19	--	6.8	9.3
		Aug-13	--	--	--	--	--	--	--	--	--	6.8	--
		Feb-14	--	299	--	261	0.6	6.6	2162	12.4	1790	7	13.2
		Aug-14	--	309	--	152	0.1	6.4	2538	18.9	--	3.7	4.2
		Feb-15	--	300	--	105	0.1	6.4	3358	15.6	--	<1	3.9
		Aug-15	--	289	--	--	--	--	--	--	--	5.8	4.9
		Feb-16	--	281	--	230	0.2	6.4	4135	15.5	--	--	4.2
BRF-50	50	May-99	--	--	--	411	0.25	6.72	490	16.16	570	130	--
		Jun-99	--	442	--	189	0	6.5	886	19.6	510	12	--
		Jul-99	--	452	--	228	0.1	6.6	1044	17.5	610	130	--
		Aug-99	--	434	--	234	0.1	6.4	1133	17.8	570	29	--
		Sep-99	--	442	--	160	0.4	6.4	1157	17.6	560	490	--
		Oct-99	--	464	--	175	0.5	6.4	1013	17.2	540	1200	--
		Nov-99	--	504	--	186	0.6	6.6	1001	17.1	550	66	--
		Nov-99	--	--	--	--	--	--	--	--	570	84	--
		Dec-99	--	536	--	170	0.4	6.6	1006	16.6	81	570	--
		May-00	--	526	--	202	0.5	6.4	1014	17.9	510	74	--
		Nov-00	--	548	--	176	0.8	6.5	1017	16.3	630	12	--
		May-01	--	540	--	153	0.2	6.6	944	17.3	590	12	--
		May-04	--	632	--	155	0.7	6.5	978	17.6	610	19	--
		Aug-06	--	547	--	133	0.4	6.6	1019	18.2	620	11	--
		Nov-06	--	494	--	136	0.3	6.6	971	17.8	560	120	--
		Feb-07	--	533	--	163	0.4	6.4	1057	16.4	580	8	--
		May-07	--	540	--	136	0.4	6.6	1015	19.8	580	25	--
		Aug-07	--	550	--	129	0.2	6.8	1048	17.9	610	36	--
		Aug-07	--	--	--	--	--	--	--	--	610	36	--
		Nov-07	--	560	--	195	0.2	6.7	1060	17.1	630	18	--
		Feb-08	--	286	--	155	0.3	6.6	531	16.6	310	82	--
		May-08	--	561	--	128	0.4	6.6	970	18.3	600	16	--
		May-08	--	--	--	--	--	--	--	--	600	24	--
		May-09	--	376	--	130	0.2	6.8	745	16.4	400	13	--
		Nov-09	--	432	--	110	0.2	6.5	793	16.3	470	16	5.8
		May-10	--	463	--	77	0.2	6.4	885	17.3	550	20	15
		Nov-10	--	526	--	99	0.1	6.1	974	16.4	--	--	18.1
		May-11	--	584	--	85	0.3	6.3	1069	17	640	60	18.9
		Nov-11	--	577.5	--	95	0.1	6.3	1134	15.5	670	38	24.4
		Nov-11	--	--	--	--	--	--	--	--	640	37	--
		May-12	--	597	--	31	0.1	6.3	1099	16.6	--	23	12.5
		Nov-12	--	598	--	115	0.1	6.4	1109	16.2	--	21	17.2
		May-13	--	613	--	81	0.2	6.4	1118	16.3	640	15	4.9
		Aug-13	--	609	--	127	0.3	6.3	1119	17.8	--	17.4	4
		Oct-14	--	--	--	109	1	6.2	1128	19.2	656	13.7	1.4
		Feb-15	--	564	--	34	0.1	6.4	1060	15.3	--	11.8	9.4
		Feb-15	--	--	--	--	--	--	--	--	--	10.4	--
		Aug-15	--	610	--	--	--	--	--	--	--	55.4	31
		Feb-16	--	603	--	135	0.1	6.3	1112	13.8	--	--	36
BRF-A	A	Nov-81	--	127	--	153	--	6.7	426	16.6	240	--	--
		Jan-82	--	90	--	-22	0	5.6	459	16.5	230	--	--
		Feb-82	--	156	--	2	0.4	6.1	404	16.1	330	--	--
		Jul-82	--	172	--	--	0.8	7.5	321	16	200	--	--
		May-95	--	133	--	201	1.9	5.7	324	16.2	150	54	--
		Nov-95	--	159	--	248	0.1	6	398	17.2	200	7	--
		Jun-96	--	175	--	224	0.1	5.9	409	16.1	250	7	--
		Nov-96	--	154	--	240	0.1	5.7	427	17.1	220	2	--
		Nov-96	--	--	--	--	--	--	--	--	230	2	--
		Jun-97	--	121	--	222	0.1	6	370	16	210	6	--
		Oct-97	--	158	--	195	0.1	5.9	413	16.9	230	<1	--
		May-98	--	130	--	275	1.7	5.8	340	16	220	19	--
		Nov-98	--	197	--	299	4.7	6.2	388	17.2	250	11	--
		May-99	--	143	--	396	0.2	6.1	392	16.5	200	16	--
BRF-B	B	Nov-81	--	169	--	107	--	7.2	378	15.8	190	--	--
		Jan-82	--	160	--	-23	0.2	6.5	435	15.8	180	--	--
		Feb-82	--	188	--	1	0.4	7.3	238	16	180	--	--
		Jul-82	--	189	--	--	--	7.3	362	15.8	220	--	--
		Apr-91	--	210	--	386	0.5	5.4	415	15.6	250	--	--
		Jun-91	--	218	--	205	0.7	6.7	410	17.1	2000	--	--
		Nov-91	--	213	--	95	0.5	6.9	441	16.2	240	7	--

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, field (NTU)
BRF-B (cont)	B	Nov-93	--	209	--	238	0.1	6.9	426	16.3	270	17	--
		May-94	--	216	--	240	0.1	7.1	393	16.3	250	6	--
		Aug-94	--	190	--	337	--	6.9	445	--	--	--	--
		Dec-94	--	217	--	125	0.3	6.9	454	15.9	230	2	--
		May-95	--	228	--	156	0.04	6.9	465	16.9	270	3	--
		Nov-95	--	218	--	148	0.1	7	439	16.2	220	8	--
		Jun-96	--	232	--	131	0.04	6.9	478	16.6	250	7	--
		Jun-96	--	--	--	--	--	--	--	--	250	3	--
		Nov-96	--	228	--	147	0.1	6.7	483	16.5	210	8	--
		Jun-97	--	234	--	134	0.1	6.9	491	16.6	250	6	--
		Oct-97	--	229	--	128	0.1	7	466	16.3	270	7	--
		May-98	--	227	--	136	0.07	6.9	429	16.7	280	1	--
		Nov-98	--	229	--	113	0.1	7.1	391	16.9	230	3	--
		May-99	--	219	--	228	0.1	6.9	474	17.1	260	1	--
BRF-BRC0.3	*BRC1*	Oct-90	--	122	--	280	8.3	7.4	275	19.3	140	3	--
BRF-BRC1.9	*BRC2*	Oct-90	--	130	--	280	8.5	7.8	300	14.1	120	8	--
BRF-C	C	Nov-81	--	81	--	266	--	6.3	272	15.3	90	--	--
		Jan-82	--	85	--	-22	3.7	5.9	315	14.9	140	--	--
		Feb-82	--	118	--	1	0.5	6.4	212	14.9	160	--	--
		Jul-82	--	185	--	--	--	7.3	270	15	240	--	--
		Nov-89	--	87	--	60	0.2	6	320	16.9	210	25	--
		Feb-90	--	216	--	10	0.4	6.6	420	16	200	5	--
		May-90	--	101	--	49	0.3	6	340	15.9	220	15	--
		Aug-90	--	124	--	185	0.2	6.2	360	15.8	230	2	--
		Nov-90	--	122	--	146	0.2	6.1	364	15.3	110	--	--
		Feb-91	--	133	--	135	0.5	6.5	407	15.3	260	--	--
		Apr-91	--	115	--	125	0.5	6	370	16.9	230	--	--
		May-91	--	115	--	267	0.3	6	380	16.7	250	--	--
		Jun-91	--	115	--	253	0.5	6.1	360	17.1	2100	--	--
		Aug-91	--	100	--	164	0.4	6.1	357	17.1	220	--	--
		Nov-91	--	103	--	259	0.9	6	340	16.9	220	5	--
		Nov-92	--	91	--	115	0.7	5.7	324	16.5	210	10	--
		May-93	--	81	--	116	0.3	6	332	17	220	6	--
		May-93	--	89	--	158	0.2	6.1	334	16.7	--	--	--
		Nov-93	--	86	--	316	0.1	5.8	302	17.3	210	1	--
		May-94	--	86	--	285	0.1	6.1	260	15.8	180	<1	--
		Dec-94	--	87	--	185	0.04	5.9	295	16.4	140	<1	--
		May-95	--	86	--	251	0.04	6	296	15.8	180	2	--
		Nov-95	--	89	--	281	0.02	6	280	16.4	170	1	--
		Jun-96	--	96	--	215	0.03	6	301	16.1	160	<1	--
		Nov-96	--	100	--	285	0.1	5.8	317	16.3	160	<1	--
		Jun-97	--	111	--	240	0.1	6.1	384	16.1	220	3	--
		Oct-97	--	126	--	286	0.1	6	445	16.5	250	<1	--
		Oct-97	--	--	--	--	--	--	--	--	250	<1	--
		May-98	--	145	--	248	0.2	6	513	16.3	370	<1	--
		May-98	--	--	--	--	--	--	--	--	370	<1	--
		Nov-98	--	166	--	266	0.1	6.1	578	16.8	420	<1	--
		May-99	--	177	--	386	0.1	6.1	799	17	540	2	--
BRF-D	D	Nov-81	--	362	--	312	--	7.2	1277	14	790	--	--
		Jul-82	--	362	--	--	0.9	8	1249	15.9	1000	--	--
		Nov-89	--	337	--	10	5.4	7.3	980	14	800	62	--
		Mar-90	--	341	--	140	8.2	7.4	1010	13.8	730	160	--
		May-90	--	336	--	216	7.2	6.2	950	15	680	120	--
		Aug-90	--	336	--	218	5.3	7.3	905	16.2	670	25	--
		Nov-90	--	338	--	203	3.7	7.1	875	13.9	620	--	--
		Feb-91	--	332	--	285	4.6	7.2	940	14.3	740	--	--
		Apr-91	--	337	--	293	2.2	5.8	904	12.9	640	--	--
		May-91	--	332	--	272	3.5	7	820	14.9	620	--	--
		Jun-91	--	336	--	4	--	7	890	14.8	510	--	--
		Aug-91	--	328	--	292	7.8	7.4	896	14.8	620	--	--
		Nov-91	--	340	--	177	1.8	7	890	15.1	600	31	--
		Feb-92	--	338	--	272	6.2	7.1	938	14.2	630	21	--
		May-92	--	337	--	250	3.9	7.1	910	13.9	620	86	--
		Aug-92	--	329	--	620	3.3	6.9	876	15.7	610	9	--
		Nov-92	--	335	--	116	1.7	7	877	14.9	580	16	--
		May-93	--	312	--	145	2.5	7	940	14.5	680	10	--
		May-93	--	325	--	270	0.3	7	985	17	--	--	--
		Nov-93	--	332	--	426	5.1	7.1	894	14.6	630	9	--
		May-94	--	330	--	294	2.3	7	800	14.9	480	9	--

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, field (NTU)
BRF-D (cont)	D	Nov-94	--	336	--	323	4.6	7.1	902	13.9	580	18	--
		May-95	--	340	--	220	3.3	7	968	15.5	620	28	--
		Nov-95	--	340	--	473	2.5	7	832	13.6	440	6	--
		Jun-96	--	328	--	397	6.9	7	946	17.6	780	36	--
BRF-E	E	Jul-82	--	150	--	--	--	7.9	515	--	310	--	--
		Aug-82	--	162	--	--	--	7.7	580	--	320	--	--
		Oct-82	--	260	--	--	--	7.1	550	--	280	--	--
		Sep-83	--	259	--	--	--	7.1	536	--	320	--	--
		Jan-85	--	175	--	--	--	7.4	485	--	280	--	--
		Dec-88	--	271	--	250	4.3	7.4	--	14	270	--	--
		Mar-89	--	234	--	0	0.3	6.8	480	14.5	260	--	--
		Aug-89	--	330	--	0	0.4	7.3	470	14.1	300	--	--
		Nov-89	--	248	--	0	0.2	7.3	480	13.3	310	2	--
		Feb-90	--	258	--	80	0.8	7.4	520	13.6	290	4	--
		May-90	--	261	--	94	0.6	7.21	530	17	320	3	--
		Jul-90	--	287	--	18	0.6	7.2	570	15.3	370	4	--
		Nov-90	--	298	--	80	0.4	7.3	70	14.2	350	--	--
		Feb-91	--	272	--	43	0.7	7.1	550	14.4	380	--	--
		May-91	--	270	--	62	0.3	7.2	560	15.2	350	--	--
		Aug-91	--	292	--	118	1.5	7.3	637	14.5	380	--	--
		Nov-91	--	284	--	34	0.4	7.2	637	14.2	370	4	--
		Feb-92	--	289	--	36	0.7	7.2	625	10.7	270	9	--
		May-92	--	280	--	87	1.3	7.3	637	14	370	4	--
		Aug-92	--	302	--	90	0.1	7	669	16	390	4	--
BRF-F	F	Dec-88	--	257	--	260	1.4	6.9	250	16	460	--	--
		Mar-89	--	262	--	100	0.3	6.6	2370	16.5	2200	--	--
		Aug-89	--	185	--	0	0.1	6.7	2200	18.2	2200	--	--
BRF-F45	F45	Nov-92	--	1043	--	115	1.2	6.8	927	16.9	440	13000	--
		Feb-93	--	414	--	343	1	6.8	911	16.4	560	22000	--
		May-93	--	384	--	85	0.7	6.8	1147	16.3	730	2800	--
		Aug-93	--	530	--	20	1.3	6.7	1176	20.6	880	1200	--
		Aug-93	--	540	--	7	1	6.7	1142	18.6	840	3400	--
		Nov-93	--	668	--	328	1.5	6.7	1276	16	990	1700	--
		Mar-94	--	442	--	261	0.8	6.7	1211	17.7	--	--	--
		May-94	--	408	--	207	0.6	6.8	1164	15	1000	2900	--
		Aug-94	--	436	--	241	0.4	6.6	1287	18.8	--	--	--
		Nov-94	--	438	--	205	1.2	6.7	1285	17.1	590	460	--
		May-95	--	430	--	219	0.6	6.7	1237	17.6	740	860	--
		Nov-95	--	418	--	260	0.4	6.6	1160	19.1	660	71	--
		Jun-96	--	412	--	224	0.5	6.7	1109	18.5	770	460	--
		Nov-96	--	397	--	199	0.2	6.3	1188	18.9	730	15	--
		Jun-97	--	398	--	199	0.2	6.7	1188	18.4	780	20	--
		Oct-97	--	412	--	175	0.3	6.6	1178	19	830	31	--
		May-98	--	402	--	183	0.2	6.6	1259	17.8	1000	21	--
		Nov-98	--	398	--	224	1.7	6.7	1006	18.3	680	620	--
		May-99	--	367	--	316	0.4	6.6	1260	18.4	960	36	--
		Nov-99	--	364	--	197	2.7	6.6	1164	21.2	760	12	--
		Jun-00	--	371	--	299	0.6	6.6	1264	17.5	880	15	--
		Jun-00	--	--	--	--	--	--	--	--	910	26	--
		Nov-00	--	400	--	292	2.5	6.6	1173	18.4	890	200	--
		May-01	--	396	--	291	2.1	6.6	1137	15.7	830	42	--
		Nov-01	--	405	--	347	2	6.6	1113	19.8	790	12	--
		May-02	--	380	--	262	1.7	6.6	1233	16.6	960	61	--
		Nov-02	--	387	--	264	0.9	6.4	1204	18.7	870	110	--
		May-03	--	393	--	222	0.6	6.5	1325	16.1	1100	110	--
		Nov-03	--	389	--	118	0.7	6.6	1286	18.6	920	67	--
		May-04	--	396	--	185	0.5	6.5	1130	16.5	1000	100	--
		Nov-04	--	390	--	121	0.3	6.6	1290	19.2	860	28	--
		May-05	--	377	--	115	0.5	6.5	1078	14.4	930	220	--
		Nov-05	--	385	--	243	0.4	6.5	1202	20.2	840	10	--
		May-06	--	374	--	205	0.2	6.5	1285	15	1000	170	--
		Jul-06	--	360	--	189	0.2	6.5	1264	18.3	--	--	--
		Nov-06	--	365	--	125	0.4	6.6	1380	19.3	1000	7	--
		Feb-07	--	340	--	202	0.6	6.3	1751	17.3	--	--	--
		May-07	--	327	--	192	0.6	6.7	1897	19.2	1600	8	--
		Nov-07	--	346	--	207	0.5	6.6	1666	20.9	1400	9.6	--
		May-08	--	319	--	196	0.7	6.6	1966	18.7	1700	8.9	--
		Nov-08	--	325	--	169	0.4	6.6	2005	19.2	1700	9.2	--
		Feb-09	--	326	--	203	0.6	6.4	1895	18.2	1600	10	--

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, field (NTU)
BRF-F45 (cont)	F45	May-09	--	322	--	195	0.4	6.7	1912	17.2	1600	6.5	--
		Aug-09	--	330	--	228	0.5	6.5	1886	16.5	1700	15	--
BRF-F45R	F45R	Nov-08	--	269	--	204	0.5	6.8	2900	16.9	2600	100	--
		Feb-09	--	289	--	211	0.4	6.6	2970	15.5	2800	39	--
		May-09	--	289	--	177	0.4	6.9	3187	14.7	3100	20	--
		Aug-09	--	301	--	197	0.4	6.8	3102	15.7	3200	17	--
		Nov-09	--	307	--	177	0.4	6.6	3242	16.3	3300	13	--
		Nov-09	--	--	--	--	--	--	--	--	3200	14	--
		Feb-10	--	313	--	201	1	6.5	3354	12.9	3200	--	--
		May-10	--	304	--	204	0.4	6.5	3310	16.1	3400	18	--
		Nov-10	--	300.5	--	204	0.2	6.4	3107	16.6	3000	25	--
		Nov-10	--	--	--	--	--	--	--	--	3000	27	--
		May-11	--	316	--	192	0.3	6.5	3366	15.8	3300	20	--
		Nov-11	--	312	--	173	0.2	6.6	3410	17.2	3300	30	9.6
		May-12	--	308	--	197	0.3	6.5	3369	16.3	--	34	35
		Nov-12	--	302	--	173	0.4	6.6	3354	15.4	--	13	3.3
		Nov-12	--	--	--	--	--	--	--	--	--	12	--
		May-13	--	315	--	193	0.5	6.7	3268	14.5	3500	22	41.5
		Aug-13	--	319	--	152	0.4	6.6	3526	16.7	--	22.8	7.7
		Feb-14	--	369	--	163	0.3	6.5	3373	14.2	3320	23.9	20.1
		Feb-14	--	--	--	--	--	--	--	--	3340	20.8	--
		Aug-14	--	320	--	151	0.1	6.5	3449	16.3	3340	22.2	4.9
		Feb-15	--	307	--	162	0.1	6.5	3425	12.4	--	23.3	19
		Aug-15	--	326	--	--	--	--	--	--	--	29.2	22
		Feb-16	--	320	--	165	0.1	6.5	3370	15.6	--	--	44
BRF-G	G	Dec-88	--	200	--	280	0.5	6.6	150	14.8	220	--	--
		Mar-89	--	190	--	0	0.3	7.3	450	15.9	250	--	--
		Aug-89	--	189	--	0	0.2	7.4	390	17.2	210	--	--
		Nov-89	--	190	--	0	0.2	7.4	400	15	240	2	--
		Feb-90	--	158	--	100	1.1	7.8	500	16.8	320	8	--
		May-90	--	190	--	220	1.9	7.35	430	17.5	250	9	--
		Aug-90	--	198	--	222	3.8	7.5	418	16.6	260	5	--
		Nov-90	--	188	--	261	3.6	7.5	433	14.6	260	--	--
		Feb-91	--	195	--	228	4	7.7	440	14.9	260	--	--
		May-91	--	193	--	345	3.4	7.4	430	15.6	280	--	--
		Aug-91	--	228	--	281	2.9	7.3	439	16.1	260	--	--
		Nov-91	--	188	--	294	4.5	7.5	548	15.3	320	8	--
		Nov-91	--	--	--	--	--	--	--	--	310	11	--
		Feb-92	--	191	--	311	7.6	7.4	735	15.1	470	2	--
		May-92	--	189	--	299	4.2	7.4	551	14.9	350	9	--
		Aug-92	--	194	--	437	4.1	7.3	452	17.3	280	6	--
		Dec-92	--	192	--	306	7.3	7.4	560	15.1	330	4	--
		May-93	--	183	--	238	4.1	7.4	482	16.6	300	6	--
		Nov-93	--	192	--	398	3	7.3	454	17.2	280	5	--
		Mar-94	--	181	--	305	7.1	7.5	777	16.1	--	--	--
		May-94	--	188	--	255	2.7	7.4	505	18.8	310	<1	--
		Aug-94	--	200	--	322	3.2	7.3	530	16	--	--	--
		Nov-94	--	188	--	269	5.4	7.4	608	16.1	290	3	--
		May-95	--	183	--	212	5.3	7.5	786	15.9	520	4	--
		Nov-95	--	185	--	420	4.9	7.3	772	16.2	430	1	--
		Jun-96	--	179	--	318	6	7.4	877	16.3	650	<1	--
		Nov-96	--	190	--	503	6.2	7.1	682	16.1	430	2	--
		Nov-96	--	42	--	390	5.9	9.2	201	16.3	80	2	--
		Jun-97	--	168	--	411	1.4	7.1	1390	18	1100	<1	--
		Jun-97	--	172	--	341	5.4	7.4	993	16	730	2	--
		Oct-97	--	198	--	427	3.5	7.3	591	14.8	370	2	--
		Oct-97	--	19	--	324	6.1	9.7	165	16	80	1	--
		May-98	--	180	--	351	0.3	7	1459	17.1	1300	<1	--
		May-98	--	44	--	226	5.1	10.7	543	20.8	370	<1	--
		Nov-98	--	199	--	440	0.3	7.3	453	16.5	300	<1	--
		Nov-98	--	190	--	406	3.9	7.4	621	15.6	470	<1	--
		May-99	--	33	--	295	4.4	10.5	662	16.9	390	7	--
		May-99	--	181	--	341	0.5	7	1540	16.6	1000	2	--
		Nov-99	--	168	--	324	0.6	7	471	19.6	280	<1	--
		Jun-00	--	172	--	485	5.4	7.3	969	18.3	750	1	--
		Nov-00	--	198	--	477	4	7.1	849	15.5	660	<1	--
		May-01	--	200	--	403	3.9	7.2	551	14.9	370	<1	--
		Nov-01	--	205	--	478	3.2	7.2	621	15.9	410	2	--
		May-02	--	187	--	533	3.1	7.1	918	15.2	740	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, field (NTU)
BRF-G (cont)	G	Nov-02	--	199	--	530	4.7	7.2	641	15.6	390	<1	--
		May-03	--	186	--	325	4.4	7.1	1179	15.6	1000	2	--
		Nov-03	--	194	--	378	3.3	7.3	869	15.6	610	<1	--
		May-04	--	175	--	289	5.1	7.2	887	15.9	780	3	--
		Nov-04	--	192	--	307	3.2	7.4	534	15.7	330	2	--
		May-05	--	182	--	255	4.8	7	980	15.1	810	2	--
		Nov-05	--	--	--	460	3.7	7.3	777	15.3	500	<1	1
		May-06	--	200	--	467	4.3	7.2	716	15.4	400	2	--
		Nov-06	--	210	--	304	4.4	7.4	476	16.2	310	9	--
		Feb-07	--	197	--	427	3.5	7	1009	15.4	--	--	--
		May-07	--	198	--	430	5.2	7.4	9	15.3	580	1	--
		Nov-07	--	205	--	469	3.5	7.2	671	15.2	420	1.8	--
		May-08	--	193	--	244	5.5	7.3	900	15.4	560	<1	--
		Nov-08	--	205	--	297	3.7	7.2	729	15.3	460	<1	--
		May-09	--	191	--	273	3.7	7.3	1276	15.3	1000	<1	--
		Nov-09	--	197	--	308	2.7	7	1077	15.6	800	<1	--
		Feb-10	--	197.5	--	369	2.2	7.2	497	13.1	270	<1	--
		May-10	--	197	--	226	0.4	6.4	477	17.9	340	<1	--
		Nov-10	--	221	--	180	0.2	6.6	475	15.2	270	<1	--
		May-11	--	190	--	423	1.5	6.8	967	15.6	720	1	--
		Nov-11	--	208	--	298	0.4	6.9	495	16.3	260	<1	0.6
		Nov-11	--	--	--	--	--	--	--	--	250	<1	--
		May-12	--	198	--	385	1.7	6.2	600	15.2	--	<1	0.6
		Nov-12	--	218	--	273	0.2	6.7	500	16.2	--	<1	1.1
		May-13	--	198	--	351	2.6	7.3	808	14.3	560	<2.5	0.3
		Aug-13	--	217	--	317	0.3	6.9	542	16.4	--	<1	1.2
		Feb-14	--	198	--	330	3	7.1	459	14.5	230	<1	2.3
		Aug-14	--	216	--	268	0.1	7	499	16.3	294	1.5	3.1
		Aug-14	--	--	--	--	--	--	--	--	292	1.4	--
		Feb-15	--	196	--	302	3.4	7.1	450	14.5	--	<1	0.5
		Aug-15	--	204	--	--	--	--	--	--	--	<1	1.2
		Feb-16	--	218	--	211	0.1	6.9	587	16.6	--	--	3.9
BRF-H	H	Dec-88	--	306	--	322	0.7	7.1	205	15.7	330	--	--
		Mar-89	--	360	--	0	0.2	7.3	800	15.6	480	--	--
		Aug-89	--	315	--	0	0.2	7.1	670	17.1	430	--	--
		Nov-91	--	332	--	188	1.3	7.1	1294	16.1	980	29	--
		Feb-92	--	333	--	122	2.2	6.9	1483	15.3	1200	22	--
		May-92	--	342	--	167	5.1	6.9	1580	15.5	2500	12	--
		Aug-92	--	344	--	-9	4.4	7	1483	17	1200	54	--
		Nov-96	--	347	--	80	4.4	6.6	1798	16.2	1300	10	--
		Jun-97	--	348	--	184	6.5	7	1940	17.5	1500	4	--
BRF-I	I	Dec-88	--	270	--	30	0.8	6.9	--	15.4	260	--	--
		Mar-89	--	276	--	200	0.7	7	480	15.6	180	--	--
		Aug-89	--	320	--	130	0.5	7.2	450	17	260	--	--
		Nov-91	--	252	--	221	0.8	7.3	490	17	280	23	--
		Feb-92	--	264	--	329	1.1	7.1	494	14.9	260	50	--
		May-92	--	260	--	298	1	7.1	486	14.9	140	60	--
		Aug-92	--	255	--	62	0.6	7.1	477	18.1	270	8	--
		Dec-92	--	240	--	315	1.2	7	489	15.9	270	44	--
		May-93	--	242	--	343	0.7	7.2	474	16.9	280	21	--
		Nov-93	--	253	--	501	0.9	7.1	463	17.3	320	60	--
		Nov-93	--	111	--	256	1.1	--	345	16.3	--	--	--
		Mar-94	--	254	--	377	0.7	7.2	441	15.4	--	--	--
		May-94	--	261	--	326	0.5	7.3	432	15.5	260	4	--
		Aug-94	--	262	--	366	0.5	7.2	498	16.3	--	--	--
		Nov-94	--	260	--	331	0.7	7.2	497	16.2	220	7	--
		May-95	--	262	--	215	1.2	7.2	487	15.4	370	53	--
		Nov-95	--	263	--	431	0.5	7	461	16.7	220	11	--
		Nov-95	--	--	--	--	--	--	--	--	240	8	--
		Jun-96	--	259	--	345	0.8	7.2	490	16	340	21	--
		Nov-96	--	252	--	522	0.8	6.9	506	16.4	360	22	--
		Nov-96	--	261	--	533	0.9	6.9	508	16.1	250	2	--
		Jun-97	--	266	--	464	0.6	7.2	513	15.7	290	3	--
		Jun-97	--	--	--	--	--	--	--	--	300	4	--
		Jun-97	--	263	--	467	0.9	7.2	518	19.5	310	15	--
		Oct-97	--	263	--	423	1.6	7.2	488	16.7	280	130	--
		Oct-97	--	260	--	408	0.8	7.2	499	17.7	270	<1	--
		May-98	--	260	--	453	0.9	7.1	472	15.2	280	16	--
		May-98	--	261	--	451	0.8	7.1	479	17.1	290	<1	--

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, field (NTU)
BRF-I (cont)	I	Nov-98	--	262	--	500	0.8	7.2	429	17.8	260	<1	--
		Nov-98	--	263	--	517	0.7	7.2	427	16.6	260	2	--
		Nov-98	--	--	--	--	--	--	--	--	270	2	--
		May-99	--	260	--	462	0.6	7.1	516	15.8	290	<1	--
		May-99	--	262	--	440	0.8	7.1	519	18.4	280	<1	--
		Nov-99	--	184	--	467	0.89	6.9	501	16.7	290	<1	--
		Jun-00	--	246	--	438	0.8	7.2	504	15.9	290	<1	--
		Nov-00	--	262	--	555	1.6	7	498	16.4	330	8	--
		May-01	--	263	--	508	0.7	7	476	14.9	310	3	--
		May-01	--	--	--	--	--	--	--	--	310	3	--
		Nov-01	--	263	--	502	2	7.1	496	17.3	320	14	--
		May-02	--	257	--	480	0.8	7.1	506	15.4	310	6	--
		Nov-02	--	258	--	519	1.2	6.9	504	16.6	320	24	--
		Nov-02	--	--	--	--	--	--	--	--	320	16	--
		May-03	--	261	--	483	0.7	7	520	7.16	320	7	--
		Nov-03	--	258.5	--	525	1.3	7.2	505	16.3	280	3	--
		Nov-03	--	--	--	--	--	--	--	--	280	2	--
		May-04	--	257	--	376	1.1	6.9	428	15.4	300	6	--
		Nov-04	--	258	--	326	0.7	7.2	520	16.2	300	6	--
		Nov-04	--	--	--	--	--	--	--	--	300	14	--
		May-05	--	250	--	316	0.8	7	439	15	300	5	--
		Nov-05	--	--	--	514	1.5	7.1	517	16.5	310	6	3
		May-06	--	267	--	529	0.8	7	515	15.4	310	2	--
		May-06	--	264	--	--	--	--	--	--	320	3	--
		Nov-06	--	265	--	276	1	7.1	530	16.5	340	6	--
		Feb-07	--	261.5	--	450	0.9	6.9	569	15.4	--	--	--
		May-07	--	262	--	485	0.9	7.1	529	15.6	290	<1	--
		Nov-07	--	262	--	439	1	7.1	529	16.8	280	2.2	--
		May-08	--	263	--	311	0.7	7.1	527	15.5	290	2.3	--
		May-08	--	--	--	--	--	--	--	--	290	2.8	--
		Nov-08	--	263	--	310	1.1	7.1	542	16.7	280	2.1	--
		May-09	--	260	--	349	0.7	7.2	533	15.3	300	5.6	--
		May-09	--	--	--	--	--	--	--	--	290	5.8	--
		Nov-09	--	264	--	310	1.1	7	5.36	16.7	310	12	--
		Feb-10	--	269	--	352	1.5	7	547	11.6	300	6.1	--
		May-10	--	270	--	333	3.9	6.9	521	19.1	330	4.9	--
		May-10	--	--	--	--	--	--	--	--	320	4.1	--
		Nov-10	--	270	--	377	0.7	6.6	531	16.5	--	--	--
		Nov-10	--	--	--	--	--	--	--	--	280	1.4	--
		May-11	--	272	--	432	0.7	6.6	560	16.1	310	3.5	--
		May-11	--	--	--	--	--	--	--	--	--	--	--
		Nov-11	--	256	--	341	0.6	6.8	574	16.6	300	<1	2.1
		May-12	--	258	--	368	0.6	6.8	555	16.6	--	3	8.1
		Nov-12	--	269	--	367	0.5	7	566	18.1	--	<1	1.8
		May-13	--	268	--	366	0.7	7.1	569	15.6	310	5.5	3
		Aug-13	--	277	--	340	0.6	6.8	573	19.6	--	1.9	2.3
		Aug-13	--	--	--	--	--	--	--	--	--	<1	--
		Feb-14	--	263	--	331	0.8	6.9	566	13.8	289	1.3	1.7
		Aug-14	--	275	--	312	0.2	6.8	594	18.6	322	<1	0.3
		Feb-15	--	280	--	292	0.1	6.8	580	14	--	<1	0.4
		Aug-15	--	235	--	--	--	--	--	--	--	<1	1.3
		Feb-16	--	281	--	418	0.1	6.8	587	15.8	--	--	4.5
BRF-J	J	Nov-91	--	240	--	302	1.1	7.2	571	17.7	350	49	--
		Feb-92	--	255	--	216	1	7.1	609	15.9	370	20	--
		May-92	--	250	--	234	0.5	7.1	624	16.6	400	6	--
		May-92	--	--	--	--	--	--	--	--	400	5	--
		Aug-92	--	245	--	582	0.1	7.1	644	16.9	440	4	--
		Nov-92	--	244	--	135	0.6	6.9	679	16.2	460	5	--
		Nov-92	--	--	--	--	--	--	--	--	450	2	--
		Feb-93	--	--	--	448	0.4	7	701	16.2	460	<1	--
		May-93	--	229	--	306	0.2	7.1	708	17.8	490	6	--
		Aug-93	--	232	--	10	0.4	7.1	687	18.9	480	1	--
		Aug-93	--	--	--	--	--	--	--	--	500	2	--
		Aug-93	--	240	--	-24	0.3	7.1	636	20	470	25	--
		Aug-93	--	--	--	--	--	--	--	--	470	19	--
		Nov-93	--	237	--	294	0.2	7	701	16.3	510	<1	--
		Mar-94	--	235	--	325	0.05	7.1	647	16.8	--	--	--
		May-94	--	237	--	269	0.04	7.1	629	16.5	390	<1	--
		Aug-94	--	240	--	301	0.02	7.1	711	16.4	--	--	--

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, field (NTU)
BRF-J (cont)	J	Nov-94	--	234	--	96	0.02	7.1	712	16	380	<1	--
		May-95	--	245	--	208	0.01	7.1	708	16.4	450	<1	--
		May-95	--	--	--	--	--	--	--	--	490	<1	--
		Nov-95	--	242	--	288	0.1	7	672	16.5	340	<1	--
		Jun-96	--	246	--	227	0.03	7	690	16.7	440	<1	--
		Nov-96	--	243	--	205	0.04	6.7	699	16.2	430	<1	--
		Jun-97	--	248	--	224	0.02	7	696	16.2	370	<1	--
		Oct-97	--	255	--	220	0.1	7	680	15.9	420	<1	--
		May-98	--	253	--	220	0.1	7	633	16	440	<1	--
		Nov-98	--	270	--	169	0.1	7	590	16.1	410	<1	--
		May-99	--	219.5	--	390	0.1	7	665	16.7	410	<1	--
		May-99	--	--	--	--	--	--	--	--	390	<1	--
		Nov-99	--	218	--	119	0.5	6.8	679	16.6	420	<1	--
		Jun-00	--	228	--	330	0.2	6.9	680	16.5	430	<1	--
		Nov-00	--	254	--	259	0.6	6.9	595	16.2	500	<1	--
		Nov-00	--	--	--	--	--	--	--	--	490	<1	--
		May-01	--	242	--	383	0.1	6.9	667	15.8	470	<1	--
		Nov-01	--	249	--	263	0.1	6.9	717	16	490	<1	--
		May-02	--	244	--	266	0.1	6.9	737	16.1	540	<1	--
		May-02	--	--	--	--	--	--	--	--	540	<1	--
		Nov-02	--	245	--	362	0.5	6.9	731	16	490	2	--
		May-03	--	242	--	278	0.1	6.9	757	16.1	560	<1	--
		May-03	--	--	--	--	--	--	--	--	550	<1	--
		Nov-03	--	241	--	87	0.4	7.1	757	16.1	510	<1	--
		May-04	--	239	--	283	0.4	6.8	694	16.4	560	3	--
		May-04	--	--	--	--	--	--	--	--	560	<1	--
		Nov-04	--	241	--	203	0	7	833	16.3	560	<1	--
		May-05	--	225.5	--	235	0.2	6.8	747	16.3	570	<1	--
		May-05	--	--	--	--	--	--	--	--	590	8	--
		Nov-05	--	248.5	--	347	0.2	6.9	873	16.4	590	1	--
		Nov-05	--	--	--	--	--	--	--	--	590	1	--
		May-06	--	232	--	392	0.2	6.9	902	16.7	630	<1	--
		Nov-06	--	238	--	339	0.2	6.9	945	16.5	700	2	--
		Nov-06	--	--	--	--	--	--	--	--	720	1	--
		Feb-07	--	235	--	363	0.4	6.7	999	16.6	--	--	--
		May-07	--	235.5	--	387	0.4	7	949	16.7	670	<1	--
		May-07	--	--	--	--	--	--	--	--	680	<1	--
		Nov-07	--	234	--	396	0.1	7	971	16.5	680	<1	--
		Nov-07	--	--	--	--	--	--	--	--	700	<1	--
		May-08	--	220	--	246	0.2	7	976	16.8	750	<1	--
		Nov-08	--	234.5	--	235	0.1	6.9	1023	16.7	730	<1	--
		Nov-08	--	--	--	--	--	--	--	--	730	<1	--
		May-09	--	211	--	304	0.3	7	1082	16.6	830	<1	--
		Nov-09	--	214	--	251	0.2	6.8	1119	16.6	870	<1	--
		Feb-10	--	222	--	429	3.4	5.9	935	14.4	690	13	--
		Mar-10	--	307	--	356	1.5	6.5	1150	14.4	--	--	--
		May-10	--	218	--	351	1.8	6.7	16.6	16.5	880	<1	--
		Nov-10	--	219	--	358	0.2	6.5	1087	17.2	810	<1	--
		May-11	--	214	--	500	1.8	6.7	1076	16.2	830	<1	--
		May-11	--	--	--	--	--	--	--	--	820	<1	--
		Nov-11	--	216	--	304	0.1	6.7	1183	17	880	<1	1.5
		May-12	--	207.5	--	346	1.3	6.7	1087	17	--	<1	1.3
		May-12	--	--	--	--	--	--	--	--	--	<1	--
		Nov-12	--	214	--	432	0.4	6.8	1090	16.3	--	<1	1.6
		May-13	--	231.5	--	377	2.5	7.2	965	16.6	700	<2.5	0.4
		May-13	--	--	--	--	--	--	--	--	700	<2.5	--
		Aug-13	--	225	--	388	0.5	6.7	1096	18.3	--	1.2	1.8
		Feb-14	--	218	--	354	0.4	6.8	1170	14.1	967	1.1	2.5
		Aug-14	--	221	--	372	0.8	6.8	1138	17.4	883	<1	0.3
		Feb-15	--	214	--	290	2.9	7	1031	14.6	--	<2	0.8
		Aug-15	--	230	--	--	--	--	--	--	--	1.4	2.3
		Aug-15	--	--	--	--	--	--	--	--	--	<1	--
		Feb-16	--	232	--	375	0.1	6.9	1057	169	--	--	4.9
BRF-K	K	Nov-90	--	264	--	130	0.4	6.9	750	16.6	450	--	--
		Feb-91	--	263	--	-12	0.4	7.4	783	15.8	510	--	--
		May-91	--	258	--	-73	0.2	7.3	760	15.3	550	--	--
		Aug-91	--	345	--	-109	0.5	7.1	795	17.1	560	--	--
		Nov-91	--	275	--	-83	0.4	7.1	795	17.8	520	61	--

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, field (NTU)
BRF-L	L	May-91	--	325	--	325	3.5	7.1	710	17.4	490	--	--
		Aug-91	--	318	--	268	4.4	7.2	824	17.3	520	--	--
		Nov-91	--	321	--	331	4.1	7.2	814	16.8	480	4	--
BRF-M	M	Nov-89	--	296	--	180	1.7	7.6	620	16.6	380	9	--
		Mar-90	--	272	--	160	4.9	7.4	620	15.8	340	1	--
		May-90	--	282	--	188	5.6	7.4	620	17.8	380	4	--
		Aug-90	--	293	--	318	4.4	7.4	658	17.8	400	7	--
		Nov-90	--	291	--	225	7.7	7.4	615	16.1	340	--	--
		Feb-91	--	270	--	315	6.5	7.3	590	16.4	420	--	--
		May-91	--	276	--	311	7.3	7.7	630	16.6	400	--	--
BRF-MW-3H	MW-3H/P-3	May-13	--	290	--	300	0.7	7.6	660	16.7	380	<2.5	2.2
		Aug-13	--	293	--	54	1.1	7.2	679	19.4	--	2.2	2.8
		Feb-14	--	282	--	46	2.1	6.2	660	15	377	<1	2.2
		Aug-14	--	291	--	3	0.3	6.9	691	18.6	396	1	--
		Feb-15	--	289	--	28	3.8	7.4	671	15.2	--	1.1	1.1
		Aug-15	--	294	--	--	--	--	--	--	--	1	1
		Feb-16	--	291	--	37	2.9	7.3	667	17.7	--	--	4
BRF-N	N	Nov-89	--	410	--	520	2.2	7	860	16.6	540	9	--
		Feb-90	--	425	--	230	4.3	7	870	15.7	540	6	--
		May-90	--	423	--	266	3.6	6.9	910	18.5	570	7	--
		Aug-90	--	423	--	357	3.7	6.9	914	17.3	580	2	--
		Nov-90	--	424	--	321	4.9	7	863	16.6	460	--	--
		Feb-91	--	276	--	213	4.7	7.4	668	16.4	400	--	--
		May-91	--	357	--	350	4.3	7.1	730	17.6	510	--	--
		Aug-91	--	392	--	276	4.8	7.1	903	17.1	540	--	--
		Nov-91	--	414	--	352	4.5	7	924	16.7	530	3	--
		Feb-92	--	389	--	337	4.6	7.1	855	16.3	500	24	--
		May-92	--	385	--	292	4.9	7.1	854	16.8	520	12	--
		Aug-92	--	404	--	523	3.5	6.9	878	18.4	530	9	--
		Nov-92	--	402	--	255	5	6.9	878	17.3	500	4	--
		May-93	--	342	--	355	4.9	7.1	789	19.3	480	3	--
		Nov-93	--	408	--	424	4.9	7	899	16.8	560	12	--
		May-94	--	380	--	298	4.1	7.2	748	19.5	400	6	--
		Nov-94	--	402	--	315	4.6	7	905	16.7	520	13	--
		May-95	--	310	--	229	5	7.2	698	19.2	440	16	--
BRF-O	O	Nov-90	--	233	--	207	0.5	7.1	1258	16.4	980	--	--
		Feb-91	--	233	--	202	0.7	7.1	1386	16.4	1100	--	--
		May-91	--	231	--	209	0.3	7	1290	17.8	1100	--	--
		Aug-91	--	347	--	70	0.6	6.88	1432	17.2	1200	--	--
		Nov-91	--	245	--	160	0.5	6.82	1461	16.8	1200	10	--
		Feb-92	--	257	--	123	0.6	6.8	1480	16.4	1200	9	--
		Feb-92	--	257	--	123	0.6	6.8	1480	16.4	1200	4	--
		May-92	--	253	--	243	0.5	6.8	1469	16.5	1200	4	--
		Aug-92	--	250	--	468	0.1	6.8	1433	18.8	1200	5	--
		Nov-92	--	254	--	110	0.6	6.7	1410	17	1100	2	--
		May-93	--	248	--	113	0.3	6.8	1472	18	1300	2	--
		May-93	--	--	--	--	--	--	--	--	1300	2	--
		Nov-93	--	248	--	384	0.1	6.6	1500	17.5	1300	2	--
		May-94	--	254	--	659	0.3	6.8	1355	17.9	1300	<1	--
		Nov-94	--	252	--	293	0.2	6.7	1537	17.3	1300	4	--
		May-95	--	265	--	154	0.2	6.7	1568	18.6	1300	2	--
		Nov-95	--	--	--	--	--	--	--	--	--	--	--
		Nov-95	--	265	--	418	0.1	6.7	1502	16.9	1200	2	--
		Jun-96	--	267	--	328	0.3	6.7	1579	19.4	1300	<1	--
		Nov-96	--	263	--	324	0.2	6.4	1639	17.6	1200	2	--
		Jun-97	--	269	--	289	0.3	6.7	1622	19.5	1400	7	--
BRF-P	P	Nov-90	--	170	--	38	0.3	11.4	768	16.5	300	--	--
		Feb-91	--	221	--	15	0.4	10.3	476	16.7	280	--	--
		May-91	--	224	--	44	0.4	9.3	450	17.3	270	--	--
		Aug-91	--	230	--	35	0.5	8.9	456	17.1	310	--	--
		Nov-91	--	228	--	6	0.4	8	483	16.7	280	95	--
BRF-PZ 2AC	PZ-2AC	May-99	--	--	--	--	--	--	--	--	230	<1	--
BRF-Q	Q	May-91	--	259	--	120	2.4	7.4	740	16.5	530	--	--
		Aug-91	--	339	--	-74	1	7.1	793	19.3	550	--	--
		Nov-91	--	280	--	12	0.8	7.1	758	18.7	460	260	--
		Feb-92	--	244	--	78	0.8	7.1	796	15	520	17	--
		May-92	--	224	--	81	1.1	7.1	746	13.7	480	13	--
		Aug-92	--	251	--	52	0.5	7.1	750	19.7	510	3	--
		Aug-92	--	--	--	--	--	--	--	--	520	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, field (NTU)
BRF-Q (cont)	Q	Nov-92	--	184	--	-80	1.2	7.1	658	18.2	440	2	--
		May-93	--	202	--	132	0.8	7.3	818	14.3	610	1	--
		Nov-93	--	200	--	291	1.5	7.1	780	19.5	620	8	--
		May-94	--	198	--	171	0.8	7.3	651	15.5	390	5	--
		Nov-94	--	170	--	193	2.7	7.1	706	18.2	460	5	--
		May-95	--	202	--	219	2.1	7.2	749	15.8	480	<1	--
		Nov-95	--	192	--	235	1.5	7	853	18.2	430	6	--
		Jun-96	--	221	--	226	1.1	7.1	736	17.7	510	<1	--
		Nov-96	--	215	--	155	1.9	6.8	763	18.7	430	4	--
		Jun-97	--	231	--	33	1	7	930	17.4	520	1	--
BRF-R	R	Nov-90	--	11	--	277	0.1	4.8	1950	16.6	2000	--	--
		Feb-91	--	9	--	325	0.5	4.8	2150	16.6	2100	--	--
		May-91	--	10	--	403	0.3	4.6	1940	18	2000	--	--
		Aug-91	--	100	--	197	0.5	4.65	2050	17.4	2100	--	--
		Nov-91	--	6	--	279	0.4	4.6	202	17.7	1900	470	--
		Feb-92	--	7	--	239	0.5	4.6	2060	16.8	2000	250	--
		May-92	--	250	--	200	0.6	7.5	511	15.7	300	80	--
		Aug-92	--	0	--	293	0.3	4.5	1950	17.7	2000	13	--
		Nov-92	--	0	--	216	0.6	4.4	1920	17.5	2000	5	--
		May-93	--	0	--	229	0.2	4.6	1930	17.6	2000	4	--
		Nov-93	--	0	--	479	0.2	4.5	1995	17.1	2000	4	--
		May-94	--	0	--	751	0.2	4.7	1834	17.5	2000	32	--
		Nov-94	--	0	--	382	0.1	4.7	2055	17.5	1900	35	--
		May-95	--	0	--	230	0.2	4.6	2099	18.4	1900	320	--
		Nov-95	--	0	--	463	0.2	4.5	1950	17.5	1800	42	--
		Jun-96	--	0	--	391	0.2	4.6	1999	18.7	1600	76	--
		Nov-96	--	8	--	425	0.2	4.4	2060	17.7	1700	36	--
		Jun-97	--	8	--	350	0.2	4.8	2083	18.4	1800	62	--
BRF-S	S	Nov-90	--	66	--	248	0.5	5.9	277	16.6	30	--	--
		Feb-91	--	25	--	230	0.4	5.7	200	16.9	260	--	--
		May-91	--	33	--	289	0.4	5.3	220	17.5	170	--	--
		Aug-91	--	36	--	348	0.5	5.4	193	17.9	120	--	--
		Nov-91	--	26	--	250	0.4	5.3	189	16.8	120	2100	--
		Feb-92	--	25	--	291	0.5	5.4	195	16.5	100	600	--
		May-92	--	19	--	331	0.5	5	196	16.5	160	770	--
		Aug-92	--	17	--	497	0.2	5	193	19.3	130	55	--
		Nov-92	--	17	--	193	0.4	5	196	17.6	230	510	--
		May-93	--	19	--	317	0.3	5.2	185	17.1	140	42	--
		Nov-93	--	20	--	467	0.1	5.1	179	17.5	140	42	--
		May-94	--	22	--	721	0.2	5.3	158	18.5	130	33	--
		Nov-94	--	20	--	406	0.1	5.3	177	17	100	270	--
		May-95	--	25	--	195	0.2	5.2	176	19.2	150	64	--
		Nov-95	--	24	--	497	0.2	5.2	165	16.9	120	110	--
		Jun-96	--	28	--	433	0.2	5.2	174	20.7	150	240	--
		Nov-96	--	26	--	461	0.2	5.1	175	17.4	170	790	--
		Jun-97	--	28	--	375	0.1	5.3	180	18.2	210	260	--
		May-11	--	47	--	526	0.5	5.1	179	18.1	120	16	--
		Nov-11	--	44	--	432	0.1	5.3	188	17.1	99	2.6	7.1
		Nov-11	--	--	--	--	--	--	--	--	110	3.3	--
		May-12	--	40	--	431	0.3	5.2	186	18.5	--	4.8	12.2
		Nov-12	--	50	--	470	0.4	5.5	193	17.1	--	4.3	15.4
		May-13	--	50.5	--	513	0.6	5.6	201	17.9	--	<2.5	3.8
		May-13	--	--	--	--	--	--	--	--	--	<2.5	--
		Aug-13	--	53	--	426	0.5	5.2	200	20.4	--	<1	3.1
		Feb-14	--	50	--	515	0.7	5.3	200	13.8	--	1.4	3.5
		Aug-14	--	55	--	635	0.1	5.3	207	19.7	--	1	2.3
		Aug-14	--	--	--	--	--	--	--	--	--	1.1	--
		Feb-16	--	69	--	456	0.1	5.4	230	13.3	--	--	22
BRF-UT0.15	*NNC2*	Oct-90	--	123	--	270	8.4	7.4	380	14.4	190	7	8
		Nov-96	--	74	--	350	9.4	6.9	216	10.7	150	29	--
		Jun-97	--	73	--	282	--	7.3	229	23	130	26	--
BRF-UT0.38	*NNC1*	Oct-90	--	123	--	276	7.9	7.4	290	18.7	140	2	3
		Nov-96	--	77	--	434	7.9	6.9	291	12.3	170	26	--
		Jun-97	--	75	--	269	--	7.3	246	23.6	140	17	--
BRF-WB0.4	*WBR1*	Oct-90	--	176	--	260	10.9	7.7	420	11.5	220	10	10
		Nov-96	--	102	--	334	9.2	7.1	268	11.8	180	36	--
		Jun-97	--	122	--	295	--	7.4	295	21.3	170	44	--
		Nov-01	--	169.5	--	492	11.6	7.9	406	11.2	--	--	--
		Nov-01	--	--	--	--	--	--	--	--	--	--	--

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, field (NTU)
BRF-WB0.4 (cont)	*WBR1*	May-02	--	125	--	514	8.3	7.6	333	26.4	--	--	--
		Nov-02	--	161	--	491	8.5	7.3	433	12.4	260	14	--
		May-03	--	148	--	509	8.7	7.4	356	14.7	220	7	--
		Nov-03	--	175	--	406	10.5	7.7	425	14.8	--	--	--
		May-04	--	160	--	371	14.6	8.2	356	20.4	--	--	--
		Nov-04	--	164	--	341	8.9	7.4	375	12.2	--	--	--
		May-05	--	153	--	318	8.5	7.3	268	11.7	--	--	--
		Nov-05	--	144	--	487	5.2	7.1	354	16	--	--	--
		May-06	--	162	--	493	6.8	7.5	397	19.2	--	--	--
		Nov-06	--	173	--	479	8.8	7.4	446	10.3	--	--	--
		Feb-07	--	173	--	509	9	7.4	488	7	--	--	--
		May-07	--	180	--	471	5.9	7.6	394	17.3	--	--	--
		Nov-07	--	167	--	522	7.9	7.6	385	10.8	--	--	--
		May-08	--	183	--	380	4.4	7.4	441	16.4	--	--	--
		Nov-08	--	190	--	330	8.7	7.4	480	10.6	--	--	--
		May-09	--	144	--	293	8.7	7.6	332	16.7	--	--	--
		Nov-09	--	150	--	332	9.6	6.9	333	12.6	--	--	--
		Feb-10	--	101	--	372	10.8	7.4	264	8.8	--	--	--
		May-10	--	98	--	321	9.2	7	219	14	--	--	--
		Nov-10	--	--	--	--	--	--	--	--	--	--	--
		May-11	--	125	--	395	9.3	7.1	261	15	--	--	--
		Nov-11	--	152	--	325	9.1	7.48	331	14.6	--	--	3.4
		May-12	--	100	--	400	8.57	6.7	230	16.4	--	--	38.1
		Nov-12	--	168	--	348	10	7.6	340	12.3	--	--	7
		May-13	--	77	--	408	9.5	5.8	197	14.7	--	--	13.8
		Feb-14	--	65	--	343	11.4	7.3	161	7.6	--	--	43.5
		Aug-14	--	132	--	302	8.8	6.8	365	18.2	--	--	3.6
*BRF-WB0.95**	*NA*	Nov-07	--	177	--	512	10.6	7.5	380	9.4	--	--	--
		May-08	--	176	--	370	8.4	7.8	394	14.3	--	--	--
		Nov-08	--	179	--	328	9.3	7.5	458	11	--	--	--
		May-09	--	140	--	314	8.7	7.4	306	16.3	--	--	--
		Nov-09	--	182	--	321	9.4	7.3	419	10.8	--	--	--
		Feb-10	--	132	--	390	10.6	7.2	310	9	--	--	--
		May-10	--	135	--	332	8.9	6.8	294	13.8	--	--	--
		Nov-10	--	--	--	--	--	--	--	--	--	--	--
		May-11	--	156	--	426	9.1	7	335	14.5	--	--	--
		Nov-11	--	180	--	345	8.79	7.29	4.09	13.6	--	--	--
		May-12	--	86	--	396	8.71	6.9	202	16.3	--	--	--
		Nov-12	--	180	--	380	9	7	460	12	--	--	--
		May-13	--	107	--	391	9.3	6.3	270	14.1	--	--	--
		Aug-13	--	181	--	363	8.2	7.2	596	19.5	--	--	--
		Feb-14	--	79	--	368	11.5	7.2	205	7	--	--	--
		Aug-14	--	170	--	313	8.5	7.5	520	17.3	--	--	--
BRF-WB1.2	*WBR2*	Oct-90	--	175	--	231	10.7	7.8	320	9.9	200	7	8
		Nov-96	--	93	--	318	9.4	7.1	248	11.9	160	46	--
		Jun-97	--	115	--	302	--	7.4	282	20.8	170	42	--
BRF-WB1.65	*WBR3*	Oct-90	--	168	--	261	10.4	7.8	320	11.5	160	10	10
		Nov-96	--	96	--	281	9.2	7.2	265	12.3	170	39	--
		Nov-96	--	65	--	277	9.4	7.3	180	10.2	150	16	--
		Jun-97	--	101	--	306	--	7.5	240	19.6	140	20	--
		Nov-01	--	173	--	487	9.6	7.9	333	11.9	--	--	--
		May-02	--	153	--	--	9.3	7.7	510	16.6	--	--	--
		Nov-02	--	140	--	510	8.9	7.4	315	13.7	190	6	--
		May-03	--	114	--	472	9.3	7.3	254	14.8	160	9	--
		Nov-03	--	148	--	392	9.1	7.7	327	15.2	--	--	--
		May-04	--	141	--	360	9.8	7.8	269	16.8	--	--	--
		Nov-04	--	120	--	293	9.5	8	261	12.7	--	--	--
		May-05	--	105	--	301	10	7.5	195	12.7	--	--	--
		Nov-05	--	167	--	454	8.8	7.8	340	15.4	--	--	--
		May-06	--	123	--	488	7.8	7.7	257	18.3	--	--	--
		Nov-06	--	149	--	505	10.3	7.8	319	10.8	--	--	--
		Feb-07	--	159	--	488	8.5	7.7	367	9.9	--	--	--
		May-07	--	150	--	425	7.5	7.8	316	15.9	--	--	--
		Nov-07	--	166	--	473	9.5	7	333	10.9	--	--	--
		May-08	--	155	--	343	9	7.9	318	13.8	--	--	--
		Nov-08	--	166	--	316	9.5	7.7	335	12.3	--	--	--
		May-09	--	96	--	311	8.9	7.5	222	16.4	--	--	--
		Nov-09	--	188	--	323	9.2	7.4	454	10.9	--	--	--
		Feb-10	--	143	--	407	10.6	7.6	346	8.6	--	--	--

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, field (NTU)
BRF-WB1.65 (cont)	*WBR3*	May-10	--	145	--	339	8.8	7	326	14.3	--	--	--
		Nov-10	--	--	--	--	--	--	--	--	--	--	--
		May-11	--	165	--	417	8	6.8	367	15.1	--	--	--
		Nov-11	--	188	--	374	7.02	7.52	442	12.98	--	--	4.3
		May-12	--	87	--	405	8.56	6.9	203	16.3	--	--	51.4
		Nov-12	--	174	--	384	8	5.9	428	12.1	--	--	12.9
		May-13	--	115	--	387	9.2	5.8	308	14	--	--	72.8
		Aug-13	--	177	--	366	8.3	7.5	585	21.4	--	--	10.5
		Feb-14	--	77	--	411	11.6	6.1	222	7.2	--	--	89.9
		Aug-14	--	177	--	332	5.8	7.3	542	18.9	--	--	9.4

* historical location unknown
-- no data
°C - degrees Celsius
CaCO3 - calcium carbonate
cm - centimeters
cont - continued
Italics indicate surface water sample locations
mg/L - milligrams per liter
mV - millivolts
NA -unable to verify location
N/A - not applicable
NM - not measured
NTU - nephelometric turbidity units
Ref. - reference
Well ID - well identification

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-1	1	04/09/87	806.04	--	24.74
		06/23/87	804.59	44.29	26.18
		02/07/92	806.53	42.91	24.25
		05/01/92	806.33	48.79	24.44
		08/24/92	805.84	42.91	24.93
		11/16/92	806.53	42.91	24.25
		11/19/92	795.34	42.91	35.43
		05/10/93	806.59	42.81	24.18
		05/12/93	806.59	42.19	24.18
		11/10/93	806.33	42.85	24.44
		05/20/94	806.59	42.85	24.18
		05/26/94	806.66	42.85	24.11
		11/29/94	806.43	42.85	24.34
		12/01/94	806.43	42.85	24.34
		05/18/95	806.73	42.85	24.05
		11/27/95	806.76	42.81	24.02
		11/30/95	806.99	42.81	23.79
		06/18/96	806.99	42.78	23.79
		06/20/96	806.82	42.78	23.95
		11/19/96	807.25	42.72	23.52
		11/20/96	807.09	42.72	23.69
		06/16/97	807.35	42.72	23.43
		06/18/97	807.28	42.65	23.49
		10/27/97	806.59	42.72	24.18
		05/19/98	806.92	42.72	23.85
		11/23/98	805.25	42.75	24.84
		05/24/99	806.00	42.75	24.08
		05/27/99	806.59	42.75	24.18
		06/30/99	806.20	42.72	23.88
		07/27/99	807.12	42.72	23.65
		08/26/99	806.30	42.72	24.48
		10/26/99	805.81	42.72	24.97
		11/30/99	806.10	42.72	24.67
		12/21/99	806.17	38.71	24.61
		12/29/99	805.54	42.78	24.54
		05/17/00	805.77	42.78	24.31
		05/19/00	806.50	41.99	24.28
		11/27/00	805.64	42.78	24.44
		11/30/00	806.17	42.78	24.61
		05/23/01	805.74	42.78	24.34

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-1 (cont)	1	05/24/01	806.50	42.78	24.28
		11/06/06	804.99	42.03	25.10
		02/13/07	805.18	42.29	24.90
		05/08/07	801.87	42.29	28.22
		08/07/07	802.36	42.29	27.72
		11/05/07	802.13	42.29	27.95
		02/04/08	803.48	42.29	26.61
		05/21/08	803.54	42.29	26.54
		05/05/09	804.04	42.29	26.05
		11/23/09	803.81	42.29	26.28
		05/19/10	803.58	42.29	26.51
		11/26/10	803.22	42.29	26.87
		05/11/11	803.64	42.29	26.44
		11/17/11	803.84	42.29	26.25
		05/22/12	803.74	42.29	26.64
		11/15/12	802.95	42.29	27.03
		05/14/13	804.46	42.29	26.48
		08/06/13	803.12	42.29	27.03
		02/10/14	803.94	42.29	26.15
		08/20/14	803.12	42.29	26.97
		02/25/15	803.44	42.29	26.64
		02/09/16	796.52	39.90	26.15
BRF-10-51	10-51	05/04/11	795.73	40.72	8.79
		11/22/11	794.69	40.72	9.28
		05/16/12	795.11	40.72	10.01
		11/07/12	794.16	40.72	10.53
		05/08/13	795.24	40.72	8.99
		08/12/13	794.16	40.72	9.94
		02/05/14	795.21	40.72	9.32
		08/21/14	794.62	40.72	9.91
		02/08/16	794.72	38.39	10.33
BRF-10-52	10-52	05/04/11	795.73	38.39	8.07
		11/21/11	794.72	38.39	8.89
		05/16/12	795.21	38.39	9.09
		11/07/12	794.42	38.39	9.58
		05/08/13	795.11	38.39	8.69
		08/12/13	794.23	38.39	9.22
		02/04/14	794.95	38.39	8.86
		08/21/14	794.65	38.39	9.15
		02/08/16	795.05	--	9.09
BRF-2	2	04/09/87	--	--	15.19

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-2 (cont)	2	06/23/87	--	33.99	16.73
		02/07/92	803.25	33.10	15.55
		05/01/92	803.22	33.01	15.58
		08/24/92	801.90	33.99	16.90
		11/16/92	803.38	33.10	15.42
		05/10/93	803.25	33.01	15.55
		11/08/93	803.30	33.00	15.50
		05/20/94	803.12	33.07	15.68
		11/29/94	803.41	33.07	15.39
		11/27/95	803.35	33.01	15.45
		06/18/96	803.38	33.04	15.42
		11/19/96	804.20	33.07	13.75
		06/16/97	804.33	33.07	13.62
		10/27/97	803.94	33.07	14.01
		05/24/99	810.83	--	12.50
BRF-20H	20H	02/04/08	809.06	35.04	22.28
BRF-22	22	02/21/91	--	14.11	7.51
		08/15/91	--	13.91	2.43
		11/21/91	--	13.91	2.43
		12/11/91	--	13.91	2.23
BRF-23	23	02/21/91	--	11.52	6.00
		08/15/91	--	10.01	1.97
		11/21/91	--	11.38	3.35
		12/10/91	--	11.29	3.35
BRF-25	25	02/21/91	--	18.90	12.80
		06/24/91	--	19.09	4.76
		11/21/91	--	21.69	5.05
		12/11/91	--	22.51	4.30
BRF-26	26	02/21/91	--	18.70	7.81
		06/20/91	--	16.60	2.89
		11/26/91	--	17.81	3.51
		12/11/91	--	18.01	2.89
BRF-27	27	02/22/91	--	18.90	10.20
		06/20/91	--	18.21	2.99
		11/26/91	--	18.90	3.35
		12/11/91	--	18.70	2.82
BRF-28	28	02/21/91	--	--	4.80
		08/15/91	--	--	2.89
		11/26/91	--	--	4.34
		12/10/91	--	--	4.31
BRF-29	29	04/12/91	791.40	30.71	25.59

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-29 (cont)	29	06/19/91	796.10	30.61	20.90
		11/19/91	796.10	30.71	20.90
		02/07/92	795.51	30.31	21.49
		05/01/92	798.75	30.71	18.24
		08/24/92	795.08	30.18	21.92
		11/16/92	807.48	30.31	9.51
		11/19/92	790.06	30.31	26.94
		05/10/93	800.13	30.41	16.86
		05/12/93	800.13	30.41	16.86
		05/17/93	795.34	30.51	21.65
		11/08/93	808.07	30.50	8.92
		11/10/93	808.07	30.51	8.92
		05/20/94	803.54	30.31	13.45
		05/26/94	797.83	30.31	19.16
		11/29/94	808.86	30.31	8.14
		11/30/94	808.10	30.31	8.89
		05/17/95	807.58	30.31	9.42
		11/27/95	797.44	30.18	19.55
		11/30/95	809.09	13.78	7.91
		06/18/96	807.45	30.25	9.55
		06/20/96	806.96	30.25	10.04
		11/19/96	809.91	30.28	7.05
		11/19/96	810.07	30.28	6.92
		11/19/96	810.07	30.28	6.92
		06/16/97	810.33	30.28	6.63
		06/18/97	809.45	30.41	7.55
		10/27/97	809.71	30.28	7.25
		05/19/98	806.89	30.28	10.07
		11/23/98	794.85	30.22	22.15
		05/24/99	806.82	30.22	10.17
		11/19/02	809.68	30.31	7.28
		11/20/02	809.68	30.31	7.28
BRF-30	30	04/16/91	804.27	26.2	14.7
		06/19/91	804.95	26.2	14.0
		11/19/91	805.97	26.4	13.0
		02/07/92	805.31	26.2	13.6
		05/01/92	805.15	26.4	13.8
		11/16/92	804.30	25.9	14.7
		05/10/93	804.36	25.9	14.6
		11/08/93	803.71	26.0	15.2
		05/20/94	803.71	26.0	15.3

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-30 (cont)	30	11/29/94	803.44	26.0	15.5
		11/27/95	802.49	25.9	16.5
		06/18/96	803.12	26.0	15.8
		11/19/96	802.03	26.0	16.6
		06/16/97	803.08	26.0	15.5
		10/27/97	801.28	26.0	17.3
		05/19/98	803.18	26.0	15.4
		11/23/98	800.75	25.9	18.2
		05/24/99	803.51	25.9	15.5
		11/19/02	802.95	25.6	15.6
		11/20/02	802.95	25.6	15.6
BRF-31	31	04/16/91	803.87	27.10	16.21
		06/17/91	803.38	27.10	16.70
		11/19/91	804.36	27.20	15.72
		02/07/92	804.79	27.10	15.29
		05/01/92	804.36	21.19	15.72
		08/24/92	803.74	27.00	16.34
		11/16/92	803.94	26.90	16.14
		11/19/92	800.07	26.90	20.01
		05/10/93	803.67	26.80	16.40
		05/12/93	803.67	26.77	16.40
		11/08/93	802.91	26.80	17.17
		11/10/93	802.92	26.80	17.16
		05/20/94	802.95	26.94	17.13
		05/26/94	802.95	26.94	17.13
		11/29/94	802.72	26.94	17.36
		12/01/94	802.66	26.94	17.42
		05/18/95	803.41	26.94	16.67
		11/27/95	818.54	26.80	17.95
		11/29/95	802.17	26.80	17.91
		06/18/96	802.76	26.80	17.32
		06/20/96	802.66	26.80	17.42
		11/19/96	801.87	26.80	17.91
		11/20/96	802.03	26.80	18.04
		06/16/97	802.79	26.80	16.99
		06/18/97	802.92	26.80	17.16
		10/27/97	800.92	26.80	18.86
		05/19/98	802.72	26.80	17.06
		11/23/98	800.00	26.80	19.69
		05/24/99	802.49	26.80	17.19

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-32	32	04/16/91	812.11	23.49	11.71
		06/19/91	813.42	23.49	10.40
		11/20/91	809.81	23.59	14.01
		02/07/92	813.94	23.59	9.88
		05/01/92	813.81	23.59	10.01
		08/24/92	810.83	23.59	12.99
		11/16/92	811.45	23.59	12.37
		05/10/93	870.77	23.59	9.61
		11/08/93	865.01	23.58	12.33
		05/20/94	814.60	23.59	9.22
		11/29/94	813.68	23.59	10.14
		11/27/95	813.48	23.59	10.33
		06/18/96	814.80	23.59	9.02
		11/19/96	814.11	23.62	9.35
		06/16/97	814.83	23.62	8.63
		10/27/97	813.09	23.62	10.37
		05/19/98	814.24	23.62	9.22
		11/23/98	812.14	23.59	11.22
		05/24/99	813.85	23.59	9.51
BRF-41	41	05/21/91	--	--	3.71
		08/13/91	--	72.51	1.51
BRF-43	43	05/21/91	--	--	60.01
		08/13/91	--	94.19	20.34
BRF-44	44	05/21/91	--	--	91.99
		08/15/91	--	200.00	47.41
		09/05/91	--	--	21.39
BRF-46	46	11/08/93	839.67	84.80	80.08
		11/09/93	839.67	84.81	80.09
		05/25/94	841.50	84.84	78.25
		08/31/94	843.18	84.84	76.57
		11/30/94	839.90	84.84	79.86
		05/16/95	850.46	84.84	69.29
		11/27/95	840.45	84.81	79.30
		11/30/95	840.45	84.81	79.30
		06/18/96	852.30	84.84	67.45
		06/18/96	852.30	84.84	67.45
		11/19/96	844.39	84.84	75.56
		06/16/97	854.43	84.84	65.52
		06/18/97	854.23	84.84	65.52
		10/27/97	843.70	84.84	76.25
		10/30/97	843.34	84.84	76.41

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-46 (cont)	46	05/19/98	852.00	84.84	67.95
		05/21/98	851.02	84.84	68.93
		11/23/98	840.16	84.91	79.59
		11/24/98	840.35	84.84	79.59
		05/24/99	848.65	84.91	71.10
		05/27/99	848.26	84.84	71.69
		11/19/02	840.06	84.71	79.89
		11/20/02	840.06	84.71	79.89
BRF-47	47	06/30/99	797.64	39.21	11.09
		07/27/99	798.62	39.21	10.10
		08/25/99	797.67	39.21	11.06
		10/26/99	796.36	39.21	12.37
		11/30/99	796.06	39.21	12.66
		12/22/99	796.33	39.21	12.40
		12/29/99	796.29	39.17	12.40
		05/17/00	796.65	39.17	12.04
		05/19/00	796.65	39.21	12.07
		11/27/00	796.19	39.17	12.50
		11/30/00	796.26	39.21	12.47
		05/23/01	796.46	39.17	12.24
		05/24/01	796.59	39.21	12.14
		08/23/06	796.39	38.71	12.53
		11/06/06	797.57	39.90	11.12
		02/14/07	795.70	39.90	12.99
		05/08/07	796.62	39.90	12.07
		08/07/07	797.28	39.90	11.42
		11/05/07	796.75	39.90	11.94
		02/04/08	797.31	39.90	11.38
		05/22/08	796.88	39.90	11.98
		05/07/09	797.44	39.90	11.25
		11/18/09	796.56	39.90	12.14
		12/21/09	796.52	39.90	12.17
		05/17/10	796.49	39.90	12.20
		11/22/10	794.72	39.90	13.98
		05/09/11	795.83	39.90	12.86
		11/15/11	796.06	39.90	12.63
		05/21/12	796.26	39.90	13.12
		11/13/12	795.57	39.90	13.35
		05/13/13	796.26	39.90	13.12
		08/06/13	795.37	39.90	13.35
		02/11/14	796.10	39.90	12.60

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-47 (cont)	47	08/18/14	795.93	39.90	12.76
		10/01/14	795.77	39.90	12.93
		02/23/15	796.06	39.90	12.63
		02/16/16	798.00	39.21	12.17
BRF-48	48	05/24/99	799.31	36.68	8.69
		06/29/99	800.79	36.98	8.53
		07/27/99	800.56	36.98	7.45
		08/25/99	800.26	36.98	7.74
		10/26/99	798.26	36.98	9.74
		11/24/99	797.57	36.98	10.43
		12/22/99	798.10	36.98	9.91
		12/29/99	798.29	36.15	9.71
		05/17/00	799.15	36.15	8.86
		05/19/00	799.11	36.98	8.89
		11/27/00	798.52	36.15	9.48
		11/30/00	798.49	36.98	9.51
		05/23/01	799.02	36.15	8.99
		05/24/01	799.02	37.07	8.99
		08/23/06	798.62	35.60	7.71
		11/06/06	798.43	39.21	9.58
		02/14/07	798.16	39.21	9.84
		05/08/07	798.72	39.21	9.28
		08/07/07	798.98	39.21	9.02
		11/05/07	799.05	39.21	8.96
		02/04/08	799.31	39.21	8.69
		05/22/08	799.21	39.21	9.02
		05/07/09	798.85	39.21	9.15
		06/22/09	799.34	39.21	8.66
		11/18/09	799.70	39.21	8.30
		05/19/10	798.36	39.21	9.65
		11/22/10	797.87	39.21	10.14
		05/09/11	797.93	39.21	10.07
		11/15/11	797.87	39.21	10.14
		05/21/12	797.67	39.21	10.66
		11/13/12	797.28	39.21	11.09
		05/13/13	797.74	39.21	10.53
		08/05/13	797.28	39.21	10.53
		02/11/14	797.57	39.21	10.43
		08/19/14	797.64	39.21	10.37
		02/23/15	797.77	39.21	10.24
		02/17/16	795.51	37.30	10.01

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-49	49	06/29/99	795.60	37.20	7.12
		07/27/99	795.14	37.20	7.58
		08/25/99	794.16	37.20	8.56
		10/26/99	794.16	37.20	8.56
		11/24/99	793.83	37.20	8.89
		12/22/99	793.80	37.20	8.92
		12/29/99	794.55	36.81	8.33
		05/17/00	795.05	36.81	7.84
		05/19/00	794.75	37.20	7.97
		11/27/00	794.39	36.81	8.50
		11/28/00	794.19	37.20	8.53
		05/23/01	794.98	36.81	7.91
		05/24/01	794.85	37.20	7.87
		08/23/06	795.51	36.58	8.27
		11/06/06	794.29	37.30	8.60
		02/15/07	793.41	37.30	9.48
		05/08/07	794.88	37.30	8.01
		08/07/07	795.14	37.30	7.74
		11/05/07	795.01	167.32	7.87
		02/04/08	795.28	37.30	7.61
		05/22/08	795.08	37.30	7.81
		05/07/09	796.06	37.30	6.82
		06/22/09	795.31	37.30	7.58
		06/23/09	795.41	37.30	7.48
		11/18/09	794.91	37.30	7.97
		05/18/10	795.54	37.30	7.35
		11/23/10	795.44	37.30	7.45
		05/10/11	795.14	37.30	7.74
		05/23/12	795.80	37.30	7.78
		11/14/12	793.21	37.30	7.91
		05/14/13	795.93	37.30	7.71
		08/07/13	795.01	37.30	7.61
		02/10/14	795.41	37.30	7.48
		08/19/14	795.47	37.30	7.41
		02/25/15	795.18	37.30	7.71
		02/17/16	795.08	38.52	7.38
BRF-50	50	05/24/99	794.82	38.68	7.94
		06/29/99	795.28	38.71	7.48
		07/27/99	795.11	38.71	7.64

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-50 (cont)	50	08/25/99	793.50	37.40	9.25
		10/26/99	793.77	37.40	8.99
		11/24/99	793.27	37.40	9.48
		12/22/99	793.47	37.40	9.28
		12/29/99	794.13	38.65	8.63
		05/17/00	794.55	38.65	8.20
		05/19/00	794.55	37.40	8.20
		11/27/00	793.86	38.65	8.89
		11/28/00	793.90	37.40	8.86
		05/23/01	794.49	38.65	8.27
		05/23/01	794.55	37.40	8.20
		08/23/06	794.19	37.40	8.56
		11/06/06	793.54	38.52	9.22
		02/15/07	792.62	38.52	10.14
		05/08/07	794.52	38.52	8.23
		08/07/07	794.91	38.52	7.84
		11/05/07	794.75	38.52	8.01
		02/04/08	795.28	38.52	7.48
		05/21/08	794.75	38.52	8.01
		05/07/09	796.03	38.52	6.73
		11/18/09	794.32	38.52	8.43
		05/18/10	794.98	38.52	7.78
		11/23/10	794.19	38.52	8.56
		05/10/11	794.16	38.52	8.60
		11/17/11	794.88	38.52	7.87
		05/23/12	794.62	38.52	8.92
		11/14/12	793.70	38.52	9.06
		05/14/13	794.69	38.52	8.89
		08/07/13	793.64	38.52	8.86
		02/03/14	794.16	38.52	8.60
		08/13/14	794.13	38.52	8.63
		10/01/14	794.06	38.52	8.69
		02/25/15	804.53	40.72	0.00
		02/10/16	794.06	46.98	7.68
BRF-A	A	11/17/81	798.49	--	--
		01/06/82	800.59	--	--
		02/07/92	804.23	99.31	8.76
		05/01/92	804.69	99.21	8.30
		08/24/92	804.66	99.51	8.33
		11/16/92	804.86	99.21	8.14
		05/10/93	805.05	99.61	7.94

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-A (cont)	A	11/08/93	794.55	99.42	8.42
		05/20/94	804.82	99.44	8.14
		11/29/94	805.35	99.44	7.61
		05/17/95	805.64	99.44	7.32
		11/27/95	801.54	99.44	11.42
		11/28/95	802.72	99.44	10.24
		06/18/96	802.92	99.44	10.04
		06/20/96	802.82	99.44	10.14
		11/19/96	803.48	99.25	9.71
		11/19/96	803.74	99.25	9.22
		06/16/97	805.35	99.25	7.84
		06/18/97	804.95	99.25	8.01
		10/27/97	803.54	99.25	9.65
		10/29/97	801.77	99.25	11.19
		05/19/98	803.48	99.25	9.71
		05/21/98	803.48	99.25	9.71
		11/23/98	800.03	99.11	13.16
		11/24/98	800.07	99.41	13.12
		05/24/99	802.23	99.11	10.96
		05/27/99	802.66	99.41	10.53
BRF-B	B	11/18/81	793.41	--	--
		01/06/82	794.91	--	--
		02/25/82	795.90	--	--
		07/14/82	796.39	--	--
		04/12/91	793.08	74.51	22.80
		06/19/91	794.78	74.51	21.10
		11/18/91	794.65	70.51	21.23
		02/07/92	792.45	70.41	23.43
		05/01/92	794.75	70.51	21.13
		08/24/92	794.78	70.60	21.10
		11/16/92	794.16	69.91	21.72
		05/10/93	794.69	70.41	21.19
		11/08/93	797.75	70.25	21.33
		11/09/93	772.57	70.28	21.33
		05/20/94	794.59	70.31	21.26
		05/26/94	772.21	70.31	21.69
		08/31/94	773.23	69.95	20.67
		11/29/94	793.90	70.31	21.95
		12/01/94	771.95	70.31	21.95
		05/17/95	794.32	70.31	21.19
		11/27/95	794.36	70.11	21.49

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-B (cont)	B	11/29/95	794.52	70.11	21.00
		06/18/96	793.96	70.21	21.88
		06/20/96	793.86	70.21	21.65
		11/19/96	794.72	70.21	21.39
		11/20/96	794.91	70.21	20.60
		06/16/97	795.83	70.21	20.28
		06/18/97	794.69	70.21	20.83
		10/27/97	794.55	70.21	21.56
		10/30/97	793.73	70.21	21.78
		05/19/98	795.47	70.21	20.64
		05/21/98	795.54	70.21	20.57
		11/23/98	794.59	69.98	21.33
		11/24/98	794.78	70.21	21.33
		05/24/99	794.95	69.98	20.96
		05/27/99	794.72	70.21	21.39
BRF-BRC0.3	*BRC1*	11/27/00	793.47	--	16.80
		05/23/01	794.42	--	15.85
BRF-BRC1.9	*BRC2*	06/16/97	795.24	--	2.30
		10/27/97	793.86	--	3.67
		05/19/98	794.85	36.35	2.69
		11/23/98	794.16	--	3.38
		05/24/99	794.16	--	2.69
		12/29/99	793.86	--	3.67
		05/17/00	794.42	--	3.12
		11/27/00	793.24	--	4.30
		05/23/01	794.46	--	3.08
		11/15/01	792.95	--	4.59
		05/29/02	795.24	--	2.30
		11/19/02	793.24	--	4.30
		05/13/03	793.73	--	3.81
		11/17/03	794.59	--	2.95
		05/12/04	794.13	--	3.41
		11/15/04	793.73	--	3.81
		05/02/05	794.52	--	3.02
		11/15/05	794.46	--	3.08
		02/03/14	794.32	--	3.22
		08/13/14	794.16	--	3.38
BRF-C	C	11/18/81	801.90	--	--
		01/06/82	800.89	--	--
		02/25/82	800.79	--	--
		07/14/82	801.80	--	--
		11/15/89	--	73.49	25.20
		02/22/90	801.15	70.31	19.59
		05/02/90	797.21	73.49	23.56

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-C (cont)	C	08/02/90	793.77	73.49	27.00
		11/06/90	796.19	72.31	24.54
		02/21/91	798.85	72.01	21.92
		04/11/91	803.84	72.01	16.90
		05/08/91	797.05	72.01	23.69
		06/19/91	795.73	72.01	25.00
		08/12/91	796.16	72.11	24.61
		11/18/91	798.10	72.21	22.64
		02/07/92	798.03	72.21	22.70
		05/01/92	798.59	72.21	22.15
		08/24/92	798.46	72.31	22.28
		11/16/92	798.46	72.21	22.28
		11/17/92	774.02	72.21	23.39
		05/10/93	798.33	72.21	22.41
		05/12/93	775.00	72.24	22.41
		05/17/93	774.95	72.18	22.46
		11/08/93	826.85	72.25	23.00
		11/10/93	774.41	72.28	23.00
		05/20/94	797.67	72.21	23.03
		05/26/94	774.31	72.21	23.10
		11/29/94	797.41	72.21	23.29
		12/01/94	774.02	72.21	23.39
		05/18/95	797.80	72.21	22.90
		11/27/95	797.18	72.18	23.52
		11/29/95	797.47	72.18	23.23
		06/18/96	797.11	72.21	23.59
		06/20/96	797.15	72.21	23.56
		11/19/96	797.15	72.21	23.82
		11/20/96	797.34	72.21	23.36
		06/16/97	798.16	72.21	22.80
		06/18/97	797.64	72.18	23.06
		10/27/97	796.98	72.21	23.98
		10/30/97	796.42	72.21	24.28
		05/19/98	797.93	72.21	23.03
		05/21/98	797.97	72.21	23.00
		11/23/98	796.59	72.08	24.21
		11/24/98	796.69	72.18	24.28
		05/24/99	797.70	72.08	23.10
		05/27/99	797.57	72.18	23.39

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-D	D	11/19/81	818.60	--	--
		07/14/82	819.09	--	--
		11/16/89	820.05	100.00	2.00
		03/01/90	770.34	98.79	51.71
		05/02/90	820.05	98.29	2.00
		08/02/90	817.26	98.29	4.79
		11/06/90	816.86	100.00	5.18
		02/28/91	819.88	98.20	2.17
		04/12/91	804.23	98.00	17.81
		05/07/91	818.04	97.60	4.00
		06/20/91	817.36	98.00	4.69
		08/12/91	817.42	98.00	4.63
		11/19/91	815.91	97.60	6.14
		02/07/92	817.88	97.70	4.17
		02/11/92	817.75	97.70	4.30
		05/01/92	818.11	97.80	3.94
		05/06/92	818.04	98.79	4.00
		08/24/92	816.83	97.60	5.22
		08/26/92	816.73	97.60	5.31
		11/16/92	817.19	97.51	4.86
		11/18/92	797.80	97.51	24.25
		05/10/93	819.59	97.51	2.46
		05/12/93	819.59	97.54	2.46
		05/17/93	818.77	97.54	3.28
		11/08/93	817.00	97.50	5.05
		11/09/93	816.99	97.54	5.05
		05/20/94	818.73	97.67	3.31
		05/25/94	751.18	97.51	70.87
		11/29/94	818.47	97.51	3.58
		11/30/94	818.47	97.51	3.58
		05/16/95	820.21	97.51	1.84
		11/27/95	818.57	97.64	3.48
		11/28/95	818.57	97.64	3.48
		06/18/96	820.28	97.51	1.77
		06/19/96	820.28	97.51	1.77
		11/19/96	819.55	97.51	2.49
		06/16/97	820.87	97.51	1.18
		10/27/97	819.36	97.51	2.69
		05/19/98	820.08	97.51	1.97
		11/23/98	815.39	97.57	5.02
		05/24/99	818.04	97.57	2.36

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-E	E	12/21/88	833.76	--	19.91
		08/03/89	--	99.80	14.34
		11/16/89	--	99.80	5.41
		02/28/90	847.15	--	6.50
		05/01/90	846.42	99.70	7.22
		07/31/90	841.96	--	11.71
		11/06/90	836.15	99.61	17.49
		02/28/91	849.34	99.61	3.64
		05/08/91	843.08	99.61	10.56
		08/12/91	841.93	99.90	11.71
		11/18/91	843.04	99.70	10.63
		02/07/92	846.19	99.70	7.48
		02/13/92	835.99	99.70	7.61
		05/01/92	846.49	99.02	7.19
		05/05/92	836.45	97.80	7.15
		08/24/92	842.19	99.11	11.45
		11/16/92	844.42	99.70	9.22
		05/10/93	846.39	99.11	7.25
		11/08/93	835.84	99.08	9.83
		05/20/94	845.90	99.11	7.71
		11/29/94	843.60	99.11	10.01
		11/27/95	846.52	99.08	6.99
		06/18/96	847.18	99.11	6.33
		11/19/96	847.70	99.15	5.81
		06/16/97	848.03	99.15	5.48
		10/27/97	842.62	99.15	10.89
		05/19/98	846.78	99.15	6.73
		11/23/98	839.37	--	14.14
		05/24/99	847.57	18.18	5.94
BRF-F	F	08/02/89	--	44.39	4.13
BRF-F45	F45	11/16/92	816.08	28.41	14.83
		11/18/92	805.12	25.79	25.79
		02/09/93	815.85	25.98	15.06
		05/10/93	816.27	28.40	14.64
		05/11/93	816.27	28.41	14.63
		08/02/93	814.91	28.41	15.99
		08/02/93	814.91	28.41	15.99
		11/08/93	813.16	31.75	17.75
		11/09/93	813.16	31.76	17.75
		03/23/94	813.02	31.76	17.88
		05/20/94	812.73	31.82	18.18

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-F45 (cont)	F45	05/26/94	812.86	31.82	18.04
		08/25/94	812.01	31.82	18.90
		11/29/94	812.20	31.82	18.70
		05/16/95	813.39	31.82	17.52
		11/27/95	813.06	31.82	17.85
		11/28/95	812.89	31.82	18.01
		06/18/96	813.68	31.82	17.22
		06/19/96	813.39	31.82	17.52
		11/19/96	816.60	31.82	17.75
		11/20/96	813.35	31.82	17.55
		06/16/97	817.59	31.82	16.77
		06/18/97	814.11	31.82	16.80
		10/27/97	815.62	31.82	18.73
		10/29/97	812.57	31.82	18.34
		05/19/98	817.22	31.82	17.13
		05/21/98	816.93	31.82	17.42
		11/23/98	813.81	--	20.51
		11/23/98	813.85	31.82	20.51
		05/24/99	816.31	--	18.01
		05/26/99	816.47	31.82	17.88
		11/22/99	813.91	31.76	20.44
		12/29/99	815.55	31.82	18.77
		01/19/00	823.20	31.82	11.15
		05/17/00	815.58	31.82	18.73
		06/15/00	815.26	31.76	19.09
		11/27/00	815.68	31.82	18.64
		11/28/00	815.65	31.76	18.70
		05/23/01	815.94	31.82	18.37
		05/23/01	815.98	31.82	18.37
		11/15/01	815.58	31.82	18.73
		11/15/01	815.62	31.82	18.73
		05/29/02	816.11	31.82	18.21
		05/29/02	816.14	31.82	18.21
		11/19/02	817.95	31.82	16.37
		11/19/02	817.98	31.82	16.37
		05/13/03	817.75	31.82	16.57
		11/17/03	816.63	31.82	17.68
		05/12/04	816.86	31.82	17.45
		11/15/04	817.55	31.82	16.77
		05/02/05	817.91	31.82	16.40

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-F45 (cont)	F45	11/15/05	814.99	31.82	19.32
		05/03/06	818.96	31.82	15.42
		11/06/06	818.90	31.82	15.42
		02/14/07	818.54	31.82	15.78
		05/08/07	818.57	31.82	15.75
		11/05/07	816.27	31.82	18.04
		05/20/08	818.37	31.82	15.94
		11/05/08	816.99	31.82	17.81
		02/10/09	818.60	31.82	15.72
		05/06/09	818.80	31.82	15.52
		08/03/09	818.44	31.82	15.88
BRF-F45R	F45R	11/04/08	816.50	31.92	17.03
		02/10/09	818.80	31.92	15.22
		05/06/09	818.93	31.92	15.09
		08/03/09	818.50	31.92	15.52
		11/03/09	819.13	31.92	15.19
		02/01/10	819.52	31.92	14.80
		05/03/10	819.06	31.92	15.26
		11/10/10	818.37	31.92	15.94
		05/02/11	819.06	31.92	15.26
		11/14/11	818.80	31.92	15.52
		05/15/12	818.73	31.92	15.39
		11/06/12	818.14	31.92	16.17
		05/06/13	820.31	31.92	14.01
		08/14/13	820.31	31.92	14.01
		02/04/14	821.13	31.92	13.19
		08/14/14	820.28	31.92	14.04
		02/10/15	820.28	31.92	14.04
		02/03/16	821.00	31.92	13.32
BRF-G	G	08/02/89	--	51.41	17.26
		11/15/89	--	51.41	12.11
		02/21/90	822.51	51.31	10.96
		05/01/90	820.05	51.41	13.39
		08/02/90	819.95	--	13.48
		11/06/90	820.14	51.41	13.32
		02/21/91	823.95	51.21	9.51
		05/07/91	820.60	51.21	12.86
		08/14/91	820.05	51.41	13.39
		11/12/91	820.18	51.41	13.25
		02/07/92	821.19	51.31	12.27

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-G (cont)	G	02/10/92	808.69	51.31	12.57
		05/01/92	820.64	51.41	12.80
		05/05/92	808.40	51.41	12.86
		08/24/92	820.08	51.31	13.39
		08/25/92	807.74	51.31	13.52
		11/16/92	821.00	51.31	12.43
		12/14/92	808.83	51.31	12.43
		05/10/93	820.73	51.31	12.70
		05/11/93	808.56	51.28	12.70
		11/08/93	808.12	54.66	16.30
		11/09/93	804.95	54.66	16.31
		03/23/94	805.28	54.66	15.98
		05/20/94	816.63	54.79	16.77
		05/24/94	804.43	54.66	16.83
		08/25/94	804.33	54.79	16.93
		11/29/94	805.74	54.79	15.52
		05/16/95	821.49	54.79	15.29
		11/27/95	820.24	54.79	16.54
		11/28/95	820.34	54.79	16.44
		06/18/96	820.96	54.79	15.81
		06/19/96	820.64	54.79	16.14
		11/18/96	821.19	54.79	15.58
		11/19/96	822.11	54.79	15.58
		06/16/97	823.26	54.79	14.44
		06/18/97	822.08	54.79	14.70
		06/18/97	821.33	51.28	15.45
		10/27/97	822.18	54.79	15.52
		10/28/97	821.03	54.79	15.75
		05/19/98	821.69	54.79	16.01
		05/21/98	821.62	54.79	16.08
		11/23/98	821.03	54.49	16.67
		05/24/99	822.61	54.49	15.09
		05/26/99	822.31	54.79	15.39
		11/23/99	820.51	54.66	17.19
		12/29/99	820.77	54.59	16.93
		05/17/00	820.90	54.59	16.80

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-G (cont)	G	06/14/00	820.01	54.66	17.68
		11/27/00	822.01	54.59	15.68
		11/28/00	821.95	54.66	15.75
		05/23/01	822.87	54.59	14.83
		05/23/01	822.87	54.66	14.83
		11/15/01	822.74	54.59	14.96
		11/15/01	822.74	54.66	14.96
		05/29/02	820.67	54.59	17.03
		05/30/02	820.67	54.66	17.03
		11/19/02	822.15	54.66	15.55
		11/21/02	822.61	54.66	15.09
		05/13/03	822.64	54.66	15.06
		11/17/03	824.41	54.66	15.75
		05/12/04	820.54	54.66	17.16
		11/15/04	822.01	54.66	15.68
		05/02/05	822.38	54.66	15.32
		11/15/05	820.44	54.66	17.26
		05/03/06	821.98	54.66	15.94
		11/06/06	821.39	54.66	16.31
		02/13/07	820.80	54.66	16.90
		05/08/07	821.29	54.66	16.40
		11/05/07	815.85	17.81	54.66
		05/20/08	820.83	54.66	16.86
		11/04/08	819.62	54.66	18.08
		05/05/09	822.05	54.66	15.65
		11/04/09	821.78	54.66	15.91
		02/02/10	822.28	54.66	15.42
		05/03/10	823.10	54.66	14.60
		11/10/10	820.80	54.66	16.90
		05/02/11	822.05	54.66	15.65
		11/15/11	821.29	54.66	16.40
		05/15/12	821.52	54.66	15.78
		11/05/12	820.24	54.66	17.45
		05/07/13	823.06	54.66	14.96
		08/14/13	820.51	54.66	17.19
		02/03/14	822.21	54.66	15.49
		08/14/14	820.73	54.66	16.96
		02/10/15	821.29	54.66	16.40
		02/03/16	821.95	54.66	15.75
BRF-H	H	03/13/89	821.10	--	29.99
		08/02/89	--	54.20	16.40
		11/20/91	840.55	53.81	10.53
		02/07/92	841.17	53.90	9.91
		02/11/92	840.78	53.90	10.30

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-H (cont)	H	05/01/92	840.91	53.90	10.20
		05/06/92	840.62	53.90	10.47
		08/24/92	839.40	53.61	11.71
		08/26/92	839.30	53.61	11.78
		11/16/92	840.26	53.81	10.83
		05/10/93	840.58	53.71	10.53
		11/08/93	817.15	56.83	15.25
		05/20/94	836.25	56.89	14.80
		11/29/94	835.79	56.89	15.29
		11/27/95	836.55	56.92	14.53
		06/18/96	837.24	59.84	13.85
		11/18/96	837.40	56.76	13.68
		11/19/96	840.94	56.89	13.88
		06/16/97	843.77	56.89	11.06
		06/18/97	838.68	56.76	12.40
		10/27/97	839.67	56.89	15.16
		05/19/98	840.78	56.89	14.04
		11/23/98	837.43	56.76	17.36
		05/24/99	841.01	56.76	13.78
BRF-I	I	03/13/89	841.08	--	29.99
		08/02/89	--	44.49	2.10
		11/20/91	866.14	19.91	4.95
		02/07/92	870.87	20.01	0.46
		02/11/92	807.38	20.01	1.02
		05/01/92	870.31	20.11	0.98
		05/06/92	806.96	20.11	1.44
		08/24/92	867.49	20.01	3.84
		08/26/92	804.49	20.01	3.90
		11/16/92	869.00	43.70	2.30
		12/14/92	808.40	43.70	--
		05/10/93	870.77	43.31	0.52
		05/11/93	807.87	43.27	0.52
		11/08/93	843.82	46.08	6.30
		11/08/93	802.10	46.10	6.30
		11/10/93	850.03	42.85	24.44
		03/23/94	804.76	46.10	3.64
		05/20/94	866.40	24.31	4.86
		05/25/94	803.08	46.10	5.31
		08/25/94	799.41	46.10	8.99
		11/29/94	867.45	24.31	7.02
		11/29/94	801.38	46.10	7.02
		05/16/95	871.26	46.10	3.22
		11/27/95	868.47	46.10	6.00
		11/28/95	868.37	46.10	6.10

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-I (cont)	I	06/18/96	871.19	46.10	3.28
		06/19/96	870.96	46.10	3.51
		11/18/96	870.01	46.10	4.46
		11/18/96	869.95	46.10	4.53
		11/19/96	870.44	24.31	4.86
		06/16/97	873.23	24.31	2.07
		06/17/97	872.24	24.31	2.23
		10/27/97	868.64	24.31	2.23
		10/28/97	867.72	24.31	6.66
		05/19/98	871.75	24.31	6.76
		05/21/98	871.59	24.31	3.54
		05/21/98	874.87	46.10	3.71
		11/23/98	864.90	46.10	3.71
		11/23/98	864.90	24.28	10.40
		05/24/99	871.10	24.11	4.17
		05/25/99	871.10	24.28	4.20
		05/25/99	871.10	24.38	4.20
		11/23/99	865.75	46.10	9.55
		12/29/99	866.70	24.54	8.56
		01/19/00	869.72	46.10	5.58
		05/17/00	866.34	24.54	8.92
		06/15/00	869.82	46.10	5.48
		11/27/00	866.08	24.54	9.19
		11/27/00	866.11	46.10	9.19
		05/23/01	869.32	24.54	5.94
		05/23/01	869.39	46.10	5.91
		11/15/01	868.86	24.54	6.40
		11/15/01	868.90	46.10	6.40
		05/29/02	870.24	24.54	5.02
		05/30/02	870.28	46.10	5.02
		11/19/02	870.44	46.10	4.82
		05/13/03	873.00	46.10	2.26
		11/17/03	871.56	46.10	3.71
		05/12/04	870.73	46.10	4.53
		11/15/04	872.34	46.10	2.92
		05/02/05	872.34	46.10	2.49
		11/15/05	866.40	46.10	8.86
		05/03/06	872.61	46.10	2.82

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-I (cont)	I	11/06/06	870.14	46.10	5.12
		02/13/07	870.60	46.10	4.69
		05/11/07	871.13	46.10	4.13
		11/05/07	864.76	46.10	10.50
		05/20/08	871.33	46.10	4.13
		11/05/08	864.80	46.10	10.47
		05/05/09	873.23	46.10	2.03
		11/03/09	872.41	46.10	2.85
		02/03/10	873.85	46.10	1.41
		05/04/10	873.49	46.10	1.77
		11/08/10	874.28	46.10	0.98
		05/02/11	872.97	46.10	2.30
		11/14/11	870.90	46.10	4.36
		05/14/12	872.01	46.10	3.25
		11/05/12	868.21	46.10	7.05
		05/06/13	873.20	46.10	2.07
		08/14/13	870.77	46.10	4.49
		02/03/14	871.98	46.10	3.28
		08/13/14	871.10	46.10	4.17
		02/10/15	871.92	46.10	3.35
		02/03/16	873.10	46.10	2.17
BRF-J	J	11/20/91	815.98	50.20	8.30
		02/07/92	812.60	50.20	7.87
		02/11/92	816.27	50.20	8.01
		05/01/92	812.27	50.10	7.78
		05/06/92	816.37	50.10	7.91
		08/24/92	812.07	50.20	7.97
		08/25/92	816.17	50.20	8.10
		11/16/92	812.43	50.20	7.61
		11/17/92	811.78	50.20	12.50
		02/09/93	816.27	50.20	8.01
		05/10/93	812.27	50.20	7.78
		05/11/93	816.50	50.16	7.78
		08/02/93	815.88	50.33	8.40
		08/02/93	815.62	50.33	8.66
		11/08/93	812.36	54.33	11.92
		11/09/93	812.37	54.33	11.91
		03/23/94	812.17	54.33	12.11
		05/20/94	807.87	54.43	12.14
		05/25/94	812.01	54.43	12.27
		11/29/94	813.55	54.43	10.73
		05/16/95	813.48	54.36	10.79
		11/27/95	812.14	54.43	12.14
		11/28/95	812.34	54.36	11.94

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-J (cont)	J	06/18/96	812.50	54.36	11.78
		06/19/96	812.40	54.36	11.88
		11/19/96	813.12	54.43	11.61
		11/20/96	813.09	54.36	11.19
		06/16/97	814.27	54.43	10.47
		06/18/97	812.89	54.36	11.38
		10/27/97	813.52	54.43	11.22
		10/29/97	812.37	54.43	11.91
		05/19/98	812.73	54.43	12.01
		05/21/98	812.57	54.43	12.17
		11/23/98	808.99	54.27	15.75
		11/24/98	808.99	54.46	15.75
		05/24/99	813.19	54.27	11.55
		05/26/99	813.22	54.46	11.52
		11/22/99	809.06	54.33	15.68
		12/29/99	810.76	54.27	13.98
		01/19/00	813.91	54.33	10.83
		05/17/00	812.27	54.27	12.47
		06/14/00	812.17	54.33	12.57
		11/27/00	811.75	54.27	12.99
		11/28/00	811.55	54.33	13.19
		05/23/01	813.09	54.27	11.65
		05/23/01	813.09	54.33	11.65
		11/15/01	812.93	54.27	11.81
		11/15/01	812.93	54.46	11.81
		05/29/02	811.06	54.27	13.68
		05/29/02	811.06	54.46	13.68
		11/19/02	812.76	54.46	11.98
		11/21/02	812.76	54.46	11.98
		05/12/03	--	54.46	10.66
		05/13/03	814.07	54.46	10.66
		11/17/03	812.47	54.46	12.27
		05/12/04	812.20	54.46	12.53
		05/13/04	--	54.46	12.53
		11/15/04	812.66	54.46	12.07
		11/16/04	--	54.46	12.07
		05/02/05	822.24	54.46	2.49
		05/02/05	--	54.46	11.35
		05/02/05	--	--	--
		11/15/05	809.81	54.46	14.93
		11/15/05	--	54.46	14.93
		05/03/06	812.83	54.46	12.11
		11/06/06	812.04	54.46	12.70
		02/13/07	811.78	54.46	12.96

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-J (cont)	J	05/08/07	812.04	54.46	12.70
		11/05/07	811.84	54.46	12.89
		05/20/08	812.60	54.46	12.14
		11/05/08	808.86	54.46	15.88
		05/05/09	813.52	54.46	11.22
		11/04/09	813.09	54.46	11.65
		02/03/10	813.71	54.46	11.02
		03/02/10	812.73	54.46	12.01
		05/04/10	814.83	54.46	9.91
		11/10/10	812.96	54.46	11.78
		05/03/11	813.35	54.46	11.38
		11/15/11	813.02	54.46	11.71
		05/15/12	813.45	54.46	10.66
		11/06/12	811.52	54.46	13.19
		05/07/13	814.17	54.46	11.29
		08/13/13	813.02	54.46	11.71
		02/06/14	812.86	54.46	11.88
		08/14/14	813.22	54.46	11.52
		02/23/15	824.74	54.46	--
		02/02/16	807.15	54.46	17.59
BRF-K	K	11/08/90	806.10	--	9.71
		02/21/91	807.61	15.58	8.20
		05/09/91	806.20	31.10	9.61
		08/14/91	806.10	31.10	9.71
		11/19/91	805.87	31.30	9.94
		02/07/92	806.07	31.30	9.74
		05/01/92	806.10	31.40	9.71
		08/24/92	806.04	31.20	9.78
		11/16/92	806.59	31.00	9.22
		05/10/93	806.43	31.10	9.38
		11/08/93	806.73	30.33	9.08
		05/20/94	806.36	30.91	9.45
		11/29/94	807.15	30.91	8.66
		06/18/96	806.79	29.99	9.02
		11/19/96	806.59	30.05	9.09
		06/16/97	807.38	30.05	8.30
		10/27/97	806.89	30.05	8.79
		05/19/98	806.66	30.05	9.02
		11/23/98	806.46	29.95	9.35
		05/24/99	806.30	29.95	9.51

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-L	L	05/07/91	801.44	59.71	30.45
		08/13/91	805.18	60.10	26.71
		11/21/91	802.46	59.81	29.46
		02/07/92	805.71	59.91	26.18
		05/01/92	805.31	59.91	26.57
		08/24/92	805.31	59.91	26.57
		11/16/92	805.38	59.91	26.54
		05/10/93	805.54	59.81	26.35
		11/08/93	805.31	59.83	26.60
		05/20/94	805.48	59.84	26.38
		11/29/94	805.45	59.84	26.41
		11/27/95	805.61	59.84	26.25
		06/18/96	805.64	59.81	26.21
		11/19/96	805.74	59.81	26.15
		06/16/97	805.84	59.81	26.05
		10/27/97	805.77	59.81	26.12
		05/19/98	805.68	59.81	26.21
		11/23/98	805.41	59.78	26.48
		05/24/99	805.61	59.78	26.28
BRF-M	M	11/15/89	--	60.50	49.61
		03/01/90	787.50	59.91	44.59
		05/02/90	806.10	60.01	25.98
		08/02/90	785.01	60.01	47.11
		11/08/90	781.10	60.10	50.98
		02/28/91	808.01	59.91	24.11
		05/09/91	779.40	59.91	52.69
		02/07/92	806.59	60.01	25.49
		05/01/92	806.33	60.10	25.79
		08/24/92	806.17	60.10	25.92
		11/16/92	807.97	60.10	24.11
		05/10/93	809.91	60.01	22.21
		11/08/93	809.09	60.00	23.00
		05/20/94	810.43	60.04	21.62
		11/29/94	806.89	60.04	25.16
		11/27/95	810.37	59.84	21.69
		06/18/96	812.24	60.04	19.82
		11/19/96	815.75	60.07	16.34
		06/16/97	821.00	60.07	11.09
		10/27/97	821.75	60.07	10.33
		05/19/98	817.59	60.07	14.50
		11/23/98	812.73	60.10	19.36
		05/24/99	829.07	60.10	3.02

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-MW-3H	MW-3H/P-3	05/07/13	819.55	40.06	10.37
		08/13/13	820.01	40.06	10.01
		02/05/14	820.21	40.06	9.81
		08/18/14	821.19	40.06	8.83
		02/11/15	820.80	40.06	9.22
		02/02/16	820.87	40.06	9.15
BRF-N	N	11/15/89	--	50.10	29.30
		02/28/90	804.49	50.20	26.71
		05/01/90	804.30	50.10	26.90
		08/02/90	804.10	50.00	27.10
		11/06/90	804.10	50.30	27.10
		02/21/91	804.59	50.10	26.61
		05/07/91	804.40	50.00	26.80
		08/12/91	803.84	50.39	27.36
		11/21/91	804.04	50.10	27.17
		02/07/92	804.43	50.39	26.77
		02/11/92	804.33	50.39	26.94
		05/01/92	804.13	50.10	27.03
		05/06/92	804.36	50.10	26.90
		08/24/92	803.97	50.10	27.23
		08/25/92	804.04	50.10	27.23
		11/16/92	804.10	50.20	27.10
		11/18/92	800.23	50.20	31.04
		05/10/93	804.20	50.20	27.00
		05/10/93	804.27	50.16	27.00
		11/08/93	804.11	50.16	27.16
		11/09/93	804.10	50.16	27.17
		05/20/94	804.10	50.26	27.07
		05/25/94	804.20	50.16	27.07
		11/29/94	804.00	50.16	27.17
		11/30/94	804.10	50.16	27.17
		05/16/95	804.49	50.16	26.67
		11/27/95	804.23	50.16	26.94
		06/18/96	804.30	50.16	26.87
		11/19/96	804.63	50.23	26.64
		06/16/97	804.72	50.23	26.54
		10/27/97	804.86	50.23	26.41
		05/19/98	804.36	50.23	26.90
		11/23/98	804.00	50.23	27.20
		05/24/99	804.17	50.23	27.03

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-O	O	11/06/90	--	57.51	7.19
		02/22/91	--	56.69	6.20
		05/08/91	795.31	57.51	6.99
		08/14/91	0.00	57.51	5.58
		11/19/91	795.18	56.79	7.12
		02/07/92	792.45	56.79	9.84
		02/10/92	794.13	56.89	8.17
		02/10/92	794.13	56.89	8.17
		05/01/92	795.08	56.89	7.22
		05/07/92	795.14	56.89	7.15
		08/24/92	795.08	57.09	7.22
		08/26/92	794.91	57.09	7.38
		11/16/92	794.55	56.79	7.74
		11/18/92	789.37	56.79	12.93
		05/10/93	794.82	56.99	7.48
		05/12/93	794.82	56.99	7.48
		11/08/93	794.80	56.92	7.50
		11/10/93	794.78	56.92	7.51
		05/20/94	795.01	56.96	7.28
		05/26/94	794.65	56.96	7.64
		11/29/94	794.39	56.96	7.91
		11/30/94	793.96	56.96	8.33
		05/17/95	795.08	56.96	7.22
		11/27/95	795.05	56.99	7.25
		11/29/95	795.44	56.99	6.86
		06/18/96	794.42	56.99	7.87
		06/19/96	794.59	56.99	7.71
		11/19/96	794.72	56.92	7.41
		11/20/96	795.67	56.92	6.63
		06/16/97	795.83	56.92	6.30
		06/18/97	795.67	56.92	6.63
		10/27/97	794.69	56.92	7.45
		05/19/98	795.57	56.92	6.56
		11/23/98	795.24	57.02	7.05
		05/24/99	795.18	57.02	7.12
BRF-P	P	11/06/90	794.85	51.41	14.67
		02/21/91	795.60	51.31	13.91
		05/09/91	795.41	51.31	14.11
		08/15/91	796.82	49.90	12.70
		11/19/91	795.28	51.51	14.24
		02/07/92	791.96	51.51	17.55
		05/01/92	794.82	51.51	14.70
		08/24/92	794.91	51.51	14.60
		11/16/92	794.23	51.51	15.29

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-P (cont)	P	05/10/93	794.55	51.41	14.96
		11/08/93	794.69	51.48	14.83
		05/20/94	794.78	51.48	14.73
		11/29/94	793.96	51.48	15.55
		11/27/95	794.65	51.44	14.86
		06/18/96	794.03	51.44	15.49
		11/19/96	794.42	51.48	14.96
		06/16/97	795.54	51.48	13.85
		10/27/97	794.32	51.48	15.06
		05/19/98	795.34	51.48	14.04
		11/23/98	794.98	51.51	14.53
		05/24/99	802.82	51.51	6.69
BRF-Q	Q	05/09/91	805.81	--	9.91
		08/14/91	805.58	15.715	10.14
		11/19/91	805.71	15.715	10.01
		02/07/92	805.71	15.715	10.01
		02/10/92	805.64	15.715	10.07
		05/01/92	805.77	15.814	9.94
		05/07/92	805.64	15.814	10.07
		08/24/92	805.71	15.814	10.01
		08/26/92	805.68	15.814	10.04
		11/16/92	806.00	15.584	9.71
		11/19/92	805.97	15.814	9.74
		05/10/93	805.55	15.715	9.74
		05/13/93	805.94	15.748	9.78
		11/08/93	805.30	15.751	9.50
		11/09/93	806.20	15.748	9.51
		05/20/94	805.94	15.748	9.78
		05/25/94	805.84	15.748	9.88
		11/29/94	806.79	15.748	8.92
		11/30/94	806.59	15.748	9.12
		05/17/95	806.43	15.748	9.28
		11/27/95	806.50	15.715	9.22
		11/30/95	806.50	15.715	9.22
		06/18/96	805.87	15.486	9.84
		06/19/96	805.87	15.486	9.84
		11/19/96	806.27	15.715	9.28
		11/20/96	806.56	15.715	9.15
		06/16/97	806.66	15.715	8.89
		06/18/97	806.56	15.715	9.15
		10/27/97	806.66	15.715	8.89
		05/19/98	806.04	15.715	9.51
		11/23/98	805.71	15.781	10.01
		05/24/99	806.17	15.781	9.55

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-R	R	11/06/90	795.34	32.09	6.86
		02/22/91	796.19	32.09	6.00
		05/08/91	795.80	31.99	6.40
		08/14/91	796.65	30.91	5.54
		11/19/91	795.41	31.99	6.79
		02/07/92	793.11	31.79	9.09
		02/10/92	794.55	31.79	7.64
		05/01/92	795.51	31.69	6.69
		05/07/92	787.57	31.69	14.63
		08/24/92	795.51	31.69	6.69
		08/26/92	795.24	31.69	6.96
		11/16/92	794.39	31.69	7.81
		11/18/92	791.99	31.69	10.20
		05/10/93	795.24	31.50	6.96
		05/12/93	795.24	31.50	6.96
		11/08/93	795.03	31.58	7.17
		11/10/93	795.01	31.59	7.19
		05/20/94	795.18	31.69	7.02
		05/26/94	794.95	31.69	7.25
		11/29/94	794.75	31.69	7.45
		11/30/94	794.42	31.69	7.78
		05/17/95	795.34	31.69	6.86
		11/27/95	795.51	31.30	6.69
		11/29/95	795.80	31.30	6.40
		06/18/96	794.82	31.30	7.38
		06/19/96	794.78	31.30	7.41
		11/19/96	795.01	31.40	6.92
		11/20/96	796.00	31.40	6.20
		06/16/97	795.96	31.40	5.97
		06/18/97	795.93	31.40	6.27
		10/27/97	795.05	31.40	6.89
		05/19/98	795.67	31.40	6.27
		11/23/98	795.57	31.36	6.63
		05/24/99	787.47	31.36	14.73
BRF-S	S	11/06/90	795.31	42.91	14.40
		02/21/91	796.06	43.60	13.65
		05/09/91	796.00	43.60	13.71
		08/15/91	797.38	41.21	12.34
		11/19/91	795.57	43.41	14.14
		02/07/92	792.59	43.41	17.13
		02/10/92	794.29	43.41	15.42
		05/01/92	795.14	43.50	14.57
		05/07/92	795.28	43.50	14.44
		08/24/92	795.28	43.50	14.44

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-S (cont)	S	08/26/92	795.28	43.50	14.44
		11/16/92	794.69	43.31	15.03
		11/19/92	790.45	43.31	19.26
		05/10/93	805.06	43.21	14.80
		05/13/93	794.91	43.21	14.80
		11/08/93	804.57	43.25	14.66
		11/10/93	795.05	43.27	14.67
		05/20/94	795.08	43.24	14.63
		05/26/94	794.78	43.24	14.93
		11/29/94	794.39	43.24	15.32
		11/30/94	794.06	43.24	15.65
		05/17/95	795.18	43.24	14.53
		11/27/95	795.01	43.18	14.70
		11/29/95	795.41	43.18	14.30
		06/18/96	794.36	43.11	15.35
		06/19/96	794.59	43.11	15.12
		11/19/96	794.52	43.14	14.83
		11/20/96	795.70	43.14	14.01
		06/16/97	795.60	43.14	13.75
		06/18/97	795.60	43.14	14.11
		10/27/97	794.39	43.14	14.96
		05/19/98	795.41	43.14	13.94
		11/23/98	795.24	43.08	14.47
		05/24/99	795.21	43.08	14.50
		05/03/11	795.28	46.98	17.65
		11/21/11	794.75	46.98	18.04
		05/16/12	795.24	46.98	18.24
		11/06/12	794.32	46.98	18.77
		05/08/13	795.24	46.98	17.55
		08/13/13	794.29	46.98	18.41
		02/06/14	795.14	46.98	17.78
		08/20/14	794.69	46.98	18.24
		02/09/16	794.19	40.72	18.86

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-WB0.4	*WBR1*	06/16/97	795.41	--	1.25
		10/27/97	787.14	--	-0.33
		05/19/98	786.35	42.91	1.12
		11/23/98	793.86	--	--
		05/24/99	793.86	--	1.64
		12/29/99	796.49	--	0.16
		05/17/00	795.73	--	0.92
		11/27/00	796.00	--	0.66
		05/23/01	796.26	--	0.39
		11/15/01	796.59	--	0.07
		11/15/01	787.47	--	--
		05/29/02	795.67	--	0.98
		05/30/02	787.47	--	--
		11/19/02	796.13	--	0.52
		11/17/03	794.29	--	2.30
		05/12/04	793.96	--	2.62
		11/15/04	793.70	--	2.89
		05/02/05	794.09	--	2.49
		11/15/05	794.42	--	2.17
		05/03/06	794.82	--	--
		11/06/06	793.27	--	3.31
		02/13/07	793.80	--	2.72
		05/08/07	794.62	--	1.97
		11/05/07	794.62	--	--
		02/04/08	794.91	--	1.67
		05/21/08	794.46	--	--
		11/05/08	793.67	--	--
		05/07/09	794.72	--	--
		05/05/10	794.29	--	--
		02/03/14	794.49	--	2.10
		08/13/14	793.54	--	3.05
*BRF-WB0.95**	*NA*	11/05/07	807.64	--	--
		05/05/10	808.40	--	--
BRF-WB1.2	*WBR2*	06/16/97	808.23	--	10.73
		10/27/97	807.94	--	11.02
		05/19/98	807.74	46.19	11.22
		11/23/98	807.97	--	11.15
		05/24/99	807.94	--	11.19
		12/29/99	807.71	--	11.42
		05/17/00	807.64	--	11.48
		11/27/00	807.74	--	11.38
		05/23/01	807.68	--	11.45
		11/15/01	807.55	--	11.58
		05/29/02	807.61	--	11.52

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-WB1.2 (cont)	*WBR2*	11/19/02	807.94	--	11.19
		05/13/03	807.91	--	11.22
		11/17/03	807.81	--	11.32
		05/12/04	807.64	--	11.48
		11/15/04	808.01	--	11.12
		05/02/05	807.97	--	11.15
		11/15/05	807.68	--	11.45
		02/03/14	809.32	--	9.81
BRF-WB1.65 (cont)	*WBR3*	06/16/97	830.58	--	2.20
		10/27/97	830.28	--	2.49
		05/19/98	830.45	49.48	2.33
		11/23/98	830.58	--	2.20
		05/24/99	832.05	--	0.72
		12/29/99	832.28	--	0.49
		11/27/00	832.78	--	--
		11/15/01	830.31	--	2.46
		05/29/02	830.31	--	2.46
		05/30/02	832.78	--	--
		11/19/02	830.51	--	2.26
		05/13/03	830.18	--	2.59
		11/17/03	830.15	--	2.62
		05/12/04	829.89	--	2.89
		11/15/04	829.99	--	2.79
		05/02/05	830.05	--	2.72
		11/15/05	829.92	--	2.85
		05/03/06	830.05	--	--
		11/06/06	829.89	--	2.89
		02/13/07	829.79	--	2.99
		05/08/07	829.99	--	2.79
		11/05/07	830.05	--	--
		02/04/08	829.86	--	2.92

Well ID	Historical Well ID Ref.	Date	GW Elevation (ft amsl)	Inorganics	Water Level Depth (ft below TOC)
BRF-WB1.65 (cont)	*WBR3*	05/21/08	829.82	--	--
		11/05/08	829.92	--	--
		05/07/09	830.12	--	--
		05/05/10	830.71	--	--
		02/03/14	831.46	--	1.31
		08/13/14	831.04	--	1.74

* historical location unknown
-- no data
cont - continued
ft - feet
ft amsl - feet above mean sea level
GW - groundwater
Italics indicate surface water sample locations
NA - not applicable
Ref. - reference
TOC - top of casing
Well ID - well identification

TVA Bull Run Fossil Plant
Existing Monitoring Well Construction Details

Well ID	Program	Function	Well Installation Date	Facility / Location	Screened Formation	Current Status	Screened Interval (ft btoc)	Latitude NAD27 (D M S)	Longitude NAD27 (D M S)	Latitude NAD83 (D M S)	Longitude NAD83 (D M S)	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)
1	STA	WQS	3/1/1987	Bottom Ash Disposal Area	Alluvium	Active Existing Compliance Well	35.5 - 45.4	N36°00'36.20"	W84°09'12.23"	N36°00'36.46"	W84°09'11.89"	833.80	830.0	4.0	46.3	3.8	43.5	790.3
2	STA	WQS	03/1987	Bottom Ash Disposal Area	Overburden	Active Existing Compliance Well	24.9 - 34.7	N36°00'34.65"	W84°09'12.22"	N36°00'34.91"	W84°09'11.89"	820.55	816.3	2.0	35.4	4.2	32.0	788.6
47	STA	WQS	03/11/1999	Bottom Ash Disposal Area	Alluvium	Active Existing Compliance Well	21.6 - 36.4	N36°00'41.34"	W84°09'34.58"	N36°00'41.59"	W84°09'34.24"	809.62	805.6	2.0	40.8	4.0	38.0	771.6
48	STA	WQS	03/11/1999	Bottom Ash Disposal Area	Alluvium	Active Existing Compliance Well	19.7 - 39.5	N36°00'32.45"	W84°09'28.65"	N36°00'32.70"	W84°09'28.31"	808.23	804.6	2.0	40.0	3.6	38.0	770.2
49	STA	WQS	4/19/1999	Gypsum Disposal Area 2A	Alluvium	Active Existing Compliance Well	17.9 - 35.0	N36°00'21.30"	W84°09'24.30"	N36°00'21.55"	W84°09'23.96"	803.13	799.2	2.0	38.0	3.9	35.0	768.1
50	STA	WQS	04/16/1999	Gypsum Disposal Area 2A	Alluvium	Active Existing Compliance Well	19.9 - 39.5	N36°00'13.34"	W84°09'21.67"	N36°00'13.59"	W84°09'21.33"	803.82	799.9	2.0	40.2	3.9	38.0	765.8
10-51	STA	WQS	10/26/2010	Main Ash Pond	Alluvium	Active Existing Compliance Well	31.0 - 40.9	N36°00'05.90"	W84°09'19.73"	N36°00'06.16"	W84°09'19.39"	805.02	800.7	2.0	41.7	4.4	39.0	766.0
10-52	STA	WQS	10/26/2010	Main Ash Pond	Alluvium	Active Existing Compliance Well	28.4 - 38.4	N36°00'02.37"	W84°09'04.95"	N36°00'02.63"	W84°09'04.60"	803.79	799.2	2.0	39.0	4.5	37.0	766.8
BRF-104	STA	WQS	12/08/2015	Railroad Loop Disposal Area	Overburden	Active Existing Compliance Well	11.6 - 16.6	N36°00'16.41"	W84°09'02.50"	N36°00'16.67"	W84°09'02.16"	814.20	810.6	2.0	17.1	3.6	15.5	798.7
BRF-107	CCR-STA	WQC-WQS	6/24/2016	Dry Fly Ash Stack	Bedrock	Active Existing Compliance Well	26.3 - 36.4	N36°01'21.23"	W84°08'52.42"	N36°01'21.49"	W84°08'52.09"	825.55	821.9	4.0	37.1	3.7	35.0	790.5
F45R	STA	WQS	9/25/2008	Dry Fly Ash Stack	Overburden / Bedrock	Active Existing Compliance Well	23.3 - 33.2	N36°01'29.15"	W84°08'40.83"	N36°01'29.41"	W84°08'40.51"	835.35	831.0	2.0	33.8	4.3	30.0	805.3
G	CCR-STA	WLC-WQS	10/27/1988	Dry Fly Ash Stack	Bedrock	Active Existing Compliance Well	Rock well no Screen	N36°01'30.04"	W84°08'34.54"	N36°01'30.30"	W84°08'34.21"	838.09	834.0	6.0	55.3	4.1	52.5	785.6
H	Other	WLC-WQS	10/26/1988	Dry Fly Ash Stack	Bedrock	Active Existing Compliance Well	Rock well no Screen	N36°01'38.82"	W84°08'37.62"	N36°01'39.08"	W84°08'37.30"	855.46	851.2	6.0	57.5	4.3	55.0	800.5
I	CCR-STA	WQC-WQS	10/26/1988	Dry Fly Ash Stack	Bedrock	Active Existing Compliance Well	Rock well no Screen	N36°01'42.35"	W84°08'47.43"	N36°01'42.61"	W84°08'47.11"	876.57	871.7	6.0	25.7	4.9	22.0	854.6
J	CCR-STA	WQC-WQS	10/09/1989	Dry Fly Ash Stack	Bedrock	Active Existing Compliance Well	Rock well no Screen	N36°01'22.75"	W84°08'49.28"	N36°01'23.01"	W84°08'48.96"	834.39	829.0	6.0	64.5	5.4	60.0	774.4
MWA	STA	WQS	10/2/2013	Proposed Landfill(b)	Bedrock	Active Existing Compliance Well	21.2 - 31.2	N36°01'45.13"	W84°08'14.86"	N36°01'45.39"	W84°08'14.54"	862.69	858.6	2.0	31.6	4.1	29.0	833.7
MWC	CCR-STA	WQS	9/17/2013	Proposed Landfill(b)	Bedrock	Active Existing Compliance Well	11.1 - 20.9	N36°01'52.32"	W84°07'56.13"	N36°01'52.59"	W84°07'55.81"	865.24	861.1	2.5	21.6	4.1	19.0	846.2
MWD	STA	WQS	9/12/2013	Proposed Landfill(b)	Bedrock	Active Existing Compliance Well	16.6 - 26.5	N36°01'49.32"	W84°07'53.84"	N36°01'49.58"	W84°07'53.52"	872.25	868.3	2.5	27.3	4.0	26.0	846.3

TVA Bull Run Fossil Plant
Existing Monitoring Well Construction Details

Well ID	Program	Function	Well Installation Date	Facility / Location	Screened Formation	Current Status	Screened Interval (ft btoc)	Latitude NAD27 (D M S)	Longitude NAD27 (D M S)	Latitude NAD83 (D M S)	Longitude NAD83 (D M S)	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)
MWE	STA	WLS	10/1/2013	Proposed Landfill(b)	Bedrock	Active Existing Compliance Well	33.0 - 42.9	N36°01'46.62"	W84°07'51.70"	N36°01'46.88"	W84°07'51.38"	890.16	886.1	2.5	43.9	4.0	No pump	NA
MWG	STA	WLS	12/17/2013	Proposed Landfill(b)	Bedrock	Active Existing Compliance Well	40.6 - 50.5	N36°01'34.53"	W84°07'59.63"	N36°01'34.79"	W84°07'59.31"	1035.35	1031.4	2.0	51.4	3.9	No pump	NA
MWI	STA	WQS	9/24/2013	Proposed Landfill(b)	Bedrock	Active Existing Compliance Well	28.5 - 38.3	N36°01'36.22"	W84°08'15.70"	N36°01'36.48"	W84°08'15.38"	855.02	850.4	2.5	38.7	4.6	36.0	819.0
MWJ	STA	WQS	9/24/2013	Proposed Landfill(b)	Bedrock	Active Existing Compliance Well	17.1 - 27.0	N36°01'40.15"	W84°08'15.47"	N36°01'40.42"	W84°08'15.15"	847.02	843.4	2.5	27.7	3.6	25.5	821.5
MWK	STA	WQS	6/11/2014	Proposed Landfill(b)	Bedrock	Active Existing Compliance Well	29.0 - 38.9	N36°01'39.13"	W84°08'14.89"	N36°01'39.40"	W84°08'14.57"	850.91	846.9	2.0	39.5	4.0	36.0	814.9
S	STA	WQS	8/21/1990	Main Ash Pond	Alluvium	Active Existing Compliance Well	38.0 - 48.0	N35°59'51.71"	W84°09'17.22"	N35°59'51.97"	W84°09'16.88"	813.60	809.5	2.0	48.5	4.1	45.5	768.1
W06	STA	WQS	2/7/2012	Proposed Landfill(b)	Bedrock	Active Existing Compliance Well	18.0 - 28.1	N36°01'52.15"	W84°08'03.29"	N36°01'52.42"	W84°08'02.97"	867.68	863.9	2.0	28.4	3.8	26.0	841.7
W07	STA	WQS	2/7/2012	Proposed Landfill(b)	Overburden	Active Existing Compliance Well	9.9 - 15.1	N36°01'52.08"	W84°08'03.25"	N36°01'52.35"	W84°08'02.93"	867.70	863.8	2.0	15.2	3.9	14.0	853.7
W08	STA	WLS	2/9/2012	Proposed Landfill(b)	Bedrock	Active Existing Compliance Well	17.4 - 27.4	N36°01'50.76"	W84°08'00.09"	N36°01'51.02"	W84°07'59.77"	863.72	859.9	2.0	27.6	3.8	No pump	NA
W09R	STA	WQS	42996	Proposed Landfill(b)	Bedrock	Active Existing Compliance Well	32.3 - 41.4	N36°01'44.65"	W84°07'51.19"	N36°01'44.91"	W84°07'50.87"	895.85	891.6	4.0	42.3	4.2	40.0	855.9
W11	STA	WQS	2/17/2012	Proposed Landfill(b)	Bedrock	Active Existing Compliance Well	21.9 - 37.0	N36°01'37.66"	W84°08'14.53"	N36°01'37.92"	W84°08'14.21"	857.68	853.7	2.0	37.3	4.0	35.0	822.7
MW-3H/P-3	CCR-STA	WQC-WQS	08/24/2005	Dry Fly Ash Stack	Bedrock	Active Existing Compliance Well	34.0 - 44.0	N36°01'22.07"	W84°09'01.98"	N36°01'22.33"	W84°09'01.65"	834.27	827.2	2.0	44.6	7.1	38.0	796.3

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 Bull Run Fossil Plant
Closed Monitoring Well Construction Details

Well ID	Well Type	Facility / Location	Installation Date	Well Abandoned	Screened Formation	TN State Plane Northing NAD 27 (ft)	TN State Plane Easting NAD 27 (ft)	Top of Casing (ft-msl) (D M S)	Top of Ground (ft-msl) (D M S)	Well Depth (feet below ground) (D M S)	Stickup (ft.) (D M S)	Well Diameter (inches) (ft NGVD 29)	Screened (ft NGVD 29)	Rationale
BRF-20H	Monitoring Well	Coal Yard	8/29/2005	9/26/2011	Bedrock	599157.38	2547878.03	831.33	829.69	33.6	1.64	2.00	23.4 - 33.4	NA
BRF-22	Leachate Well Point	Bottom Ash Pond Area 2	UNK	UNK	UNK	591274.47	2545712.70	826.80	UNK	UNK	UNK	UNK	UNK	Hand-driven well points. Well removed or destroyed.
BRF-23	Leachate Well Point	Bottom Ash Pond Area 2	UNK	UNK	UNK	591902.75	2546851.36	813.00	UNK	UNK	UNK	UNK	UNK	Hand-driven well points. Well removed or destroyed.
BRF-25	Leachate Well Point	Railroad Loop Disposal Area	3/1991	UNK	UNK	592373.62	2547645.53	817.90	UNK	UNK	UNK	UNK	UNK	Well destroyed. Pipe in West Dredge Cell.
BRF-26	Leachate Well Point	Railroad Loop Disposal Area	3/1991	UNK	UNK	592731.02	2548083.54	817.06	UNK	UNK	UNK	UNK	UNK	Well destroyed. Pipe in East Dredge Cell.
BRF-27	Leachate Well Point	Railroad Loop Disposal Area	3/1991	UNK	UNK	592879.80	2548129.37	816.71	UNK	UNK	UNK	UNK	UNK	Well destroyed. Pipe in East Dredge Cell.
BRF-28	Leachate Well Point	Railroad Loop Disposal Area	UNK	UNK	UNK	593703.88	2545831.25	UNK	UNK	UNK	UNK	UNK	UNK	Hand-driven well points. Well removed or destroyed.
29	Monitoring Well	Railroad Loop Disposal Area	3/21/1991	7/28/16 (well not found)	Overburden	592315.79	2547700.86	823.32	820.20	31	flush	4.00	6.0-31.0	Well could not be located and location did not appear suitable for current groundwater monitoring networks.
30	Monitoring Well	Railroad Loop Disposal Area	3/21/1991	7/28/16	Overburden	592929.76	2548192.85	818.95	818.37	27	flush	4.00	6.5-26.5	Well was observed to be grouted.
31	Monitoring Well	Railroad Loop Disposal Area	3/21/1991	7/28/16 (well not found)	Overburden	592953.73	2548243.32	819.68	819.69	27.7	flush	4.00	5.0-27.7	Well could not be located and location did not appear suitable for current groundwater monitoring networks.
32	Monitoring Well	Railroad Loop Disposal Area	3/22/1991	7/28/16 (well not found)	Overburden	593493.99	2548227.19	823.35	823.36	23.7	flush	4.00	3.3-23.3	Well could not be located and location did not appear suitable for current groundwater monitoring networks.
BRF-41	Domestic Water Well	Offsite	NA	NA	NA	600749.49	2549395.28	NA	NA	NA	NA	NA	NA	Water supply well was not located during a 2015 private well location survey. Closure of the well will be verified in the Water Use Survey.
BRF-43	Domestic Water Well	Offsite	NA	NA	NA	594750.54	2547701.43	NA	NA	NA	NA	NA	NA	Water supply well was not located during a 2015 private well location survey. Closure of the well will be verified in the Water Use Survey.
BRF-44	Domestic Water Well	Offsite	NA	NA	NA	595366.45	2548182.79	NA	NA	NA	NA	NA	NA	Water supply well was not located during a 2015 private well location survey. Closure of the well will be verified in the Water Use Survey.
46	Monitoring Well	Railroad Loop Disposal Area	3/5/1993	7/28/2016	Bedrock	593347.05	2547341.76	919.75	916.34	82.35	UNK	2	Unknown	Well location did not appear suitable for current monitoring well networks.
A	Monitoring Well	Railroad Loop Disposal Area	9/29/1980	10/28/2010	Overburden	592229.69	2547217.23	813.18	812.98	100	0.20	4.00	20 - 30	NA
B	Monitoring Well	Railroad Loop Disposal Area	9/29/1980	7/29/2016	Overburden	592269.07	2547700.19	815.90	814.50	70	1.4	4	Screen: 25.0-35.0 Open Hole: 35.0-70.0	Well location did not appear suitable for current monitoring well networks.

TVA Bull Run Fossil Plant
Closed Monitoring Well Construction Details

Well ID	Well Type	Facility / Location	Installation Date	Well Abandoned	Screened Formation	TN State Plane Northing NAD 27 (ft)	TN State Plane Easting NAD 27 (ft)	Top of Casing (ft-msl) (D M S)	Top of Ground (ft-msl) (D M S)	Well Depth (feet below ground) (D M S)	Stickup (ft.) (D M S)	Well Diameter (inches) (ft NGVD 29)	Screened (ft NGVD 29)	Rationale
C	Monitoring Well	Railroad Loop Disposal Area	9/29/1980	7/29/2016	Overburden	592879.80	2548231.17	820.79	819.28	71	1.508624	4	Screen: 20.0-30.0 Open Hole: 30.0-71.0	Well location did not appear suitable for current monitoring well networks.
D	Monitoring Well	Railroad Loop Disposal Area	9/29/1980	NA	Bedrock	593407.38	2547006.24	820.40	820.36	100	0.03	4.00	No screen open well 13.5 - 86.5	Recommended for closure due to problems with casing corrosion.
BRF-F	Monitoring Well	Ash Disposal Area 1	10/27/1988	10/1990	Bedrock	599858.09	2548191.93	838.60	838.60	46	n/a	2	10 - 46	Well closed due to concerns that well might impair the integrity of the ash pond and/or dike.
BRF-F45	Monitoring Well	Dry Fly Ash Stack	5/19/1992	10/28/2010	Overburden Bedrock	598312.38	2547205.65	834.35	831.69	28.12	4.30	2.00	18.1 - 27-4	Well closed due to potential entry of surface water. Replaced by MW-F45R.
K	Monitoring Well	Dry Fly Ash Stack	8/31/1990	7/28/16 (well not found)	Bedrock	598312.38	2547205.65	815.80	815.80	31.1	flush	4.00	No screen open well 21.1 - 31.1	Well could not be located and location did not appear suitable for current groundwater monitoring networks.
BRF-L	Monitoring Well	Coal Yard	9/28/1989	9/22/2011	Bedrock	598189.74	2546013.26	831.89	831.88	50	flush	6.00	23.4 - 33.4	NA
BRF-M	Monitoring Well	Coal Yard	10/5/1989	9/22/2011	Bedrock	598211.01	2546025.81	832.09	832.08	60	flush	6.00	No screen open well 31 - 29	NA
BRF-N	Monitoring Well	Coal Yard	10/2/1989	9/22/2011	Bedrock	598188.38	2546037.90	831.19	831.20	60	flush	6.00	No screen open well 31 - 29	NA
BRF-O	Monitoring Well	Sluice Pond	8/29/1990	11/2000	Bedrock	595230.77	2543921.89	802.29	802.30	61	flush	2.00	50.9 - 60.7	Well had siltation problems.
BRF-P	Monitoring Well	Stilling Pond	9/4/1990	NA	Bedrock	589640.38	2545804.20	809.49	809.50	52.2	flush	2.00	42.3 - 52.2	Problems with annular seal. Grout was leaching into screen affecting water quality.
BRF-PZ 2AC	Piezometer	Bottom Ash Pond Area 2	3/15/1999	NA	Bedrock	592435.00	2545800.00	822.23	818.89	47.2	3.346416	1.00	37.40 - 45.93	Installed for temporary groundwater monitoring in Area 2A.
BRF-Q	Monitoring Well	Sluice Pond	8/28/1990	9/22/2011	Overburden	598300.70	2547190.33	815.69	815.70	15.1	flush	2.00	5.1 - 15.1	NA
BRF-R	Monitoring Well	Sluice Pond	8/28/1990	11/2000	Overburden	595243.84	2543914.80	802.19	802.20	32.5	flush	2.00	22.3 - 32.1	NA
MW-1H/P-1	Monitoring Well	Coal Yard	8/25/2005	9/25/2008	Overburden Bedrock	599119.74	2546658.86	838.93	835.99	25.2	2.94	2.00	15.0 - 25.0	Well location did not appear suitable for current monitoring well networks.
MWB	Monitoring Well	Proposed Landfill	10/9/2013	7/27/2016	Bedrock	601553.59	2551033.74	864.01	860.62	29.4	3.39	2.00	19.0 - 29.0	Well located within proposed landfill footprint.
MWF	Monitoring Well	Proposed Landfill	9/30/2013	7/27/2016	Bedrock	600846.86	2552847.54	966.93	963.40	39	3.53	2.00	26.0 - 36.0	Limited groundwater present.
MWH	Monitoring Well	Proposed Landfill	10/12/2013	7/27/2016	Bedrock	599883.22	2551318.85	998.94	995.55	50	3.39	2.00	38.0 - 48.0	Limited groundwater present.

TVA Bull Run Fossil Plant
Closed Monitoring Well Construction Details

Well ID	Well Type	Facility / Location	Installation Date	Well Abandoned	Screened Formation	TN State Plane Northing NAD 27 (ft)	TN State Plane Easting NAD 27 (ft)	Top of Casing (ft-msl) (D M S)	Top of Ground (ft-msl) (D M S)	Well Depth (feet below ground) (D M S)	Stickup (ft.) (D M S)	Well Diameter (inches) (ft NGVD 29)	Screened (ft NGVD 29)	Rationale
W01	Monitoring Well	Proposed Landfill	1/19/2012	7/27/2016	Bedrock	600575.95	2551300.48	891.60	888.39	52.3	3.21	2.00	38.5 - 48.5	Well located within proposed landfill footprint.
W02	Monitoring Well	Proposed Landfill	1/24/2002	7/27/2016	Bedrock	601267.12	2551390.32	853.56	850.44	32.6	3.12	2.00	15.0 - 25.0	Well located within proposed landfill footprint.
W03	Monitoring Well	Proposed Landfill	1/25/2012	7/27/2016	Bedrock	601047.70	2552182.37	892.89	889.52	37.3	3.37	2.00	20.0 - 30.0	Well located within proposed landfill footprint.
W04	Monitoring Well	Proposed Landfill	1/30/2012	7/27/2016	Bedrock	601083.00	2551661.38	868.24	865.07	42.5	3.17	2.00	21.0 - 36.0	Well located within proposed landfill footprint.
W05	Monitoring Well	Proposed Landfill	3/2/2012	7/27/2016	Bedrock	601196.73	2550543.37	868.46	865.28	27	3.18	2.00	10.0 - 20.0	Existing well MWA in similar location and would be used to monitor under the state permit.
W09	Monitoring Well	Proposed Landfill(b)	2/14/2012	9/1/2017	Bedrock	601126.92	2552671.60	899.84	896.70	24.28	3.139	2.00	13.7 - 23.7	Well closed due to blockage in casing. Well replaced with W-09R.
W10	Monitoring Well	Proposed Landfill	2/16/2012	7/27/2016	Bedrock	600853.11	2550900.28	899.84	896.70	37.6	3.14	2.00	16.0-26.0	Well located within proposed landfill footprint.

Well construction depths based on video logging performed by Stantec.
Ground surface elevations are based on survey datum and/or well completion data.

Abbreviations:

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
NA	Not Available
NAD27	North American Datum of 1927
NAD83	North American Datum of 1983
UNK	Unknown (design and construction details not located)

Stantec Consulting Services Inc.
1409 North Forbes Road
Lexington, KY 40511-2050
Tel: (859) 422-3000
Fax: (859) 422-3100

December 10, 2010
File: 175560058L02

Mr. Ron Skelton
Tennessee Valley Authority
1101 Market Street, LP 4T-C
Chattanooga, Tennessee 37402

Re: Abandonment of Instrumentation
Bull Run Fossil Plant
Oak Ridge, Tennessee

Dear Ron:

As requested, Stantec Consulting Services Inc. (Stantec) has completed the instrumentation abandonment at the above referenced site in accordance with our proposal dated October 22, 2010 and TVA's Standard Operating Procedures for: Groundwater Monitoring Well Abandonment. Two monitoring wells were abandoned during the period from October 27 through October 28, 2010.

The overdrill and grout method was used for abandonment of well F-45. The existing surface protection (bollards, protective cover and concrete surface pad) were removed and stockpiled adjacent to the drilling site for disposal by others. A drill rig equipped with hollow stem augers was used to abandon the monitoring well. The drill cuttings generated from these activities were also stockpiled at the locations for future disposal by others. Upon augering the material and removal of all of the PVC material, the resulting hole was backfilled using a cement-bentonite grout (5% bentonite by weight). The grout material was placed by tremmie method.

The grout-in-place method was used for abandoning Well A. The existing surface protection, (bollards) were removed, prior to grouting. The well was then tremmie-grouted using cement-bentonite grout (5% bentonite by weight). Using the drill rig wench, the well casing was then pulled from the borehole and placed adjacent to the site for removal by others.

Table 1 presents additional information for the monitoring wells that were abandoned.

Table 1. Summary of Abandoned Instrumentation

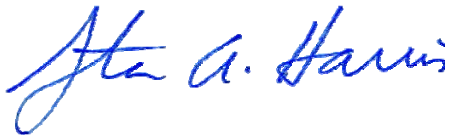
Well ID	Measured Well Depth (ft)	Measured Water Level (ft)	Borehole Diameter (in)	Amount of Grout Used (gal)
F45	32	16	9	100
A	100	8.4	4	90

The initial instrumentation installation log for each of the instruments identified in Table 1 is attached.

Stantec appreciates the opportunity to provide these services to TVA. If you need further assistance contact our office.

Sincerely,

STANTEC CONSULTING SERVICES INC.



Stan A. Harris, PE
Principal

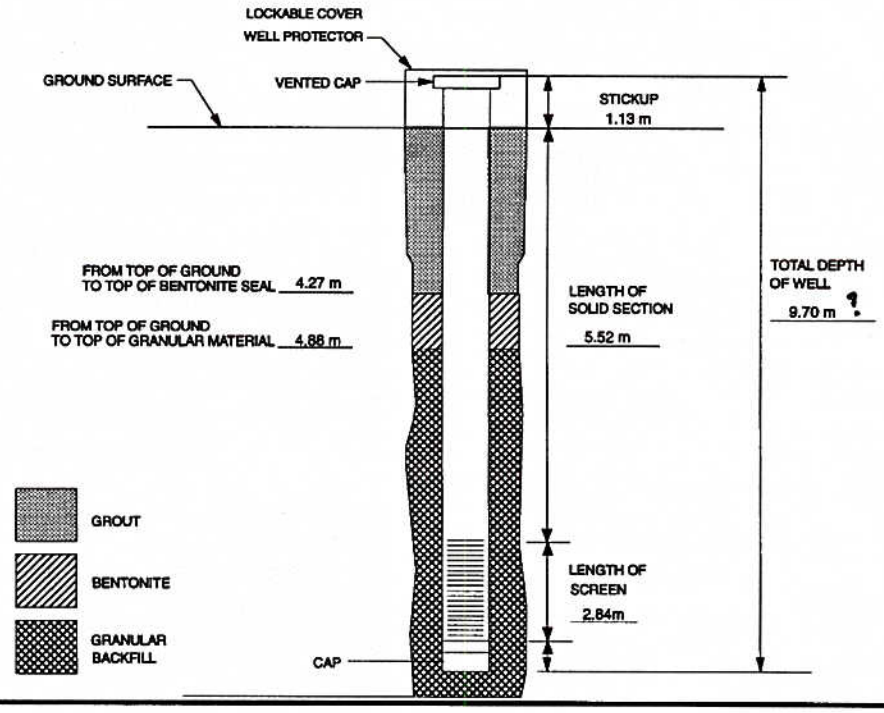
/lfb

Attachment

MONITORING WELL INSTALLATION RECORD

PROJECT	BULL RUN		
WELL NUMBER	F45	INSTALLATION DATE	5-19-92
PLANT COORDINATES	EAST 1257.78 m	NORTH	-291.12 m
GROUND SURFACE ELEVATION	253.5 m-msl	TOP OF INNER CASING	254.31 m-msl
BACKFILL MATERIAL		SLOT SIZE	0.0254 cm
CASING MATERIAL	SCH 40 PVC	CASING DIAMETER	5.2 6.0 cm
DRILLING TECHNIQUE	Hollow Stem Augers and HQ Coring	DRILLING CONTRACTOR	Law Engineering
BOREHOLE DIAMETER	21.0 cm	FIELD REPRESENTATIVE	Kenny Johnson
LOCKABLE COVER ?	YES	FILTER CLOTH AROUND SCREEN?	NO
DRILLING FLUID	Potable H_2O		
COMMENTS	Protective Cover and Stickup added on 8-27-93		

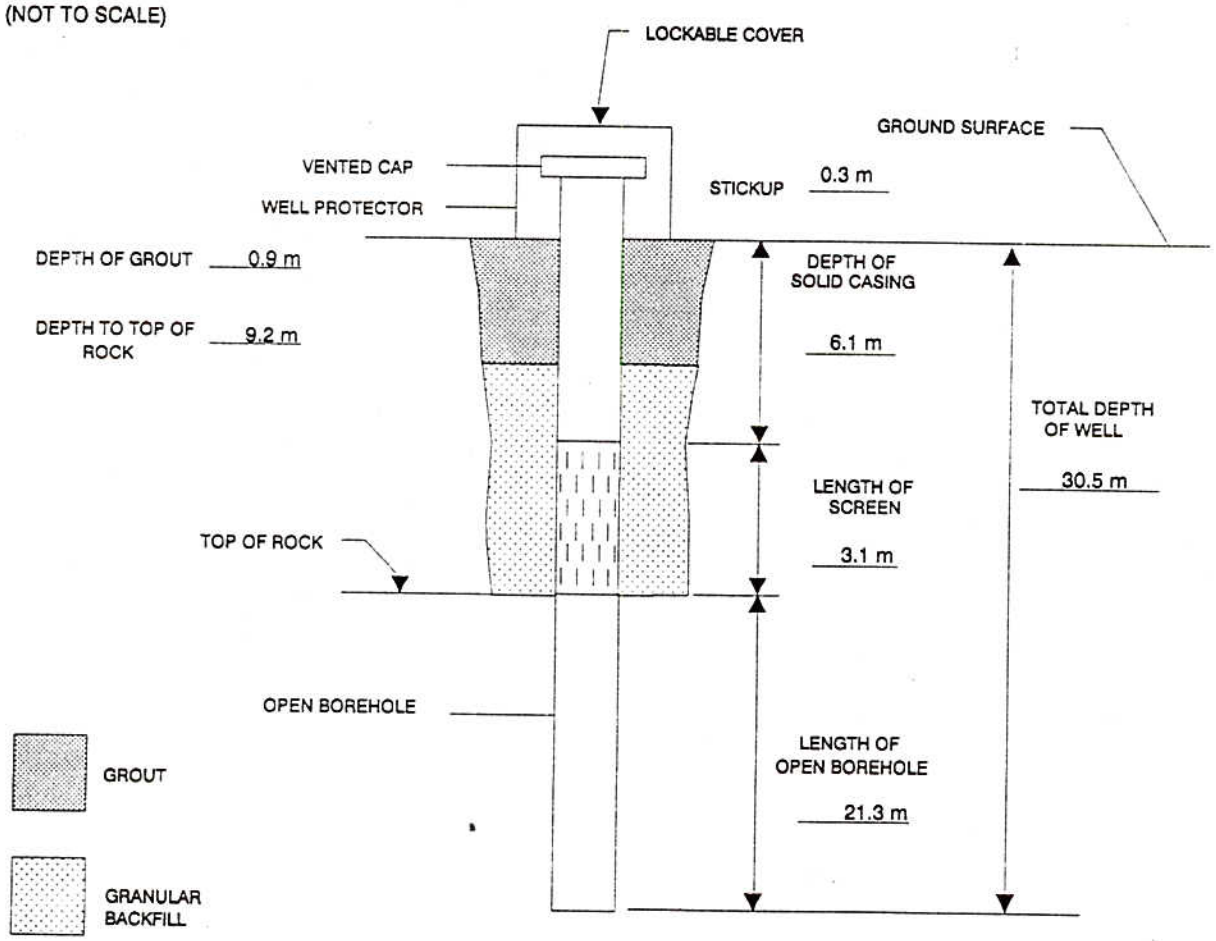
(NOT TO SCALE)



ROCK MONITORING WELL INSTALLATION RECORD

PROJECT	BULL RUN		
WELL NUMBER	A	INSTALLATION DATE	9-29-80
PLANT COORDINATES EAST	-416.3 m	NORTH	-1812.2 m
GROUND SURFACE ELEVATION	247.5 ft-msl	TOP OF INNER CASING	247.86 m-msl
BACKFILL MATERIAL	PEA GRAVEL	SLOT SIZE	0.2cm x 15cm (vertical)
CASING MATERIAL	GALVANIZED STEEL	CASING DIAMETER	10.16 cm
DRILLING TECHNIQUE IN SOIL	Auger	DRILLING TECHNIQUE IN ROCK	PERCUSSION
OUTER BOREHOLE DIAMETER	30.5 cm	DRILLING CONTRACTOR	TVA
LOCKABLE COVER ?	NO	OPEN BOREHOLE DIAMETER	10.16 cm
DRILLING FLUID	Water	FIELD REPRESENTATIVE	J.M. Davenport
COMMENTS			

(NOT TO SCALE)



ENG LAB 4/25/95 MGS\MTWELLA.DRW

CLOSED MONITORING WELLS				
WELL ID	NORTHING (FEET)	EASTING (FEET)	LATITUDE (D-M-S)	LONGITUDE (D-M-S)
30	592929.76	2548192.85	N36°00'24.19"	W84°08'47.14"
46	593347.05	2547341.76	N36°00'28.48"	W84°08'57.40"
B	592269.07	2547700.19	N36°00'17.75"	W84°08'53.29"
C	592879.80	2548231.17	N36°00'23.69"	W84°08'46.68"
E	600818.49	2548876.60	N36°01'42.07"	W84°08'37.00"
LFJMWB	601553.59	2551033.74	N36°01'48.93"	W84°08'10.57"
LFJMWF	600846.86	2552847.54	N36°01'41.60"	W84°07'48.66"
LFJMWH	599883.22	2551318.85	N36°01'32.36"	W84°08'07.49"
LFJW01	600575.95	2551300.48	N36°01'39.21"	W84°08'07.55"
LFJW02	601267.12	2551390.32	N36°01'46.03"	W84°08'06.30"
LFJW03	601047.70	2552182.37	N36°01'43.71"	W84°07'56.71"
LFJW04	601083.00	2551661.38	N36°01'44.16"	W84°08'03.04"
LFJW05	601196.73	2550543.37	N36°01'45.49"	W84°08'16.62"
BRF_CCPLF_W09	601126.92	2552671.60	N36°01'44.38"	W84°07'50.71"
LFJW10	600853.11	2550900.28	N36°01'42.03"	W84°08'12.36"

NOTES:

1. THE AERIAL MAPPING PROVIDED BY USDA NAIP IS BASED ON HORIZONTALDATUM NAD27 USING STATE PLANE TENNESSEE COORDINATE SYSTEM AND VERTICAL DATUM NGVD29. THE ORTHO-PHOTOGRAPHY WAS PERFORMED IN 2014. GEODETIC COORDINATES SHOWN ARE NAD83.
2. ALL BOUNDARY LINES ARE APPROXIMATE WORKING BOUNDARIES, TO BE CONFIRMED BY TVA.
3. WELLS CLOSED IN MARCH 2016, AND SEPTEMBER 2017.
4. WELLS 29, 31, 32, K, AND MW-1H/P-1 WERE NOT FOUND AND PRESUMED TO HAVE BEEN PREVIOUSLY CLOSED.

LEGEND

TVA BOUNDARY LINE

CLOSED WELL LOCATION

RECORD DRAWING

250 0 500 1000 FEET
GRAPHIC SCALE

Stantec
3052 Beaumont Centre Circle
Lexington, Kentucky 40513
www.stantec.com

REV NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV NO.
R 1	11/15/17	DRP	MSJ	JGB	BLB	SEB	MST	JCK	608390	–	1
UPDATE WELL ID NAME											
R 0	10/02/17	DRP	MSJ	JGB	BLB	SEB	MST	JCK	608390	–	–
ISSUED AS-BUILT AS PER PROJECT ID 608390											

DISCIPLINE INTERFACE

SCALE: 1"=500' EXCEPT AS NOTED

YARD
GROUNDWATER INSTRUMENTATION

MONITORING WELL NETWORK AND OBSERVATION WELLS CLOSED WELL LOCATION PLAN

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
D.R. PLEIMAN	M.S. JENNINGS	J.G. BANTON	B.L. BRYANT	S.E. BENNET	M.S. TURNBOW	J.C. KAMMEYER

BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 20.1	DATE 10/02/17	49	C	10W858-05	R 1

STANTEC	1
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:500
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

PLOT DATE: 11/15/2017 USER: JENNINGS, MATTHEW
N:\PROJECTS\POWER\BULL_RUN\FGD\PROJECTS\608390\CAD\MICROSTATION\10W858-05-C-R1.DGN

Groundwater Monitoring Well Abandonment Checklist

Plant: **Date:** 7-28-16

TVA Project Number: **Page** 1 **of** 1

Well No. 30

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	✓			
2	Geodetic coordinates agree with those on implementation plan?	✓			
	Hand-held GPS readings -				
	Latitude:				
	Longitude:				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature - James Andrew	James Andrew			
	P&CC Engineering Rep. Signature - Chris Hensley	Chris Hensley			
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing) N/A Previously filled w/ cement			✓	_____ feet
5	Well depth in general agreement with existing well construction details?			✓	
6	Water Depth (feet below top of casing)			✓	_____ feet
7	Approximate well casing stickup above ground =			✓	_____ inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by -	Stantec			
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature: James Andrew				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			✓	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?				
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.	Removed previously cemented Gluch mount				
b.					
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: **Date:** 7-28-16

TVA Project Number: **Page** 1 **of** 1

Well No. 46

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	✓			
2	Geodetic coordinates agree with those on implementation plan?	✓			
	Hand-held GPS readings -				
	Latitude:				
	Longitude:				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature - James Andrew	James Andrew			
	P&CC Engineering Rep. Signature - Chris Hensley	Chris Hensley			
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				84.87 feet
5	Well depth in general agreement with existing well construction details?				
6	Water Depth (feet below top of casing)				76.56 feet
7	Approximate well casing stickup above ground =				40 inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by -	Stantec			
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature:				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			✓	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?				
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.	Extracted approximately 10 Ft. of PVC casing				
b.					
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: **Date:** 7-29-16

TVA Project Number: **Page** 1 **of** 1

Well No. B

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	✓			
2	Geodetic coordinates agree with those on implementation plan?	✓			
	Hand-held GPS readings -				
	Latitude:				
	Longitude:				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature - James Andrew				
	P&CC Engineering Rep. Signature - Chris Hensley				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				70.58 feet
5	Well depth in general agreement with existing well construction details?				
6	Water Depth (feet below top of casing)				21.88 feet
7	Approximate well casing stickup above ground =				9 inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by -	Stantec			
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature:				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			✓	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?				
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.					
b.					
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: **Date:** 7-28-16

TVA Project Number: **Page** 1 **of** 1

Well No. C

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	✓			
2	Geodetic coordinates agree with those on implementation plan?	✓			
	Hand-held GPS readings -				
	Latitude:				
	Longitude:				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature - James Andrew				
	P&CC Engineering Rep. Signature - Chris Hensley				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				72.15 feet
5	Well depth in general agreement with existing well construction details?				
6	Water Depth (feet below top of casing)				23.50 feet
7	Approximate well casing stickup above ground =				9 inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by -	Stantec			
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature:				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			✓	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?				
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.					
b.					
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: **Date:** 7-28-16

TVA Project Number: **Page** 1 **of** 1

Well No. E

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	✓			
2	Geodetic coordinates agree with those on implementation plan?	✓			
	Hand-held GPS readings -				
	Latitude:				
	Longitude:				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature - James Andrew				
	P&CC Engineering Rep. Signature - Chris Hensley				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				17.83 feet
5	Well depth in general agreement with existing well construction details?	✓			
6	Water Depth (feet below top of casing)				10.83 feet
7	Approximate well casing stickup above ground =				11 inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by -	Stantec			
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature:				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			✓	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?				
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.	Extracted approximately 12.5 ft. of casing				
b.					
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: **Date:** 7-27-16

TVA Project Number: **Page** 1 **of** 1

Well No. LFJMW8

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	✓			
2	Geodetic coordinates agree with those on implementation plan?	✓			
	Hand-held GPS readings -				
	Latitude:				
	Longitude:				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature - James Andrew				
	P&CC Engineering Rep. Signature - Chris Hensley				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				32.60 feet
5	Well depth in general agreement with existing well construction details?				
6	Water Depth (feet below top of casing)				6.0 feet
7	Approximate well casing stickup above ground =				42 inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by -	Stantec			
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature:				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			✓	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?				
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.	Extracted approximately 22.5 ft. casing				
b.	and 10 ft of screen				
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: **Date:** 7-27-16

TVA Project Number: **Page** 1 **of** 1

Well No. LFJMWF

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	✓			
2	Geodetic coordinates agree with those on implementation plan?	✓			
	Hand-held GPS readings -				
	Latitude:				
	Longitude:				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature - James Andrew				
	P&CC Engineering Rep. Signature - Chris Heasley				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				39.90 feet
5	Well depth in general agreement with existing well construction details?				
6	Water Depth (feet below top of casing)				39.58 feet
7	Approximate well casing stickup above ground =				42 inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by -	Stantec			
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature:				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			✓	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?				
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.	Extracted approximately 20 ft. of casing				
b.					
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: **Date:** 7-27-16

TVA Project Number: **Page** 1 **of** 1

Well No. 4FJMWH

	Description	Yes	No	NA	Comments
		✓			
1	Existing groundwater monitoring well to be closed.	✓			
2	Geodetic coordinates agree with those on implementation plan?	✓			
	Hand-held GPS readings -				
	Latitude:				
	Longitude:				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature - James Andrew				
	P&CC Engineering Rep. Signature - Chris Hensley				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				51.65 feet
5	Well depth in general agreement with existing well construction details?				
6	Water Depth (feet below top of casing)				51.15 feet
7	Approximate well casing stickup above ground =				42 inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by -	Stantec			
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature:				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			✓	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?				
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.	Extracted approximately 40 ft. of casing				
b.	10 ft. of screen and bottom plug				
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: **Date:** 7-26-16

TVA Project Number: **Page** 1 **of** 1

Well No. LFJW01

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	✓			
2	Geodetic coordinates agree with those on implementation plan?	✓			
	Hand-held GPS readings - NAD 27				
	Latitude: Northing 600575.951				
	Longitude: Easting 2551200.477				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature - James Andrew				
	P&CC Engineering Rep. Signature - Chris Hemsley				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				52.47 feet
5	Well depth in general agreement with existing well construction details?	✓			
6	Water Depth (feet below top of casing)				44.14 feet
7	Approximate well casing stickup above ground =				38 inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by -	Stantec			
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature:				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			✓	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?				
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.	Extracted approximately 12 ft. of casing				
b.					
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: **Date:** 7-26-16

TVA Project Number: **Page** 1 **of** 1

Well No. LFIW02

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	✓			
2	Geodetic coordinates agree with those on implementation plan?	✓			
	Hand-held GPS readings - NAD 27				
	Latitude: Northing 601267.122				
	Longitude: Easting 2557390.315				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature - James Andrew				
	P&CC Engineering Rep. Signature - Chris Hensley				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				28.95 feet
5	Well depth in general agreement with existing well construction details?	✓			
6	Water Depth (feet below top of casing)				19.35 feet
7	Approximate well casing stickup above ground =				38 inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by -	Stantec			
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature:				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			✓	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?				
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.	Extracted approximately 8 Ft. of casing				
b.					
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: **Date:** 7-27-16

TVA Project Number: **Page** 1 **of** 1

Well No. LFJW03

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	✓			
2	Geodetic coordinates agree with those on implementation plan?	✓			
	Hand-held GPS readings -				
	Latitude:				
	Longitude:				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature - James Andrew				
	P&CC Engineering Rep. Signature - Chris Hensley				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				33.54 feet
5	Well depth in general agreement with existing well construction details?				
6	Water Depth (feet below top of casing)				23.05 feet
7	Approximate well casing stickup above ground =				38 inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by -	Stantec			
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature:				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			✓	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?				
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.	Extracted approximately 23 ft. of casing				
b.	and 4 ft. of screen				
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: **Date:** 7-26-16

TVA Project Number: **Page** 1 **of** 1

Well No. LFIW04

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	✓			
2	Geodetic coordinates agree with those on implementation plan?	✓			
	Hand-held GPS readings - NAD 27				
	Latitude: Northing 601083.004				
	Longitude: Easting 2551661.375				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature - James Andrew				
	P&CC Engineering Rep. Signature - Chris Hensley				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				39.78 feet
5	Well depth in general agreement with existing well construction details?				
6	Water Depth (feet below top of casing)				34.67 feet
7	Approximate well casing stickup above ground =				39 inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by -	Stantec			
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature:				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			✓	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?				
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.	Extracted approximately 4 Ft. of casing				
b.					
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: **Date:** 7-27-16

TVA Project Number: **Page** 1 **of** 1

Well No. LFJW05

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	✓			
2	Geodetic coordinates agree with those on implementation plan?	✓			
	Hand-held GPS readings -				
	Latitude:				
	Longitude:				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature - James Andrew				
	P&CC Engineering Rep. Signature - Chris Heasley				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				22.97 feet
5	Well depth in general agreement with existing well construction details?				
6	Water Depth (feet below top of casing)				14.90 feet
7	Approximate well casing stickup above ground =				39 inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by -	Stantec			
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature:				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			✓	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?				
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.	Extracted approximately 12.5 ft. casing				
b.	and 10 ft. of screen.				
c.					

Groundwater Monitoring Well Abandonment Checklist

Plant: **Date:** 7-27-16

TVA Project Number: **Page** 1 **of** 1

Well No. 4FJW10

	Description	Yes	No	NA	Comments
1	Existing groundwater monitoring well to be closed.	✓			
2	Geodetic coordinates agree with those on implementation plan?	✓			
	Hand-held GPS readings -				
	Latitude:				
	Longitude:				
3	Correct well ID and location verified by the following people (**min. of two signatures required**):				
	Stantec Rep. Signature - James Andrew				
	P&CC Engineering Rep. Signature - Chris Hensley				
	Generation Construction Rep. Signature -				
	Cascade Drilling Rep. Signature -				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				29.58 feet
5	Well depth in general agreement with existing well construction details?				
6	Water Depth (feet below top of casing)				21.12 feet
7	Approximate well casing stickup above ground =				39.5 inches
8	Construction debris\materials removed from well abandonment site?	✓			
	Concrete pad and bollards removed by -	Stantec			
9	Well Closure Documented By:				
	Print Name: James Andrew				
	Signature:				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?			✓	
	Performed By:				
	Verified & Approved By:				
11	Picture taken at well site?				
a.	Before start of construction?	✓			
b.	After well abandonment completed?	✓			
c.	Performed By: James Andrew				
12	Miscellaneous				
a.	Extracted approximately 19 ft. of casing				
b.	and 4 ft. of screen.				
c.					

Groundwater Monitoring Well Checklist

Plant: BRF

Date: 9-13-2017

Project Number: 608390

Well No. LFJW09

	Description	Yes	No	N/A	Comment
1	Existing groundwater monitoring well to be closed - dedicated pump unremovable	X			
2	Geodetic coordinates agree with those on implementation plan?				
	Hand-Held GPS readings -				
	Latitude: 36° 01' 44.38" N				
	Longitude: 84° 07' 50.71" W				
3	Correct well ID and location verified by the following people **(min. of two signatures required)**:				
	Stantec Rep. Signature - /s/ Craig Millhollin				
	P&CC Engineering Rep. Signature -				
	Generation Construction Rep. Signature -				
	Stantec Drilling Rep. Signature - /s/ Tim Caudill				
	GUBMK Rep. Signature -				
4	Well Depth (feet below top of casing)				21.7feet
5	Well Depth in general agreement with existing well construction details				Yes
6	Water Depth (feet below top of casing)				NA-below depth of blockage
7	Approximate well casing stickup above ground =				41 inches
8	Construction debris/materials removed from well abandonment site				
	Concrete pad and bollards removed by –	X			Reused on W09R
9	Well Closure Documented By:				
	Print Name: Craig Millhollin				
	Signature: /S/ Craig Millhollin				
	Company: Stantec				
10	All areas impacted by construction activities graded, re-seeded and straw added?				
	Performed By: Craig Millhollin				
	Verified & Approved By: Tim Caudill, Stantec Driller				
11	Picture taken at well site?				
a.	Before start of construction?	X			
b.	After well abandonment completed?	X			
c.	Performed By: Craig Millhollin				
12	Miscellaneous				
a.					
b.					
c.					
d.					

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: 30

Start Date: 7-28-16 Site Name: BRF Oversight By: J. Andrew

End Date: _____ Abandoned By: Thompson Project Name: TVA BRF GWMW Closures

Well Details (Check one per section):

Casing Diameter

_____ 2”
X 4”
_____ 6”
_____ Other/NA

Well Type

X Permanent
_____ Temporary
_____ Geoprobe® Screen Point (GSP) or Equiv.
_____ Flush Mount/Stickup

Casing Material

X PVC
_____ Steel
_____ Other/NA

Abandonment Details (Check one per section):

Remove surface features from previously grouted flush mount

Abandonment Method (as detailed in TVA-KIF-SOP-46)

_____ Overdrill and Grout
_____ Well Extraction
X Grout in Place
_____ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
_____ Bentonite Sealing- Pellets Only (low-risk GSP only)
_____ Probe Hole Grouting (higher risk GSP only)
_____ Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

_____ Type 1 Portland Cement mixed with 3-5% bentonite
_____ Bentonite Pellets
_____ Neat Cement
25 gallons Other 30% solids bentonite grout

Overdrilled Well Cuttings and Debris N/A

_____ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
_____ Disposed of at TVA on-site disposal area

Reviewed By: _____ 8/16/2016
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

End of Procedure

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: 46

Start Date: 7-28-16 Site Name: BRF Oversight By: J. Andrew

End Date: _____ Abandoned By: Thompson Project Name: TVA BRF GWMW Closures

Well Details (Check one per section):

Casing Diameter

- X 2”
- _____ 4”
- _____ 6”
- _____ Other/NA

Well Type

- X Permanent
- _____ Temporary
- _____ Geoprobe® Screen Point (GSP) or Equiv.
- _____ Flush Mount/Stickup

Casing Material

- X PVC
- _____ Steel
- _____ Other/NA

Abandonment Details (Check one per section):

Abandonment Method (as detailed in TVA-KIF-SOP-46)

- _____ Overdrill and Grout
- _____ Well Extraction
- X Grout in Place
- _____ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- _____ Bentonite Sealing- Pellets Only (low-risk GSP only)
- _____ Probe Hole Grouting (higher risk GSP only)
- _____ Re-proved for through-the-rod grouting (GSP only alternative)

Knocked out bottom plug with drill rods; tremmie-backfilled well casing with high-solids bentonite grout; removed wellhead and bollards; extracted 10 feet of PVC well casing.

Materials and Quantity Used

- _____ Type 1 Portland Cement mixed with 3-5% bentonite
- _____ Bentonite Pellets
- _____ Neat Cement
- 17 gallons Other 30% solids bentonite grout

Overdrilled Well Cuttings and Debris N/A

- _____ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
- _____ Disposed of at TVA on-site disposal area

Reviewed By: _____ 8/16/2016

Signature Date/Time

Barry Bryant TN Driller #949

Print Name

End of Procedure

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: B

Start Date: 7-29-16 Site Name: BRF Oversight By: J. Andrew

End Date: _____ Abandoned By: Thompson Project Name: TVA BRF GWMW Closures

Well Details (Check one per section):

Casing Diameter

_____	2”
X	4”
_____	6”
_____	Other/NA

Well Type

X	Permanent
_____	Temporary
_____	Geoprobe® Screen Point (GSP) or Equiv.
_____	Flush Mount/Stickup

Casing Material

_____	PVC
X	Steel
_____	Other/NA

Abandonment Details (Check one per section):

Removed wellhead and bollards; steel casing present 8" below ground; tremmie-backfilled well casing with high-solids bentonite grout.

Abandonment Method (as detailed in TVA-KIF-SOP-46)

_____	Overdrill and Grout
_____	Well Extraction
X	Grout in Place
_____	Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
_____	Bentonite Sealing- Pellets Only (low-risk GSP only)
_____	Probe Hole Grouting (higher risk GSP only)
_____	Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

_____	Type 1 Portland Cement mixed with 3-5% bentonite
_____	Bentonite Pellets
_____	Neat Cement
42 gallons	Other 30% solids bentonite grout

Overdrilled Well Cuttings and Debris N/A

_____	Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
_____	Disposed of at TVA on-site disposal area

Reviewed By: _____ 8/16/2016
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

End of Procedure

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: C

Start Date: 7-29-16 Site Name: BRF Oversight By: J. Andrew

End Date: _____ Abandoned By: Thompson Project Name: TVA BRF GWMW Closures

Well Details (Check one per section):

Casing Diameter

_____	2”
X	4”
_____	6”
_____	Other/NA

Well Type

X	Permanent
_____	Temporary
_____	Geoprobe® Screen Point (GSP) or Equiv.
_____	Flush Mount/Stickup

Casing Material

_____	PVC
X	Steel
_____	Other/NA

Abandonment Details (Check one per section):

Removed wellhead and bollards; steel casing present 9" below ground; tremmie-backfilled well casing with high-solids bentonite grout.

Abandonment Method (as detailed in TVA-KIF-SOP-46)

_____	Overdrill and Grout
_____	Well Extraction
X	Grout in Place
_____	Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
_____	Bentonite Sealing- Pellets Only (low-risk GSP only)
_____	Probe Hole Grouting (higher risk GSP only)
_____	Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

_____	Type 1 Portland Cement mixed with 3-5% bentonite
_____	Bentonite Pellets
_____	Neat Cement
56 gallons	Other 30% solids bentonite grout

Overdrilled Well Cuttings and Debris N/A

_____	Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
_____	Disposed of at TVA on-site disposal area

Reviewed By: _____ 8/16/2016
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

End of Procedure

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: E

Start Date: 7-28-16 Site Name: BRF Oversight By: J. Andrew

End Date: _____ Abandoned By: Thompson Project Name: TVA BRF GWMW Closures

Well Details (Check one per section):

Casing Diameter

_____	2”
X	4”
_____	6”
_____	Other/NA

Well Type

X	Permanent
_____	Temporary
_____	Geoprobe® Screen Point (GSP) or Equiv.
_____	Flush Mount/Stickup

Casing Material

X	PVC
_____	Steel
_____	Other/NA

Abandonment Details (Check one per section):

Abandonment Method (as detailed in TVA-KIF-SOP-46)

Knocked out bottom plug with drill rods; tremmie-backfilled well casing with high-solids bentonite grout; removed wellhead and bollards; extracted 12.5 feet of PVC well casing.

_____	Overdrill and Grout
X	Well Extraction
_____	Grout in Place
_____	Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
_____	Bentonite Sealing- Pellets Only (low-risk GSP only)
_____	Probe Hole Grouting (higher risk GSP only)
_____	Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

_____	Type 1 Portland Cement mixed with 3-5% bentonite
_____	Bentonite Pellets
_____	Neat Cement
25 gallons	Other 30% solids bentonite grout

Overdrilled Well Cuttings and Debris N/A

_____	Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
_____	Disposed of at TVA on-site disposal area

Reviewed By: _____ 8/16/2016
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

End of Procedure

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: LFJMWB

Start Date: 7-27-16 Site Name: BRF Oversight By: _____

End Date: _____ Abandoned By: Thompson Project Name: TVA BRF GWMW Closures

Well Details (Check one per section):

Casing Diameter

X	2”
	4”
	6”
	Other/NA

Well Type

X	Permanent
	Temporary
	Geoprobe® Screen Point (GSP) or Equiv.
	Flush Mount/Stickup

Casing Material

X	PVC
	Steel
	Other/NA

Abandonment Details (Check one per section):

Knocked out bottom plug with drill rods; tremmie-backfilled well casing with high-solids bentonite grout; removed wellhead and bollards; extracted 22.6 feet of PVC riser and 10 feet of PVC screen.

Abandonment Method (as detailed in TVA-KIF-SOP-46)

	Overdrill and Grout
X	Well Extraction
	Grout in Place
	Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
	Bentonite Sealing- Pellets Only (low-risk GSP only)
	Probe Hole Grouting (higher risk GSP only)
	Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

	Type 1 Portland Cement mixed with 3-5% bentonite
	Bentonite Pellets
	Neat Cement
15 gallons	Other 30% solids bentonite grout

Overdrilled Well Cuttings and Debris N/A

	Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
	Disposed of at TVA on-site disposal area

Reviewed By: _____ 8/16/2016
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

End of Procedure

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: LFJMWF

Start Date: 7-27-16 Site Name: BRF Oversight By: J. Andrew

End Date: _____ Abandoned By: Thompson Project Name: TVA BRF GWMW Closures

Well Details (Check one per section):

Casing Diameter

- X 2”
- _____ 4”
- _____ 6”
- _____ Other/NA

Well Type

- X Permanent
- _____ Temporary
- _____ Geoprobe® Screen Point (GSP) or Equiv.
- _____ Flush Mount/Stickup

Casing Material

- X PVC
- _____ Steel
- _____ Other/NA

Abandonment Details (Check one per section):

Abandonment Method (as detailed in TVA-KIF-SOP-46)

- _____ Overdrill and Grout
- X Well Extraction
- _____ Grout in Place
- _____ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- _____ Bentonite Sealing- Pellets Only (low-risk GSP only)
- _____ Probe Hole Grouting (higher risk GSP only)
- _____ Re-proved for through-the-rod grouting (GSP only alternative)

Knocked out bottom plug with drill rods; tremmie-backfilled well casing with high-solids bentonite grout; removed wellhead and bollards; extracted approximately 20 feet of PVC well casing.

Materials and Quantity Used

- _____ Type 1 Portland Cement mixed with 3-5% bentonite
- _____ Bentonite Pellets
- _____ Neat Cement
- 21 gallons Other 30% solids bentonite grout

Overdrilled Well Cuttings and Debris N/A

- _____ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
- _____ Disposed of at TVA on-site disposal area

Reviewed By: _____ 8/16/2016
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

End of Procedure

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: LFJMWH

Start Date: 7-27-16 Site Name: BRF Oversight By: J. Andrew

End Date: _____ Abandoned By: Thompson Project Name: TVA BRF GWMW Closures

Well Details (Check one per section):

Casing Diameter

- X 2”
- _____ 4”
- _____ 6”
- _____ Other/NA

Well Type

- X Permanent
- _____ Temporary
- _____ Geoprobe® Screen Point (GSP) or Equiv.
- _____ Flush Mount/Stickup

Casing Material

- X PVC
- _____ Steel
- _____ Other/NA

Abandonment Details (Check one per section):

Abandonment Method (as detailed in TVA-KIF-SOP-46)

- _____ Overdrill and Grout
- X Well Extraction
- _____ Grout in Place
- _____ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- _____ Bentonite Sealing- Pellets Only (low-risk GSP only)
- _____ Probe Hole Grouting (higher risk GSP only)
- _____ Re-proved for through-the-rod grouting (GSP only alternative)

Knocked out bottom plug with drill rods; tremmie-backfilled well casing with high-solids bentonite grout; removed wellhead and bollards; extracted 40 feet of PVC riser and 10 feet of PVC screen.

Materials and Quantity Used

- _____ Type 1 Portland Cement mixed with 3-5% bentonite
- _____ Bentonite Pellets
- _____ Neat Cement
- 27 gallons Other 30% solids bentonite grout

Overdrilled Well Cuttings and Debris N/A

- _____ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
- _____ Disposed of at TVA on-site disposal area

Reviewed By _____ 8/16/2016
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

End of Procedure

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: LFJW01

Start Date: 7-26-16 Site Name: BRF Oversight By: J. Andrew

End Date: _____ Abandoned By: Thompson Project Name: TVA BRF GWMW Closures

Well Details (Check one per section):

Casing Diameter

X 2”
_____ 4”
_____ 6”
_____ Other/NA

Well Type

X Permanent
_____ Temporary
_____ Geoprobe® Screen Point (GSP) or Equiv.
_____ Flush Mount/Stickup

Casing Material

X PVC
_____ Steel
_____ Other/NA

Abandonment Details (Check one per section):

Abandonment Method (as detailed in TVA-KIF-SOP-46)

_____ Overdrill and Grout
X Well Extraction
_____ Grout in Place
_____ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
_____ Bentonite Sealing- Pellets Only (low-risk GSP only)
_____ Probe Hole Grouting (higher risk GSP only)
_____ Re-proved for through-the-rod grouting (GSP only alternative)

Knocked out bottom plug with drill rods; tremmie-backfilled well casing with high-solids bentonite grout; removed wellhead and bollards; extracted approximately 12 feet of PVC well casing.

Materials and Quantity Used

_____ Type 1 Portland Cement mixed with 3-5% bentonite
_____ Bentonite Pellets
_____ Neat Cement
18 gallons Other 30% solids bentonite grout

Overdrilled Well Cuttings and Debris N/A

_____ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
_____ Disposed of at TVA on-site disposal area

Reviewed By: _____ 8/16/2016
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

End of Procedure

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: LFJW02

Start Date: 7-26-16 Site Name: BRF Oversight By: J. Andrew

End Date: _____ Abandoned By: Thompson Project Name: TVA BRF GWMW Closures

Well Details (Check one per section):

Casing Diameter

- X 2”
- _____ 4”
- _____ 6”
- _____ Other/NA

Well Type

- X Permanent
- _____ Temporary
- _____ Geoprobe® Screen Point (GSP) or Equiv.
- _____ Flush Mount/Stickup

Casing Material

- X PVC
- _____ Steel
- _____ Other/NA

Abandonment Details (Check one per section):

Abandonment Method (as detailed in TVA-KIF-SOP-46)

- _____ Overdrill and Grout
- X Well Extraction
- _____ Grout in Place
- _____ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- _____ Bentonite Sealing- Pellets Only (low-risk GSP only)
- _____ Probe Hole Grouting (higher risk GSP only)
- _____ Re-proved for through-the-rod grouting (GSP only alternative)

Knocked out bottom plug with drill rods; tremmie-backfilled well casing with high-solids bentonite grout; removed wellhead and bollards; extracted approximately 8 feet of PVC well casing.

Materials and Quantity Used

- _____ Type 1 Portland Cement mixed with 3-5% bentonite
- _____ Bentonite Pellets
- _____ Neat Cement
- 10 gallons Other 30% solids bentonite grout

Overdrilled Well Cuttings and Debris N/A

- _____ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
- _____ Disposed of at TVA on-site disposal area

Reviewed By: _____ 8/16/2016
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

End of Procedure

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: LFJW03

Start Date: 7-27-16 Site Name: BRF Oversight By: J. Andrew

End Date: _____ Abandoned By: Thompson Project Name: TVA BRF GWMW Closures

Well Details (Check one per section):

Casing Diameter

- X 2”
- _____ 4”
- _____ 6”
- _____ Other/NA

Well Type

- X Permanent
- _____ Temporary
- _____ Geoprobe® Screen Point (GSP) or Equiv.
- _____ Flush Mount/Stickup

Casing Material

- X PVC
- _____ Steel
- _____ Other/NA

Abandonment Details (Check one per section):

Abandonment Method (as detailed in TVA-KIF-SOP-46)

- _____ Overdrill and Grout
- X Well Extraction
- _____ Grout in Place
- _____ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- _____ Bentonite Sealing- Pellets Only (low-risk GSP only)
- _____ Probe Hole Grouting (higher risk GSP only)
- _____ Re-proved for through-the-rod grouting (GSP only alternative)

Knocked out bottom plug with drill rods; tremmie-backfilled well casing with high-solids bentonite grout; removed wellhead and bollards; extracted approximately 23 feet of PVC riser and 4 feet of PVC screen.

Materials and Quantity Used

- _____ Type 1 Portland Cement mixed with 3-5% bentonite
- _____ Bentonite Pellets
- _____ Neat Cement
- 13 gallons Other 30% solids bentonite grout

Overdrilled Well Cuttings and Debris N/A

- _____ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
- _____ Disposed of at TVA on-site disposal area

Reviewed By: _____ 8/16/2016
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

End of Procedure

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: LFJW04

Start Date: 7-26-16 Site Name: BRF Oversight By: J. Andrew

End Date: _____ Abandoned By: Thompson Project Name: TVA BRF GWMW Closures

Well Details (Check one per section):

Casing Diameter

- X 2”
- _____ 4”
- _____ 6”
- _____ Other/NA

Well Type

- X Permanent
- _____ Temporary
- _____ Geoprobe® Screen Point (GSP) or Equiv.
- _____ Flush Mount/Stickup

Casing Material

- X PVC
- _____ Steel
- _____ Other/NA

Abandonment Details (Check one per section):

Knocked out bottom plug with drill rods; tremmie-backfilled well casing with high-solids bentonite grout; removed wellhead and bollards; extracted approximately 4 feet of PVC well casing.

Abandonment Method (as detailed in TVA-KIF-SOP-46)

- _____ Overdrill and Grout
- X Well Extraction
- _____ Grout in Place
- _____ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- _____ Bentonite Sealing- Pellets Only (low-risk GSP only)
- _____ Probe Hole Grouting (higher risk GSP only)
- _____ Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

- _____ Type 1 Portland Cement mixed with 3-5% bentonite
- _____ Bentonite Pellets
- _____ Neat Cement
- 13 gallons Other 30% solids bentonite grout

Overdrilled Well Cuttings and Debris N/A

- _____ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
- _____ Disposed of at TVA on-site disposal area

Reviewed By: _____ 8/16/2016
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

End of Procedure

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: LFJW05

Start Date: 7-27-16 Site Name: BRF Oversight By: J. Andrew

End Date: _____ Abandoned By: Thompson Project Name: TVA BRF GWMW Closures

Well Details (Check one per section):

Casing Diameter

- X 2”
- _____ 4”
- _____ 6”
- _____ Other/NA

Well Type

- X Permanent
- _____ Temporary
- _____ Geoprobe® Screen Point (GSP) or Equiv.
- _____ Flush Mount/Stickup

Casing Material

- X PVC
- _____ Steel
- _____ Other/NA

Abandonment Details (Check one per section):

Abandonment Method (as detailed in TVA-KIF-SOP-46)

- _____ Overdrill and Grout
- X Well Extraction
- _____ Grout in Place
- _____ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- _____ Bentonite Sealing- Pellets Only (low-risk GSP only)
- _____ Probe Hole Grouting (higher risk GSP only)
- _____ Re-proved for through-the-rod grouting (GSP only alternative)

Knocked out bottom plug with drill rods; tremmie-backfilled well casing with high-solids bentonite grout; removed wellhead and bollards; extracted 12.5 feet of PVC riser and 10 feet of PVC screen.

Materials and Quantity Used

- _____ Type 1 Portland Cement mixed with 3-5% bentonite
- _____ Bentonite Pellets
- _____ Neat Cement
- 13 gallons Other 30% solids bentonite grout

Overdrilled Well Cuttings and Debris N/A

- _____ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
- _____ Disposed of at TVA on-site disposal area

Reviewed By: _____ 8/16/2016
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

End of Procedure

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: LFJW10

Start Date: 7-27-16 Site Name: BRF Oversight By: J. Andrew

End Date: _____ Abandoned By: Thompson Project Name: TVA BRF GWMW Closures

Well Details (Check one per section):

Casing Diameter

- X 2”
- _____ 4”
- _____ 6”
- _____ Other/NA

Well Type

- X Permanent
- _____ Temporary
- _____ Geoprobe® Screen Point (GSP) or Equiv.
- _____ Flush Mount/Stickup

Casing Material

- X PVC
- _____ Steel
- _____ Other/NA

Abandonment Details (Check one per section):

Abandonment Method (as detailed in TVA-KIF-SOP-46)

- _____ Overdrill and Grout
- X Well Extraction
- _____ Grout in Place
- _____ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- _____ Bentonite Sealing- Pellets Only (low-risk GSP only)
- _____ Probe Hole Grouting (higher risk GSP only)
- _____ Re-proved for through-the-rod grouting (GSP only alternative)

Knocked out bottom plug with drill rods; tremmie-backfilled well casing with high-solids bentonite grout; removed wellhead and bollards; extracted 19 feet of PVC riser and 4 feet of PVC screen.

Materials and Quantity Used

- _____ Type 1 Portland Cement mixed with 3-5% bentonite
- _____ Bentonite Pellets
- _____ Neat Cement
- 15 gallons Other 30% solids bentonite grout

Overdrilled Well Cuttings and Debris N/A

- _____ Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
- _____ Disposed of at TVA on-site disposal area

Reviewed By: _____ 8/16/2016
Signature Date/Time

Barry Bryant TN Driller #949
Print Name

End of Procedure

Monitoring Well Abandonment Form

General Information

Monitoring Well Number: LFJW09

Date: 9-13-2017 Project Name: TVA-BRF-608390

Oversight By: C. Millhollin Abandoned By: Stantec

Well Details (Check one per section):

Casing Diameter

X	2”
	4”
	6”
	Other/NA

Well Type

X	Permanent
	Temporary
	Geoprobe® Screen Point (GSP) or Equiv.

Casing Material

X	PVC
	Steel
	Other/NA

Abandonment Details (Check one per section):

Abandonment Method (as detailed in TVA-KIF-SOP-46)

X	Overdrill and Grout
X	Well Extraction
	Grout in Place
	Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
	Bentonite Sealing- Pellets Only (low-risk GSP only)
	Probe Hole Grouting (higher risk GSP only)
	Re-proved for through-the-rod grouting (GSP only alternative)

Grouted casing in-place; pulled 14.0' w/ 7.1' remaining; overdrilled to 23.0' bgs.

Materials and Quantity Used

	Type I Portland Cement mixed with 3-5% bentonite
	Bentonite Pellets
	Neat Cement
40 gallons	Other - 30 % Solids Bentonite grout

Overdrilled Well Cuttings and Debris

	Staged Onsite for Disposal (covered top and bottom with poly-sheeting)
	Disposed of at TVA on-site disposal area

Reviewed By: _____ 9-14-2017
Signature Date/Time

Barry Bryant TN Driller # 949
Print Name

End of Procedure

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Appendix B

Monitoring Well Abandonment Documentation

Table 2. Monitoring Well Abandonment Form

General Information

Monitoring Well Number: L

Date: 9/22/11 Project Name: BRF Well Abandonment

Oversight By: P. White Abandoned By: Stantec

Well Details (Check one per section):

Casing Diameter
- ___ 2"
- ___ 4"
- X 6"
- ___ Other/NA

Well Type
- X Permanent
- ___ Temporary
- ___ Geoprobe® Screen Point (GSP) or Equiv.

Casing Material
- X PVC
- ___ Steel
- ___ Other/NA

- 6" PVC casing seated into bedrock (27' bgs);
- 5 7/8" open borehole in bedrock below casing (13' below casing);
- Flush-mount wellhead

Abandonment Details (Check one per section):

Abandonment Method (as detailed in TVA-KIF-SOP-46)
- X Overdrill and Grout
- X Well Extraction (partial)
- ___ Grout in Place
- ___ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- ___ Bentonite Sealing- Pellets Only (low-risk GSP only)
- ___ Probe Hole Grouting (higher risk GSP only)
- ___ Re-proved for through-the-rod grouting (GSP only alternative)

- Well was blocked-off @ surface;
- Cleaned-out using solid-stem augers to 50.5' bgs;
- Encountered rock-like resistance @ 50.0' bgs;
- Water @ 23.0' bgs after augering;
- Tremmie-backfilled w/ cement-bentonite (5% bentonite by wt.)
- Removed upper 6.5' of 6" PVC casing using hollow-stem augers;
- Reclaimed area.

Materials and Quantity Used
- 6-94lb Cement Bag / 30lb Bentonite Type I Portland Cement mixed with 3-5% bentonite
- ___ Bentonite Pellets
- ___ Neat Cement
- ___ Other ___

Overdrilled Well Cuttings and Debris
- X Staged Onsite for Disposal (~~covered top and bottom with poly sheeting~~)
- ___ Drummed for Disposal

Reviewed By: Patrick White
Signature

9/22/11
Date/~~Time~~

Patrick White
Print Name

End of Procedure

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Table 2. Monitoring Well Abandonment Form

General Information

Monitoring Well Number: M

Date: 9/22/11 Project Name: BRF Well Abandonment

Oversight By: P. White Abandoned By: Stantec

Well Details (Check one per section):

Casing Diameter

- ___ 2"
- ___ 4"
- X 6"
- ___ Other/NA

Well Type

- X Permanent
- ___ Temporary
- ___ Geoprobe® Screen Point (GSP) or Equiv.

Casing Material

- X PVC
- ___ Steel
- ___ Other/NA

- 6" PVC casing seated into bedrock (31' bgs);
- 5 7/8" open borehole in bedrock below casing (29' below casing);
- Flush-mount wellhead

Abandonment Details (Check one per section):

- Well open to 60.0' bgs;
- Water level @ 9.1' bgs;
- Tremmie-backfilled w/ cement-bentonite (5% bentonite by wt.);
- Removed upper 5' of 6" PVC casing using hollow-stem augers;
- Reclaimed area.

Abandonment Method (as detailed in TVA-KIF-SOP-46)

- X Overdrill and Grout
- X Well Extraction (partial)
- X Grout in Place
- ___ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- ___ Bentonite Sealing- Pellets Only (low-risk GSP only)
- ___ Probe Hole Grouting (higher risk GSP only)
- ___ Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

- 8-94 lb Cement Bags Type 1 Portland Cement mixed with 3-5% bentonite
- 1-50 lb Bentonite Bag Bentonite Pellets
- ___ Neat Cement
- ___ Other ___

Overdrilled Well Cuttings and Debris

- X Staged Onsite for Disposal ~~(covered top and bottom with poly-sheeting)~~
- ___ Drummed for Disposal

Reviewed By: Patrick White
Signature

9/22/11
Date ~~Time~~

Patrick White
Print Name

End of Procedure

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Table 2. Monitoring Well Abandonment Form

General Information

Monitoring Well Number: N

Date: 9/22/11 Project Name: BRF Well Abandonment

Oversight By: P. White Abandoned By: Stantec

Well Details (Check one per section):

Casing Diameter

- ___ 2"
- ___ 4"
- X 6"
- ___ Other/NA

Well Type

- X Permanent
- ___ Temporary
- ___ Geoprobe® Screen Point (GSP) or Equiv.

Casing Material

- X PVC
- ___ Steel
- ___ Other/NA

- 6" PVC casing seated into bedrock (31' bgs);
- 5 7/8" open borehole in bedrock below casing (29' below casing)
- Flush-mount wellhead.

Abandonment Details (Check one per section):

Abandonment Method (as detailed in TVA-KIF-SOP-46)

- X Overdrill and Grout
- X Well Extraction (partial)
- X Grout in Place
- ___ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- ___ Bentonite Sealing- Pellets Only (low-risk GSP only)
- ___ Probe Hole Grouting (higher risk GSP only)
- ___ Re-proved for through-the-rod grouting (GSP only alternative)

- Well blocked-off @ surface;
- Cleaned-out to 60.0' w/ solid-stem augers;
- Rock-like resistance @ 60.0'
- Water @ 19.5' bgs after augering;
- Tremmie-backfilled w/ cement-bentonite (5% bentonite by wt.)
- Removed upper 5' of 6" PVC casing using hollow-stem augers.
- Reclaimed area

Materials and Quantity Used

- 8-94 lb Cement bags Type 1 Portland Cement mixed with 3-5% bentonite
- 1-50 lb Bentonite bag Bentonite Pellets
- ___ Neat Cement
- ___ Other ___

Overdrilled Well Cuttings and Debris

- X Staged Onsite for Disposal ~~(covered top and bottom with poly-sheeting)~~
- ___ Drummed for Disposal

Reviewed By: Patrick White (Signature) 9/22/11 (Date/Time)

Patrick White (Print Name)

End of Procedure

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Table 2. Monitoring Well Abandonment Form

General Information

Monitoring Well Number: Q

Date: 9/22/11 Project Name: BRF Well Abandonment

Oversight By: P. White Abandoned By: Stantec

Well Details (Check one per section):

Casing Diameter
- X 2"
- ____ 4"
- ____ 6"
- ____ Other/NA

Well Type
- X Permanent
- ____ Temporary
- ____ Geoprobe® Screen Point (GSP) or Equiv.

Casing Material
- X PVC
- ____ Steel
- ____ Other/NA

- 2" PVC well casing (riser) and 10' slotted screened set to ~15' bgs
- well borehole depth = 15.1' bgs
- Flush-mount wellhead

Abandonment Details (Check one per section):

Abandonment Method (as detailed in TVA-KIF-SOP-46)
- X Overdrill and Grout
- X Well Extraction
- ____ Grout in Place
- ____ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- ____ Bentonite Sealing- Pellets Only (low-risk GSP only)
- ____ Probe Hole Grouting (higher risk GSP only)
- ____ Re-proved for through-the-rod grouting (GSP only alternative)

- well open to 15.5' bgs;
- water @ 10.5' bgs;
- Knocked-off btm well plug using 4" drill rods;
- Tremmie-backfilled well riser and screen w/ cement-bentonite (5% bentonite by wt.)
- Pulled 2" PVC well riser and screen w/ drill rig winch;
- Overdrilled to 15.8' w/ hollow-stem augers;
- Tremmie-backfilled w/ cement-bentonite (5% bentonite by wt.)
- Reclaimed area.

Materials and Quantity Used
- 3-94/16 Cement Bags Type 1 Portland Cement mixed with 3-5% bentonite
- 15 16 Bentonite Bentonite Pellets
- ____ Neat Cement
- ____ Other ____

Overdrilled Well Cuttings and Debris
- X Staged Onsite for Disposal ~~(covered top and bottom with poly-sheeting)~~
- ____ Drummed for Disposal

Reviewed By: Patrick White PG Signature

9/22/11 Date/~~Time~~

Patrick White Print Name

End of Procedure

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Table 2. Monitoring Well Abandonment Form

General Information

Monitoring Well Number: MW-7H / P-7

Date: 9/23/11 Project Name: BRF Well Abandonment

Oversight By: P. White Abandoned By: Stantec

Well Details (Check one per section):

Casing Diameter

- X 2"
- ___ 4"
- ___ 6"
- ___ Other/NA

Well Type

- X Permanent
- ___ Temporary
- ___ Geoprobe® Screen Point (GSP) or Equiv.

- 2" PVC riser and screen (10') into bedrock (37.3' bgs);
- 7¼" diam. borehole in soil (18' bgs) and 3.78" borehole into bedrock (18' - 38.6' bgs)
- 2" PVC riser broken-off @ ground surface.

Casing Material

- X PVC
- ___ Steel
- ___ Other/NA

Abandonment Details (Check one per section):

- Well open to 34.8' bgs;
- Water @ 5.5' bgs;
- Knocked-off btm well plug using AW drill rods;
- Tremmie-backfilled well casing w/ cement-bentonite grout;
- Pulled all PVC riser and screen w/ drill rig winch;
- Overdrilled w/ solid-stem augers to 39.0'
- Tremmie backfilled borehole w/ cement-bentonite (5% bentonite by wt)

Abandonment Method (as detailed in TVA-KIF-SOP-46)

- X Overdrill and Grout
- X Well Extraction
- ___ Grout in Place
- ___ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- ___ Bentonite Sealing- Pellets Only (low-risk GSP only)
- ___ Probe Hole Grouting (higher risk GSP only)
- ___ Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used

- 5-94 lb Cement Bags Type I Portland Cement mixed with 3-5% bentonite
- 25 lb Bentonite Bentonite Pellets
- ___ Neat Cement
- ___ Other ___

Overdrilled Well Cuttings and Debris

- X Staged Onsite for Disposal (~~covered top and bottom with poly sheeting~~) - Reclaimed area.
- ___ Drummed for Disposal

Reviewed By: Patrick White
Signature

9/23/11
Date/Time

Patrick White
Print Name

End of Procedure

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Table 2. Monitoring Well Abandonment Form

General Information

Monitoring Well Number: MW-114/P-11

Date: 9/23/11 Project Name: BRF Well Abandonment

Oversight By: P. White Abandoned By: Stantec

Well Details (Check one per section):

Casing Diameter
- X 2"
- ___ 4"
- ___ 6"
- ___ Other/NA

Well Type
- X Permanent
- ___ Temporary
- ___ Geoprobe® Screen Point (GSP) or Equiv.

Casing Material
- X PVC
- ___ Steel
- ___ Other/NA

- 2" PVC riser and screen (10') into bedrock (27.0' bgs);
- 7¼" diam. borehole in soil (17.6' bgs) and 5.78" borehole in bedrock (17.6' - 27.7')
- 2" PVC Riser extended above ground ~3'; exp. plug @ top.

Abandonment Details (Check one per section):

- Well open to 27.4' bgs;
- Water @ 15.2' bgs;
- Knocked-off btm well plug using AW drill rods;
- Tremmie-backfilled well casing w/ cement-bentonite grout;
- Pulled all PVC well casing using drill rig winch;
- Overdrilled w/ 5 1/4" solid-stem augers to 28.0' bgs;
- Tremmie-backfilled borehole w/ cement-bentonite (5% bentonite by wt);
- Reclaimed area.

Abandonment Method (as detailed in TVA-KIF-SOP-46)
- X Overdrill and Grout
- X Well Extraction
- ___ Grout in Place
- ___ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- ___ Bentonite Sealing- Pellets Only (low-risk GSP only)
- ___ Probe Hole Grouting (higher risk GSP only)
- ___ Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used
- 3½ - 94 lb Cement Bags Type 1 Portland Cement mixed with 3-5% bentonite
- 2016 Bentonite Bentonite Pellets
- ___ Neat Cement
- ___ Other ___

Overdrilled Well Cuttings and Debris
- X Staged Onsite for Disposal ~~(covered top and bottom with poly-sheeting)~~
- ___ Drummed for Disposal

Reviewed By: Patrick White
Signature

9/23/11
Date/Time

Patrick White
Print Name

End of Procedure

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Table 2. Monitoring Well Abandonment Form

General Information

Monitoring Well Number: MW-15H/P-15

Date: 9/22/11 Project Name: BRF Well Abandonment

Oversight By: P. White Abandoned By: Stantec

Well Details (Check one per section):

Casing Diameter

- X 2"
- ____ 4"
- ____ 6"
- ____ Other/NA

Well Type

- X Permanent
- ____ Temporary
- ____ Geoprobe® Screen Point (GSP) or Equiv.

Casing Material

- X PVC
- ____ Steel
- ____ Other/NA

- 2" PVC riser and screen into bedrock (37.8' bgs);
- 7 1/4" diam. borehole in soil (17.6' bgs) and 3.78" borehole in bedrock (17.6' - 38.2' bgs)
- 2" PVC riser found broken-off @ ground surface

Abandonment Details (Check one per section):

- Well open to 36.8' bgs;
- Water @ 20.8' bgs;

Abandonment Method (as detailed in TVA-KIF-SOP-46)

- X Overdrill and Grout
- X Well Extraction
- ____ Grout in Place
- ____ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- ____ Bentonite Sealing- Pellets Only (low-risk GSP only)
- ____ Probe Hole Grouting (higher risk GSP only)
- ____ Re-proved for through-the-rod grouting (GSP only alternative)

- Knocked-off btm well plug using AW drill rods
- Tremmie-backfilled well casing w/ cement-bentonite grout;
- Pulled all well casings using drilling winch;
- Overdrilled w/ solid-stem augers to 38.5' bgs.
- Tremmie-backfilled borehole w/ cement-bentonite (5% bentonite by wt)

Materials and Quantity Used

- 5-94lb Cement Bgs Type 1 Portland Cement mixed with 3-5% bentonite
- 25 lbs Bentonite Bentonite Pellets
- ____ Neat Cement
- ____ Other ____

Overdrilled Well Cuttings and Debris

- X Staged Onsite for Disposal ~~(covered top and bottom with poly sheeting)~~ - Reclaimed area.
- ____ Drummed for Disposal

Reviewed By: Patrick White 9/22/11

Signature Date/~~Time~~

Patrick White

Print Name

End of Procedure

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Table 2. Monitoring Well Abandonment Form

General Information

Monitoring Well Number: MW-204/P-20

Date: 9/26/11 Project Name: BRF Well Abandonment

Oversight By: P. White Abandoned By: Stantec

Well Details (Check one per section):

Casing Diameter
- ___ 2"
- ___ 4"
- ___ 6"
- ___ Other/NA

Well Type
- X Permanent
- ___ Temporary
- ___ Geoprobe® Screen Point (GSP) or Equiv.

Casing Material
- X PVC
- ___ Steel
- ___ Other/NA

- 2" PVC riser and screen into bedrock (33.6' bgs);
- 7¼" diam. borehole in soil (23' bgs) and 3.78" borehole in bedrock (23'-33.6' bgs);
- 2" PVC Riser found broken-off @ ground surface.

Abandonment Details (Check one per section):

- well open to 34.0' bgs;
- Water @ 22.0' bgs;
- Knocked-off btm well plug using AW drill rods;
- Tremmie-backfilled well casing w/ cement-bentonite grout;
- Pulled all well casing using drill rig winch;
- Over-drilled w/ solid stem augers to 35.0' bgs;
- Tremmie-backfilled borehole w/ cement-bentonite (5% bentonite by wt);
- Reclaimed area.

Abandonment Method (as detailed in TVA-KIF-SOP-46)
- X Overdrill and Grout
- X Well Extraction
- ___ Grout in Place
- ___ Bentonite Sealing- Pellets and Neat Cement (low-risk GSP only)
- ___ Bentonite Sealing- Pellets Only (low-risk GSP only)
- ___ Probe Hole Grouting (higher risk GSP only)
- ___ Re-proved for through-the-rod grouting (GSP only alternative)

Materials and Quantity Used
- 4-94/lb Cement Bags Type I Portland Cement mixed with 3-5% bentonite
- 20 lb Bentonite Bentonite Pellets
- ___ Neat Cement
- ___ Other ___

Overdrilled Well Cuttings and Debris
- X Staged Onsite for Disposal (~~covered top and bottom with poly-sheeting~~)
- ___ Drummed for Disposal

Reviewed By: Patrick White QP
Signature

9/26/11
Date/~~Time~~

Patrick White
Print Name

End of Procedure

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Appendix C

Monitoring Well Pre- and Post-Closure Photographs

Photo 1
Well L: Pre-Closure.

Photo 2
Well L: Post-Closure

Photo 3
Well M: Pre-Closure.

Photo 4
Well M: Post-Closure.

Photo 5

Well N: Pre-Closure.

Photo 6

Well N: Post-Closure Immediately After Augering and Grouting

Photo 7
Well Q: Pre-Closure.

Photo 8
Well Q: Post-Closure

Photo 9

Well MW-7H/P-7: Pre-Closure.

Photo 10

Well MW-7H/P-7: Post-Closure.

Photo 11

Well MW-11H/P-11: Pre-Closure.

Photo 12

Well MW-11H/P-11: Post-Closure.

Photo 13

Well MW-15H/P-15: Pre-Closure.

Photo 14

Well MW-15H/P-15: Pulled Well Casing (similar for wells Q, MW-7H, MW-11H & MW-20H).

Photo 15

Well MW-15H/P-15: Post-Closure.

Photo 16

Well MW-20H/P-20: Pre-Closure.

Photo 17

Well MW-20H/P-20: Post-Closure.

APPENDIX I

WELL PLUGGING AND ABANDONMENT FORM

WELL PLUGGING AND ABANDONMENT
FIELD OPERATIONS PLANNING FORM

1. Well No.: MW-1H Date Installed: 08/25/2005

2. Coordinates: North: 599119.74 East: 2546658.86 Location: East End of Coal Pile

3. Total Depth (ft): 25.2 Inside Diam. (in): 2.0 Stickup Length (ft): 5.0

   Total Casing Length (ft): 15.0 Screen Length (ft): 10.0 Casing Material: Sch 40 PVC

4. Reason for abandonment: In preparation for expansion of coal storage area

5. Required site preparation (removal of bollards, pads, etc.): removal of existing 2-inch well casing and tremie grouting

6. Plugging specification document no: in accordance with S&ME proposal 3108507

7. Health and safety considerations for well abandonment crew: ammonia training, PPE

8. TVA Field Contact: Matthew Williams Phone No: 865-599-4371

9. Technical oversight: Mark Boggs, P.G. (TVA); Mr. Todd Justice, P.E. (S&ME)

10. Approved by:(TVA): _____ Date: _____

11. Approved by:(S&ME): Christa Todd Justice Date: 10-02-2008

Field Operations Planning Form

1. Well abandonment: Date Started: 09/25/2008 Date Completed: 09/25/2008

2. Observations via downhole camera: N/A

3. Actual method used to abandon this well: casing removal, overdrilling, and tremie grout

4. Actual depth grouted 25.0 ft

5. Problems and/or deviations from specifications: Not encountered

6. Site cleanup completed: Date: 09/25/2008

7. Comments: No additional comments

8. P&A Report Prepared by: Nathan Peterson Date: 9/30/2008

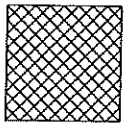
APPENDIX II

GEOTECHNICAL BORING LOG

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES

(Shown in Graphic Log)



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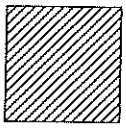
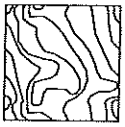
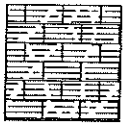


Lean Clay

Fat Clay



Weathered Rock



Shaley Limestone

WATER LEVELS

(Shown in Water Level Column)

▽ = Water Level At Termination of Boring
▼ = Water Level Taken After 24 Hours
◄ = Loss of Drilling Water
HC = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES

(Shown in Samples Column)

▮ Shelby Tube

☒ Split Spoon

I Rock Core

☐ No Recovery

TERMS

Standard Penetration Resistance - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586.

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks excluded) Divided by the Total Length of the Core Run Times 100%.

S&ME

PROJECT: **TVA BRF - Monitoring Well Installation and Abandonment**
Clinton, Tennessee
S&ME Project No. 1431-08-445

BORING LOG:
B-F45R

DATE DRILLED: **9/24/08**
ELEVATION: **Not Recorded**
DRILLING METHOD: **CME 550, 4¼" H.S.A.**
BORING DEPTH: **29.6 feet**
LOGGED BY: **NJP**
WATER LEVEL @ TOB: **11.6 feet**
DRILLER: **D. Hedges**
WATER LEVEL @ 24 hrs: **13.6 feet**

NOTES: **Soil and bedrock descriptions based on visual observation of obtained samples. Well MW-F45R was installed approximately 17 ft northeast of well F45.**

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SAMPLE TYPE	STANDARD PENETRATION TEST (SPT) DATA (blows/ft)	SPT INTERVALS (blows/6 inches) 1st	2nd	3rd	4th	N VALUE
0		CLAY (CL)- Brown to reddish brown; moist; stiff to hard; with gravel; FILL			1			5	5	6		11
5					2			12	11	9		20
10			▽		3			6	6	41		47
15		CLAY (CH)- Grayish Brown; moist; stiff; some silt; with a few chert fragments; FILL	▼		4			6	7	8		15
		Weathered Limestone- Gray; dry; fine grained			5		>>	50/2				50/2
20		Auger Refusal Encountered at 19.8'. Began HQ Coring at 19.8'.										
		SHALEY LIMESTONE- Gray and Maroon; fine grained; very slight to slight weathering; moderately hard to hard; apparent dip of bedding is at 35 degrees; bedding plane fractures are present. Water loss of 100% occurred at start of coring.			REC 49% RQD 22%							
25		SHALEY LIMESTONE- Dark Gray to maroon; completely weathered from 24.7' to 25.8'; rock reduced to a medium to coarse grained sand; poorly graded; with shale fragments and fine rounded gravel.			REC 81% RQD 31%							
		SHALEY LIMESTONE- Dark Gray, brown, to maroon; completely weathered from 25.8' to 26.2'; rock reduced to a sandy clay with shale fragments.										
		SHALEY LIMESTONE- Gray and maroon; fine grained; very slight to slight weathering; hard to moderately hard; apparent dip of bedding at 35 degrees; bedding plane fractures are present that exhibit some iron staining.										
		HQ Coring Terminated at 29.6'										

BORING LOG - TVA 08-445.GPJ 10/2/08

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

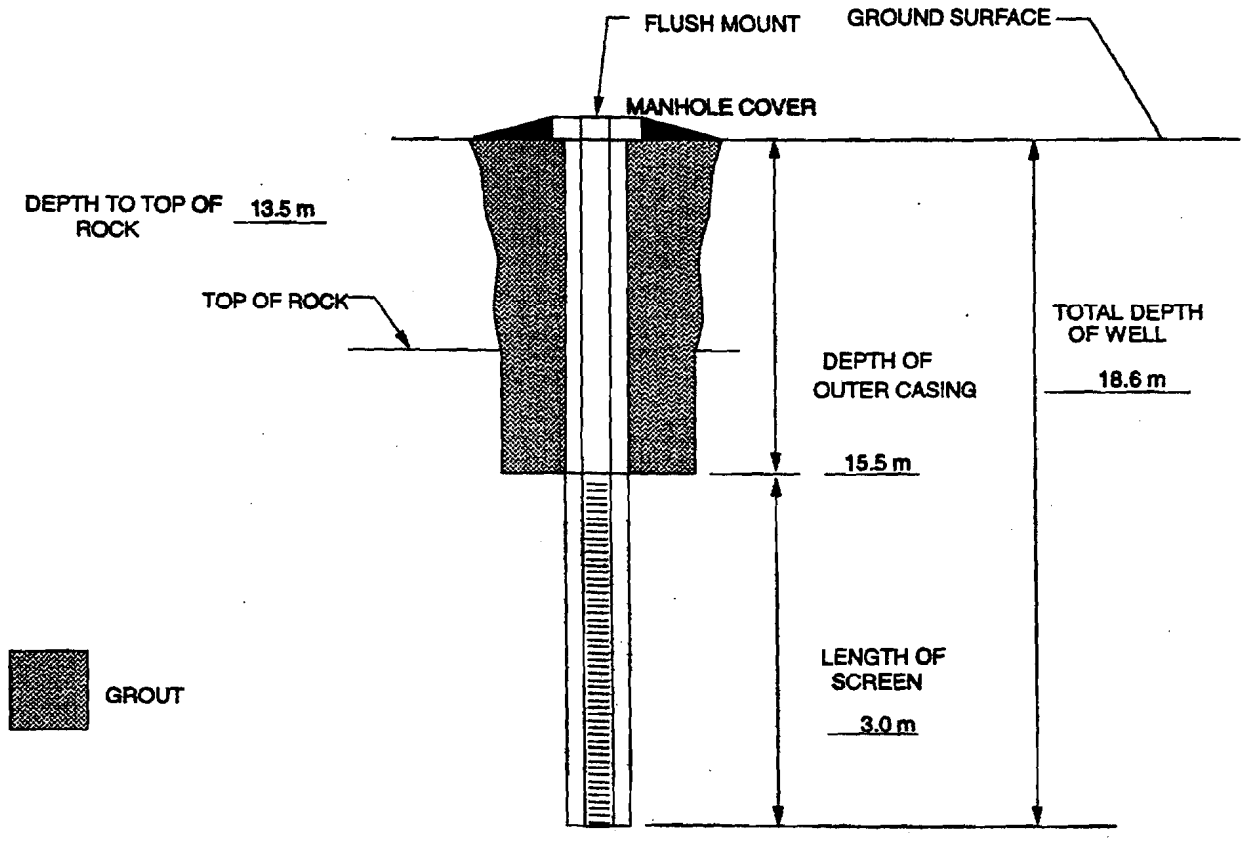
S&ME

Abandoned

ROCK MONITORING WELL INSTALLATION RECORD

PROJECT	BULL RUN		
WELL NUMBER	O	INSTALLATION DATE	8-29-90
PLANT COORDINATES EAST	-667.99 m	NORTH	-477.16 m
GROUND SURFACE ELEVATION	244.54 m-msl	TOP OF INNER CASING	244.54 m-msl
BACKFILL MATERIAL	GROUT	SLOT SIZE	.02 cm
CASING MATERIAL	SCH 40 PVC	OUTER CASING DIAMETER	10 cm
DRILLING TECHNIQUE IN SOIL	HSA	INNER CASING DIAMETER	5 cm
BOREHOLE DIAMETER IN SOIL	25 cm	DRILLING TECHNIQUE IN ROCK	HQ
LOCKABLE COVER ?	YES	BOREHOLE DIAMETER IN ROCK	9.5 cm
DRILLING FLUID	POTABLE WATER	DRILLING CONTRACTOR	LAW - JOHN VOGEL
COMMENTS	ABANDONED	FIELD REPRESENTATIVE	MEL WAGNER

(NOT TO SCALE)

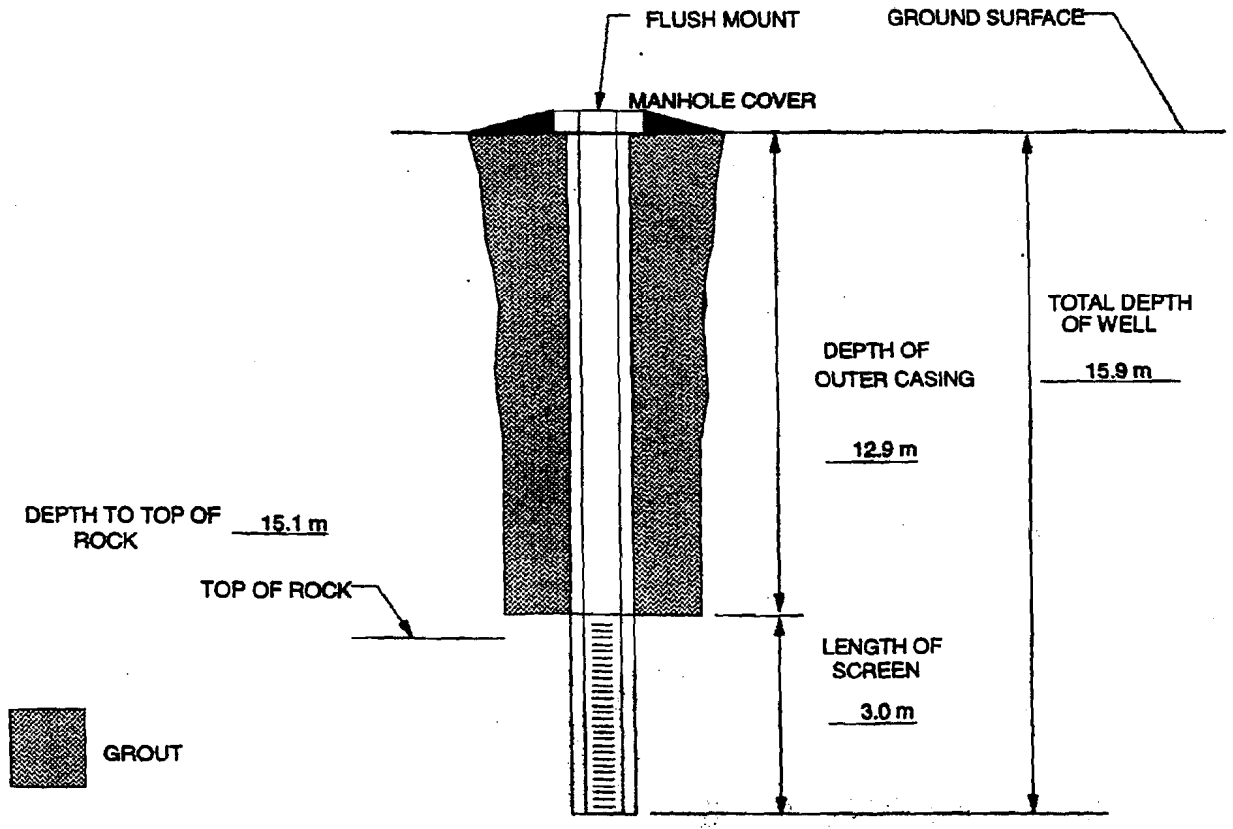


Abandoned

ROCK MONITORING WELL INSTALLATION RECORD

PROJECT	BULL RUN		
WELL NUMBER	P	INSTALLATION DATE	9-4-90
PLANT COORDINATES EAST	-1235.26 m	NORTH	-2183.28 m
GROUND SURFACE ELEVATION	246.74 m-msl	TOP OF INNER CASING	246.74 m-msl
BACKFILL MATERIAL	GROUT	SLOT SIZE	.02 cm
CASING MATERIAL	SCH 40 PVC	OUTER CASING DIAMETER	10 cm
DRILLING TECHNIQUE IN SOIL	HSA	INNER CASING DIAMETER	5 cm
BOREHOLE DIAMETER IN SOIL	25 cm	DRILLING TECHNIQUE IN ROCK	HQ
LOCKABLE COVER ?	YES	BOREHOLE DIAMETER IN ROCK	9.5 cm
DRILLING FLUID	POTABLE WATER	DRILLING CONTRACTOR	LAW - R.TILLERY / J.VOGEL
COMMENTS	PROBLEMS WITH BOREHOLE SILTATION	FIELD REPRESENTATIVE	MEL WAGNER

(NOT TO SCALE)

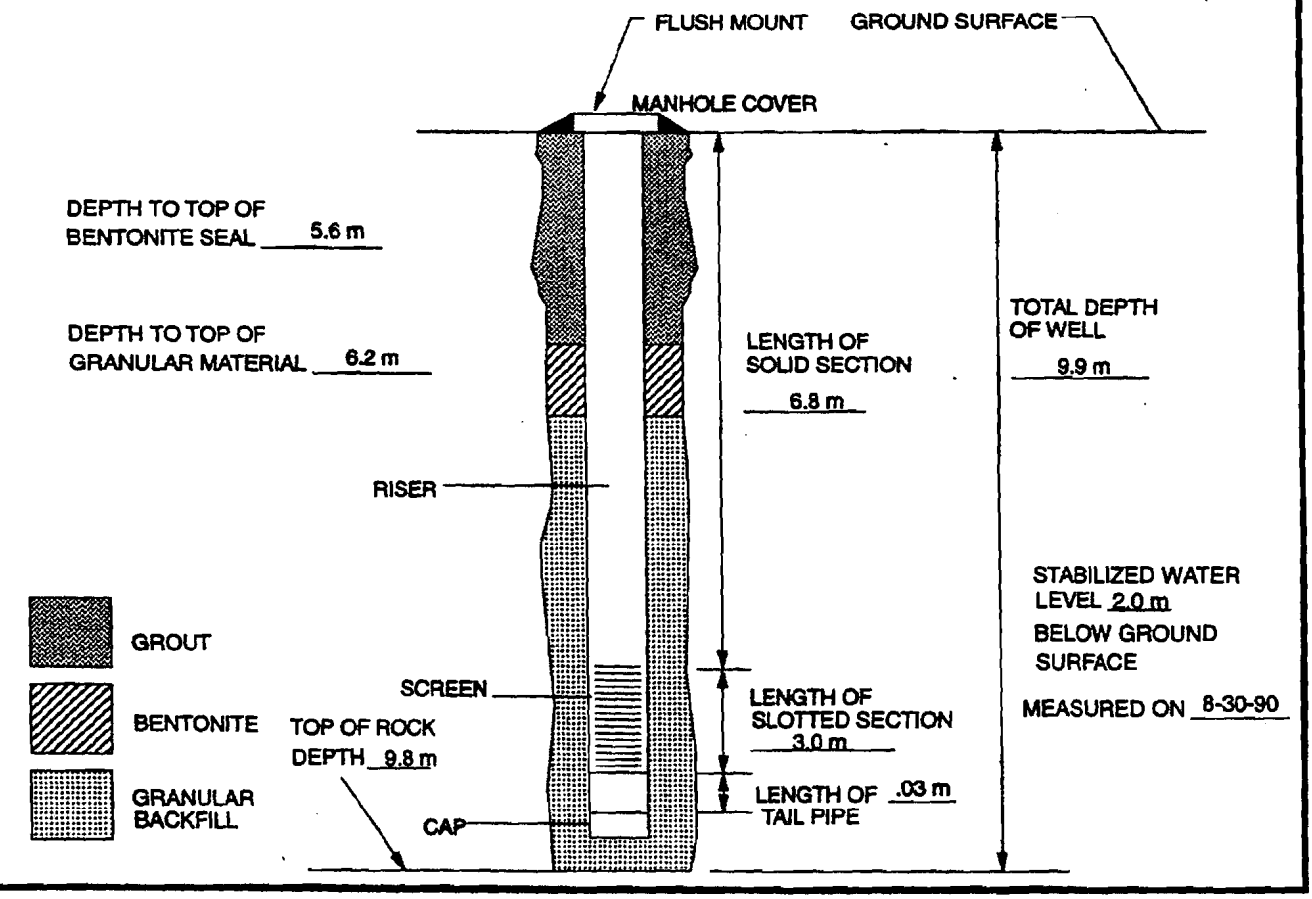


Abandoned

MONITORING WELL INSTALLATION RECORD

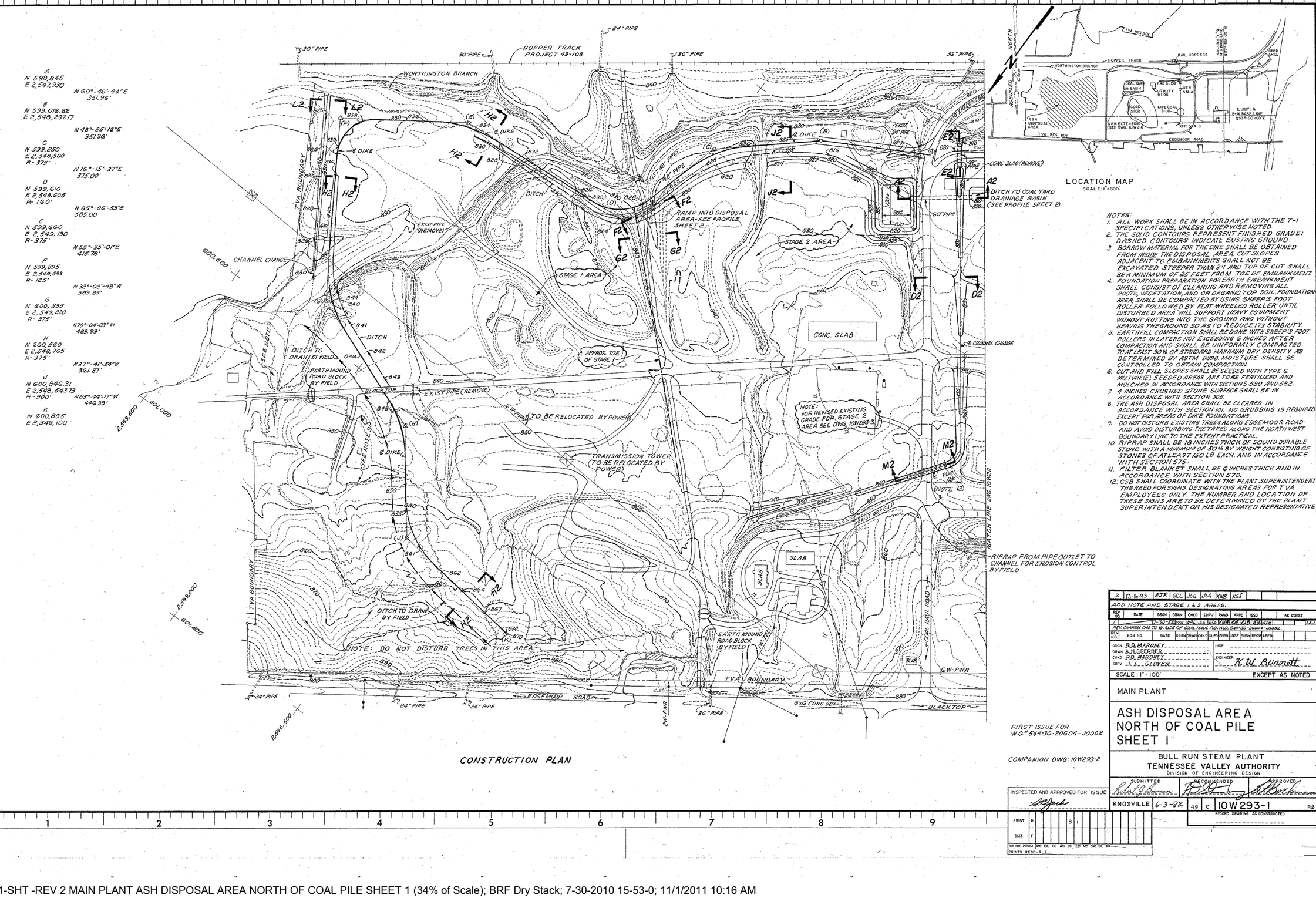
PROJECT	BULL RUN		
WELL NUMBER	R	INSTALLATION DATE	8-28-90
PLANT COORDINATES	EAST -667.36 m	NORTH	-472.7 m
GROUND SURFACE ELEVATION	244.51 m-msl	TOP OF INNER CASING	244.51 m-msl
BACKFILL MATERIAL	SAND	SLOT SIZE	.02 cm
CASING MATERIAL	SCH 40 PVC	CASING DIAMETER	5 cm
DRILLING TECHNIQUE	HSA	DRILLING CONTRACTOR	LAW- JOHN VOGEL
BOREHOLE DIAMETER	20 cm	FIELD REPRESENTATIVE	MEL WAGNER
LOCKABLE COVER ?	YES	FILTER CLOTH AROUND SCREEN?	NO
DRILLING FLUID	NONE		
COMMENTS	ABANDONED		

(NOT TO SCALE)

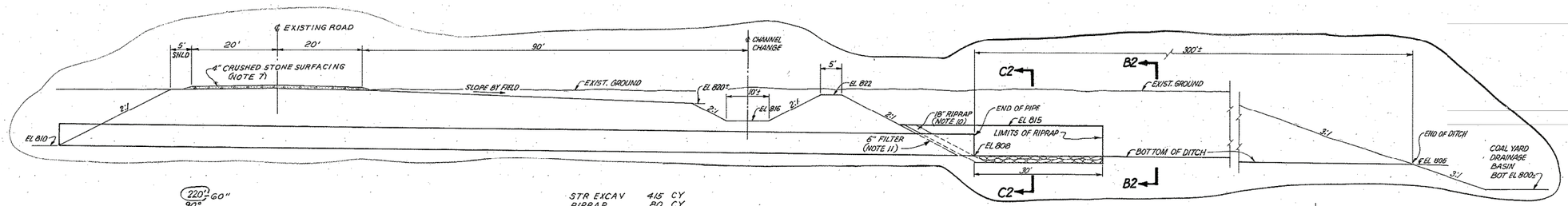


APPENDIX L
DRAWINGS

10W293-1 C 49



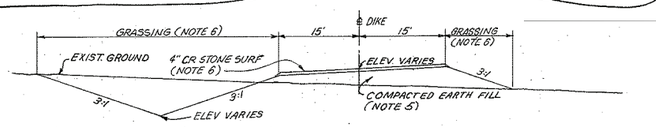
1982-06_BRF-10W293-1-SHT -REV 2 MAIN PLANT ASH DISPOSAL AREA NORTH OF COAL PILE SHEET 1 (34% of Scale); BRF Dry Stack; 7-30-2010 15-53-0; 11/1/2011 10:16 AM



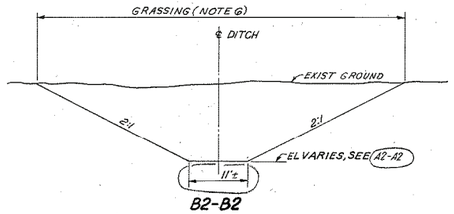
220'± 60" 90° CLASS III CONCRETE

STR EXCAV	415	CY
RIPRAP	80	CY
FILTER	47	TN

SECT A2-A2



J2-J2



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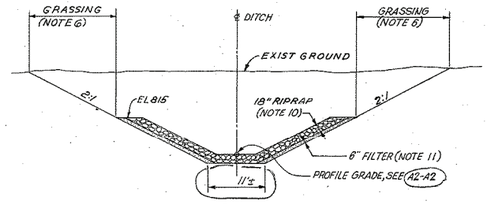
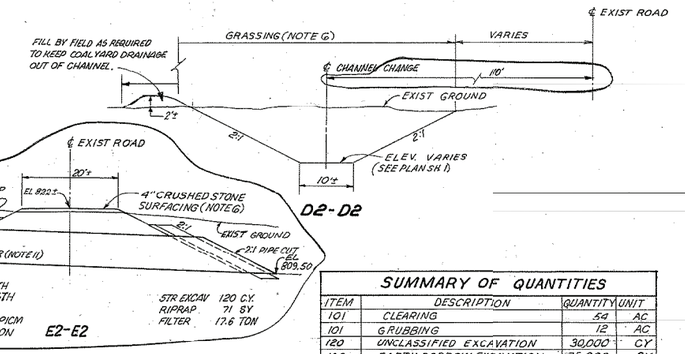


C2-C2

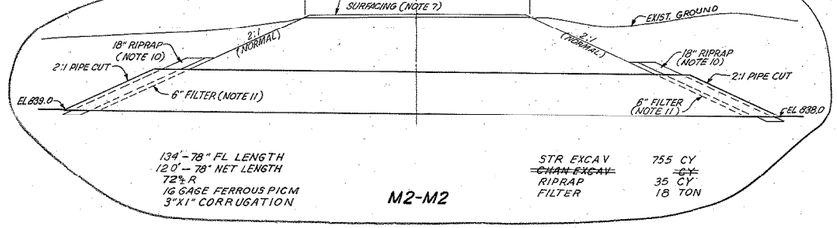


72'-78" FL LENGTH
60'-78" NET LENGTH
88°±
16 GAGE FERROUS PICM
3"X1" CORRUGATION

STR EXCAV	120	CY
RIPRAP	71	SY
FILTER	17.6	TON

D2-D2

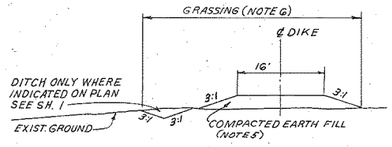
E2-E2



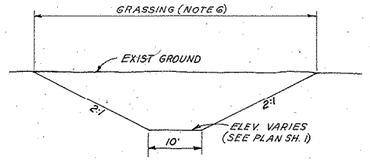
134'-78" FL LENGTH
120'-78" NET LENGTH
72° R
16 GAGE FERROUS PICM
3"X1" CORRUGATION

STR EXCAV	755	CY
~~CHAN EXCAV~~	~~CY~~	
RIPRAP	35	CY
FILTER	18	TON

M2-M2



H2-H2

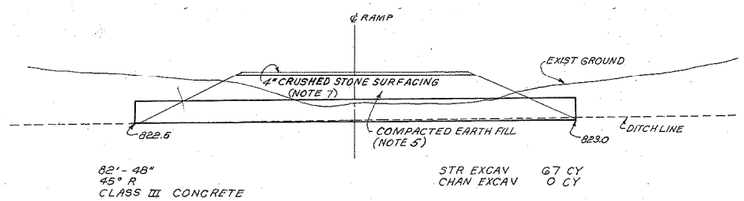


L2-L2

SUMMARY OF QUANTITIES

ITEM	DESCRIPTION	QUANTITY	UNIT
101	CLEARING	54	AC
101	GRUBBING	12	AC
120	UNCLASSIFIED EXCAVATION	30,000	CY
123	EARTH BORROW EXCAVATION	75,000	CY
125	EXCAVATION FOR STRUCTURES	147	CY
305	CRUSHED STONE SURFACING	750	TON
462	48" PIPE CULVERT, CLASS III CONC.	82	LF
462	60" PIPE CULVERT, CLASS III CONC.	220	LF
481	78" PIPE CULVERT	180	LF
570	FILTER BLANKET	83	TON
575	RIPRAP	186	C.Y.
580	SEEDING	40,000	SY
582	MULCHING	40,000	SY
	FOUNDATION STRIPPING	18,000	CY
110	EXIST 60" PIPE REMOVE & RELOCATE	70±	LF

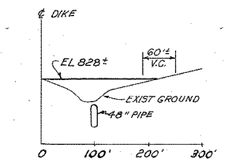
NOTE:
FOR GENERAL NOTES SEE SHEET 1.



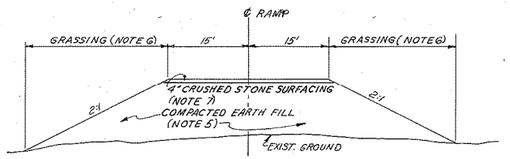
82'-48" 45° R CLASS III CONCRETE

STR EXCAV	67	CY
CHAN EXCAV	0	CY

F2-F2



PROFILE, RAMP INTO DISPOSAL AREA
SCALE 1"=100'



G2-G2

FIRST ISSUE FOR W.O.# 544-30-20604-J0002

COMPANION DWG: 10W293-1

INSPECTED AND APPROVED FOR ISSUE

REV NO.	ECN NO.	DATE	DSGN	DWN	CHK	SUPV	ENGR	INSP	SUBM	RECM	APPD
1	L	7-30-82	VPE	VRL	VLG	JLG	WJB	RJB	RJB	FJG	SBJ

REV: CHANNEL CHG TO W. SIDE OF COAL HAUL RD. W.O. 544-30-20604-J0002.

DSGN	R.D. MARONEY	INSP	
DRWN	A.H. SPEEBER	ENGINEER	
CHKD	R.D. MARONEY		R. W. Burnett
SUPV	J. L. GLOVER		

SCALE: 1" = 10' EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA NORTH OF COAL PILE SHEET 2

BULL RUN STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

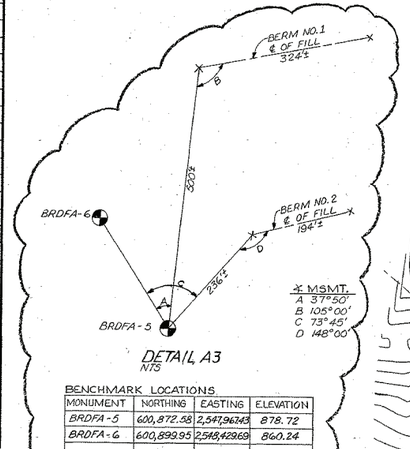
SUBMITTED	RECOMMENDED	APPROVED
Robert J. Brenner	R.D. Maroney	R. W. Burnett
KNOXVILLE	6-3-82	

49 C 10W293-2 R1
RECORD DRAWING AS CONSTRUCTED

PRINTS REQD—R 1

1982-06_BRF-10W293-2-SHT -REV 1 MAIN PLANT ASH DISPOSAL AREA NORTH OF COAL PILE SHEET 2 (35% of Scale); BRF Dry Stack; On-Screen Takeoff; 1/31/2014 02:18 PM

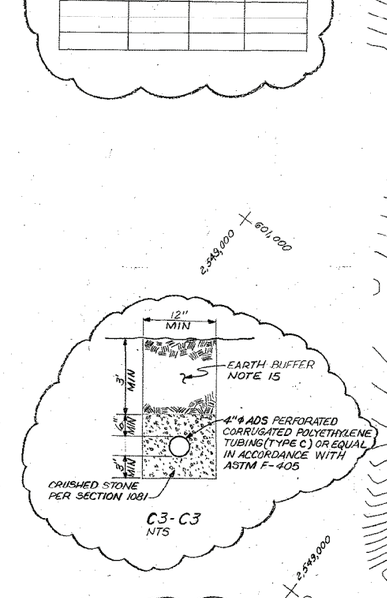
10W293-3 | C | 49



DETAIL A3
NTS

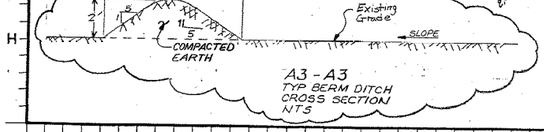
BENCHMARK LOCATIONS

MONUMENT	NORTHING	EASTING	ELEVATION
BRDFA-5	600,872.58	2,547,967.43	878.72
BRDFA-6	600,899.95	2,548,429.69	860.24



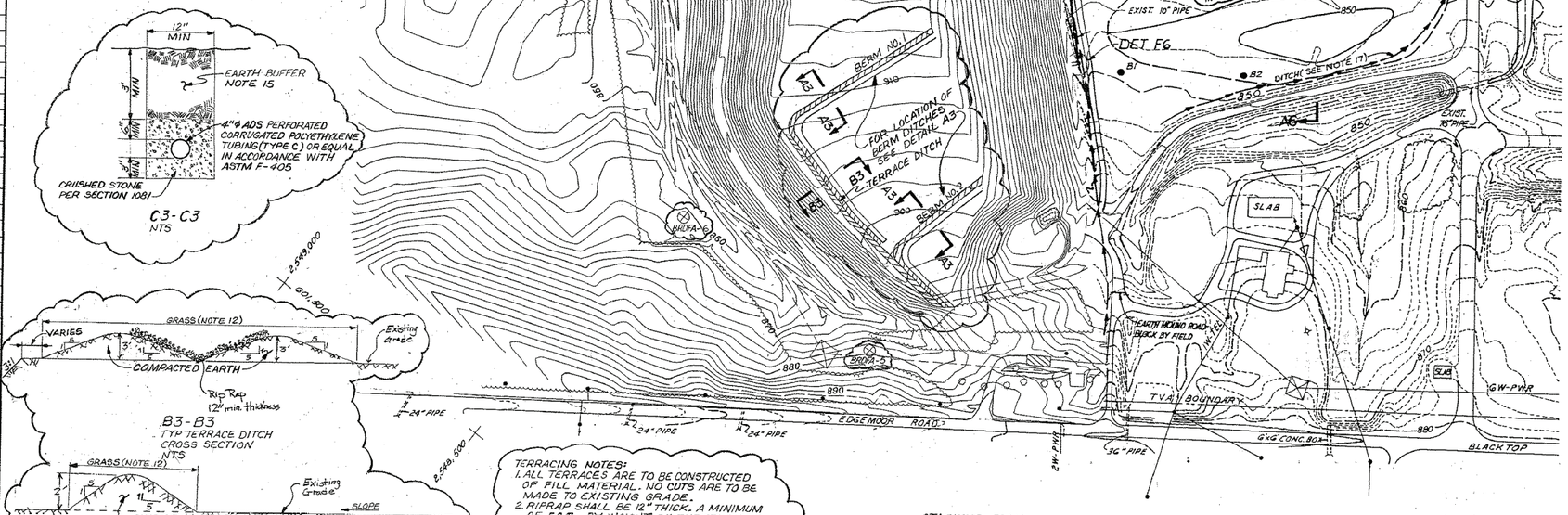
C3-C3
NTS

B3-B3
TYP TERRACE DITCH
CROSS SECTION
NTS

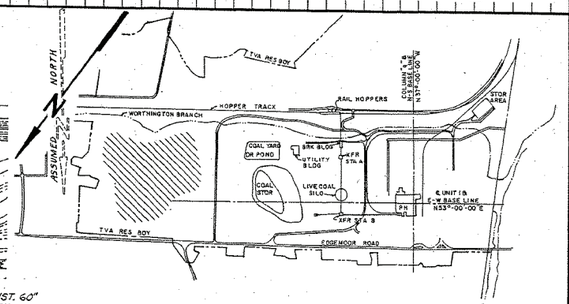


A3-A3
TYP BERM DITCH
CROSS SECTION
NTS

TERRACING NOTES:
1. ALL TERRACES ARE TO BE CONSTRUCTED OF FILL MATERIAL. NO CUTS ARE TO BE MADE TO EXISTING GRADE.
2. RIPRAP SHALL BE 12" THICK. A MINIMUM OF 50%, BY WEIGHT, OF THE STONES SHALL BE 50 LB. EACH AND IN ACCORDANCE WITH SECTION 575.



STACKING PLAN
PHASE I



LOCATION MAP
SCALE: 1"=800'

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. ASH FILL SHALL BE PLACED IN HORIZ LAYERS 8 TO 12 INCHES THICK (ABSOLUTE MAX OF 12-INCH THICKNESS). THE ASH FILL SHALL BE ROLLED BY SMOOTH SURF. STEEL WHEEL VIBRATORY ROLLERS (6-10 TON) FOR COMPACTION & TO FORM A HARDENED SURF. CRUST FOR DUST CONTROL.
4. THE FIRST AREA TO BE FILLED WITH ASH SHALL BE THE LOW AREA IN THE SOUTHEAST CORNER OF THE PHASE I STACKING AREA. THIS PORTION OF THE PHASE I STACKING AREA SHALL BE FILLED TO AN ELEVATION TO SUCH THAT THE FLOWLINE OF THE DITCH ALONG THE INSIDE OF THE DIKE CAN BE FORMED TO PREVENT RAINFALL RUNOFF FROM COLLECTING IN THIS AREA. AFTER FILLING THIS LOW AREA, THE PHASE I STACKING AREA FILLING SHALL PROCEED FROM EDGEMOOR ROAD SOUTHEASTERLY TOWARD NORTHINGTON BRANCH.
5. ASH FILL SHALL BE PLACED TO WITHIN 12 INCHES OF THE FINISHED GRADE INDICATED ON THIS DRAWING WITH PARTICULAR ATTENTION TO MAINTAINING GOOD SURFACE DRAINAGE (MINIMUM 3% SLOPE) AT ALL TIMES.
6. ASH FILL PLACED AND COMPACTED TO ITS FINAL GRADE SHALL BE COVERED WITH A MINIMUM OF 12 INCHES OF EARTH AND SEEDED WITH TYPE 4 MIXTURE 1 OR TYPE B. SEEDED AREAS SHALL BE FERTILIZED AND MULCHED IN ACCORDANCE WITH SECTIONS 580 AND 582 RESPECTIVELY.
7. UNCOVERED AREAS OF ASH FILL SHALL BE KEPT TO A MINIMUM. AREAS AS SMALL AS PRACTICAL AS DETERMINED BY THE FIELD, SHALL BE FILLED TO GRADE, COVERED WITH EARTH AND SEEDED. THE FINISHED SLOPE OF THE ASH FILL SHALL BE COVERED WITH EARTH AND SEEDED IN PROGRESSION WITH THE ASH RAISING.
8. ALL WET AREAS SHALL BE GRADED TO DRAIN OR THE WATER PUMPED OFF AND THEN ALLOWED TO DRY BEFORE PLACING ASH ON THAT AREA.

NOTES FOR PHASE I CLOSURE:
9. ALL WORK FOR CLOSURE OF THE PHASE I DRY FLY ASH STACKING AREA SHALL BE PERFORMED IN ACCORDANCE WITH THE REQUIREMENTS SPECIFIED IN THE CLOSURE/POST CLOSURE PLAN, PHASE I, DRY FLY ASH STACKING FACILITY, TENNESSEE VALLEY AUTHORITY, BULL RUN FOSSIL PLANT, PREPARED FOR THE TENNESSEE VALLEY AUTHORITY BY TRIBBLE & RICHARDSON INC. AND LAW ENGINEERING INC. THIS DOCUMENT SHALL HEREINAFTER BE REFERRED TO AS THE CLOSURE PLAN.
10. THE 12" MINIMUM THICKNESS COMPACTED CLAY SOIL LAYER SHALL BE CONSTRUCTED IN ACCORDANCE WITH AND MEET THE REQUIREMENTS OF SECTION III.B OF THE CLOSURE PLAN.
11. THE 12" MINIMUM THICKNESS VEGETATIVE SUPPORT LAYER SHALL MEET THE REQUIREMENTS OF SECTION III.B.4.c. OF THE CLOSURE PLAN.
12. FERTILIZING, SEEDING, AND MULCHING SHALL BE IN ACCORDANCE WITH SECTION III.B.4.c. AND APPENDIX B OF THE CLOSURE PLAN. PERMANENT SEEDING SHALL BE TYPE B. TEMPORARY SUMMER SEEDING SHALL BE TYPE 10.

FOR NOTES NUMBER 13 & ABOVE SEE 10W293-6.

REV NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT I.D.	AS CONST
3	9-30-82	BLE	GCL	EJR	JLG	KWB	RDB		5060	
REV. STAGE 1, ADD BERM 1 & 2, & TERRACE DITCH & PERF PIPE.										
2	11-4-82	EJR	GCL	JLG	JLG	KWB	RDB			
REV. EXIST. GRADE STAGE 2 & ADD BUFFER MATERIAL.										
1	4-15-82	RDB	CHR	RDB	JLG	TWB	RDB			
REMOVE SECT A4-A4, SHOW CUT PLANE OF A5-A5 & ADD NOTES 9 THRU 12.										

DSGN K. R. ELDER
DRWN K.R. LEE, T.N. PYLES, J.C. MORRIS
CHKD V. P. ELDER
SUPV J. L. GLOVER

INSP
ENGINEER K. W. Burnett

SCALE: 1" = 100'
EXCEPT AS NOTED

FIRST ISSUE FOR W.O. 544-30-20604-J0002

COMPANION DRAWINGS: 10W293-1, 2, 4, & 6.

MAIN PLANT

ASH DISPOSAL AREA NORTH OF COAL PILE SHEET 3

BULL RUN STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

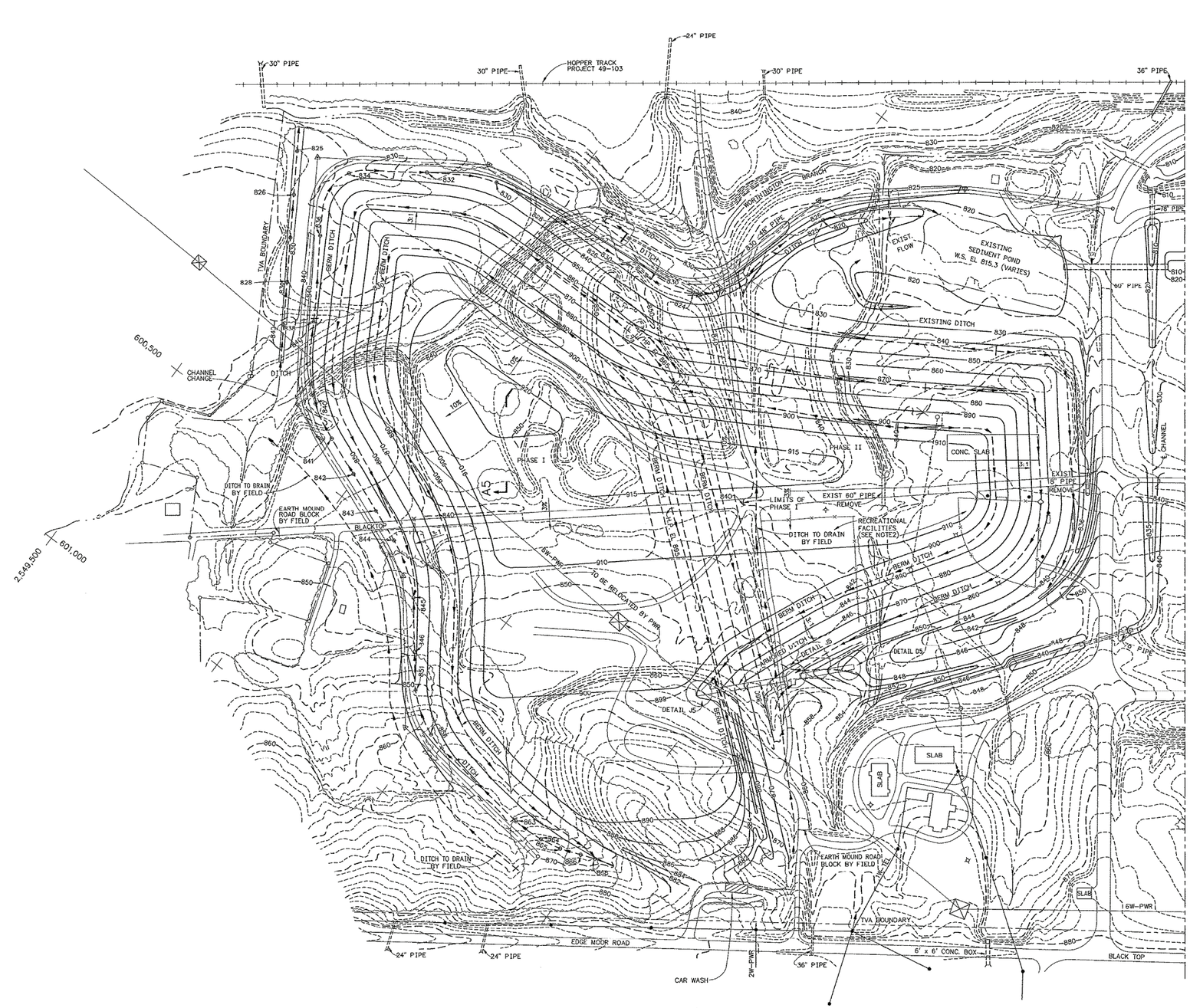
SUBMITTED	RECOMMENDED	APPROVED
Robert J. Burrows		John E. Holladay Jr.

INSPECTED AND APPROVED FOR ISSUE
O. P. Shortreed

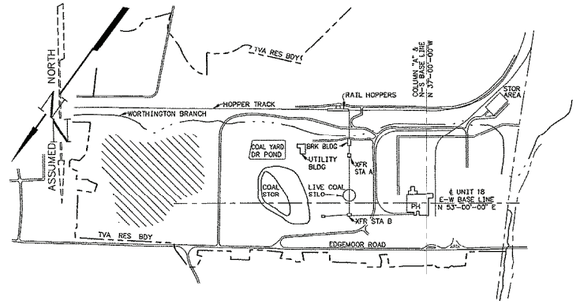
KNOXVILLE | 11/5/82 | 49 | C | 10W293-3 R3
RECORD DRAWING AS CONSTRUCTED

PRINT H 3
SIZE F

1982-11_BRF-10W293-3-SHT -REV 3 MAIN PLANT ASH DISPOSAL AREA NORTH OF COAL PILE SHEET 3 (34% of Scale); BRF Dry Stack; 7-30-2010 15-53-0; 11/1/2011 10:17 AM



STACKING PLAN
PHASE II



LOCATION MAP
SCALE: 1"=800'

NOTES:

1. FOR GENERAL NOTES SEE 10W293-3.
2. TVA SHALL NOTIFY THE LOCAL COMMUNITY RECREATION GROUP TO REMOVE EXISTING FACILITIES (SHOWN ON PLAN) WITHIN A MINIMUM OF 1 YEAR PRIOR TO USE OF PHASE II PORTION OF THE DISPOSAL AREA.
3. — — — — — — HEAVY DASHED CONTOURS INDICATE LIMITS OF PHASE I STACKING.

COMPANION DRAWINGS: 10W293-1, 2, 3 & 5

R 3 JUN 0 6 2002 | CWH | HLB | REP | VJGK | H

ELECTRONICALLY RESTORED – NO MODIFICATIONS

REV. NO.	DATE	ENGR	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST

SCALE: 1"=100'-0" EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA NORTH OF COAL PILE SHEET 4

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
V.P. ELDER	J.C.H./A.H.S.	J.L. GLOVER	K.W. BURNETT	F.D. STANSBURY	J.E. MULLOWAY	O.P. THORTON

BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R14	DATE 12-7-82	49	C	10W293-4	R 3

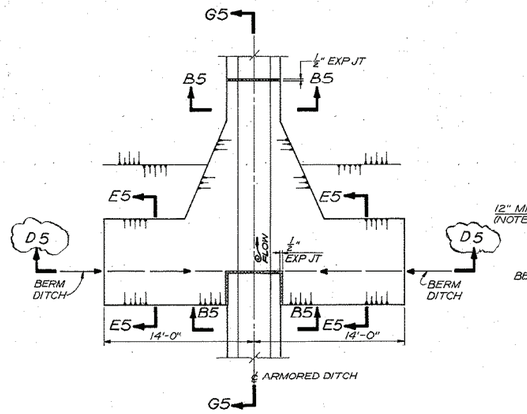
ELECTRONICALLY RESTORED DRAWING
THIS DRAWING HAS BEEN COMPLETELY REDRAWN AND SUPERSEDES : (10W293-4 R2)

TASK COMPLETED BY: | REV NO.

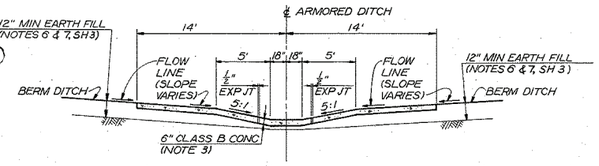
PLOT FACTOR:1200
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

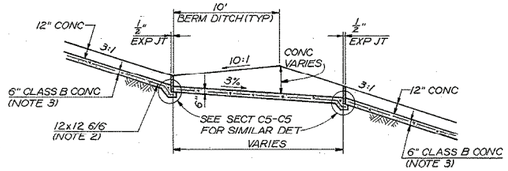
ACCESS DRAWING HAS CERTIFIED THAT CONVERSION OF DRAWING TO ELECTRONIC FORMAT IS ACCURATE AS NOTED BY THIS STAMP.



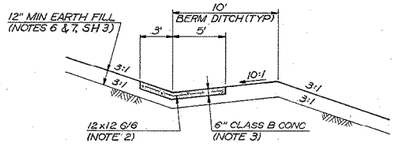
DET J5
SH 4



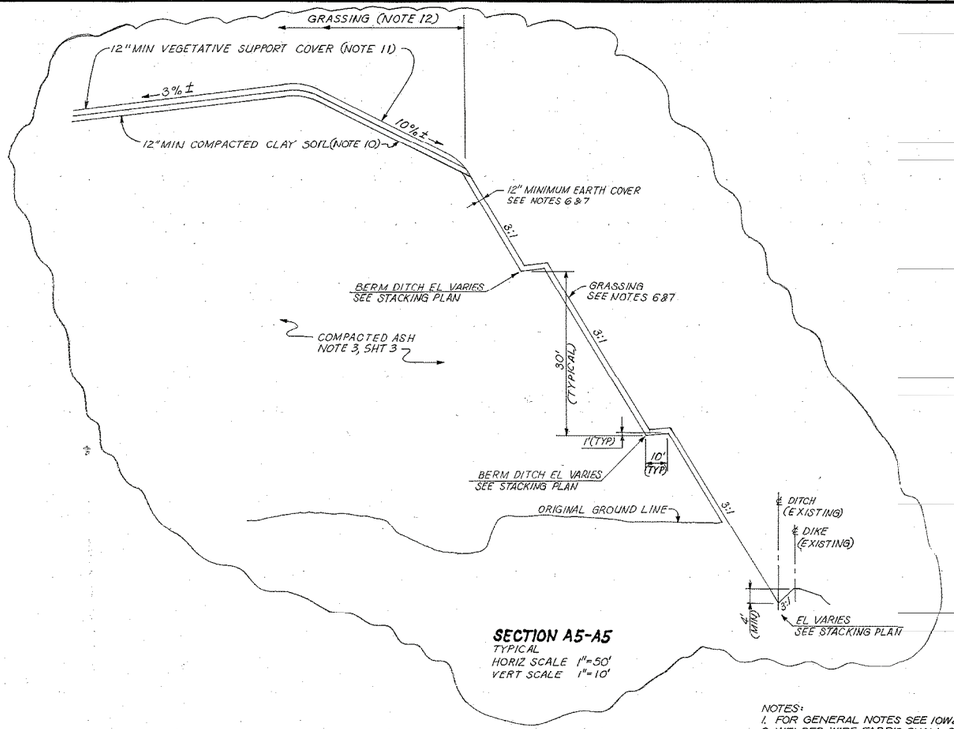
D5-D5



G5-G5

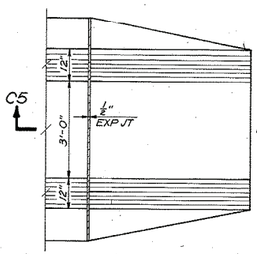


E5-E5

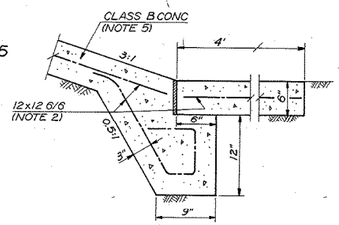


SECTION A5-A5
TYPICAL
HORIZ SCALE 1"=50'
VERT SCALE 1"=10'

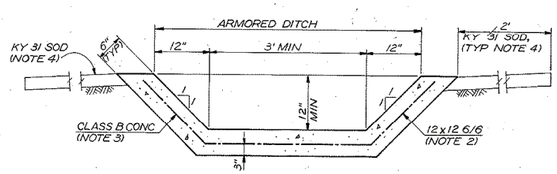
NOTES:
1. FOR GENERAL NOTES SEE 10W293-3.
2. WELDED WIRE FABRIC SHALL CONFORM TO ASTM A185 PLAIN FINISH AND SHALL HAVE A MINIMUM LAP DISTANCE OF 8 INCHES.
3. CONCRETE SHALL CONFORM TO SECTION 400, ITEM 402.
4. SODDING SHALL CONFORM TO SECTION 581.



DET D5
END OF ARMORED DITCH
TYPICAL SECTION
SH 4
NTS



C5-C5



B5-B5
CONCRETE ARMORED DITCH
TYPICAL SECTION
SH 4
SCALE: 1" = 1'

FIRST ISSUE FOR
W.O. NO. 544-30-20604-J0002

COMPANION DRAWING:
10W293-4

INSPECTED AND APPROVED FOR ISSUE
J. L. Hamilton

REV NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	AS CONST
	7-12-82	MEP	DHR	VPE	JLG	KWB	KWB		
	RENAME EXIST A5-A5 TO D5-D5; ADD NEW SECTION A5-A5								

DSGN VP ELDER
DRWN Thomas H. Hooten
CHKD VP ELDER
SUPV J. L. GLOVER
INSP
ENGINEER K. W. Burnett

SCALE: 1" = 5' EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA NORTH OF COAL PILE SECTIONS & DETAILS

BULL RUN STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

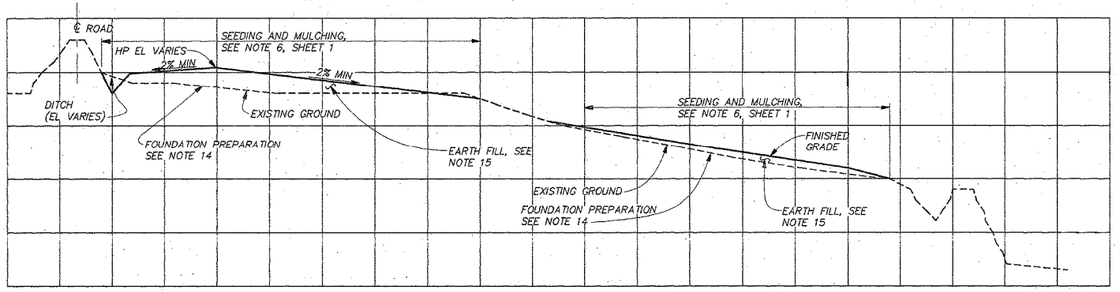
SUBMITTED	RECOMMENDED	APPROVED
Robert J. Brunner	F. D. Stone, Jr.	John E. Hollberg

KNOXVILLE 12-7-82 | 49 | C | 10W293-5 | R1
RECORD DRAWING AS CONSTRUCTED

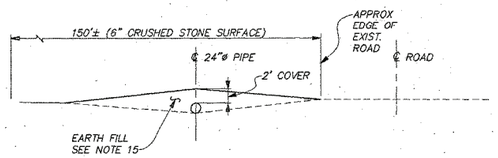
PRINT H 1
SIZE F
DR OR PROJ ME EE CE AD CO ED MD TP EP SW BL HP YC
PRINTS REQD-R

6821TL7-696633

1982-12_BRF-10W293-5-SHT -REV 1 MAIN PLANT ASH DISPOSAL AREA NORTH OF COAL PILE SECTIONS & DETAILS (35% of Scale); BRF Dry Stack; On-Screen Takeoff; 1/31/2014 02:19 PM



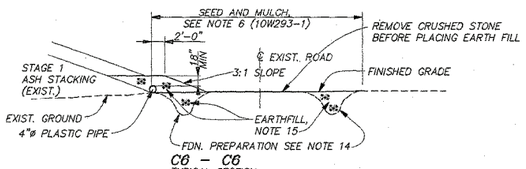
A6 – A6
TYPICAL SECTION
(10W293-3)
1"=50' HORIZONTAL
1"=10' VERTICAL



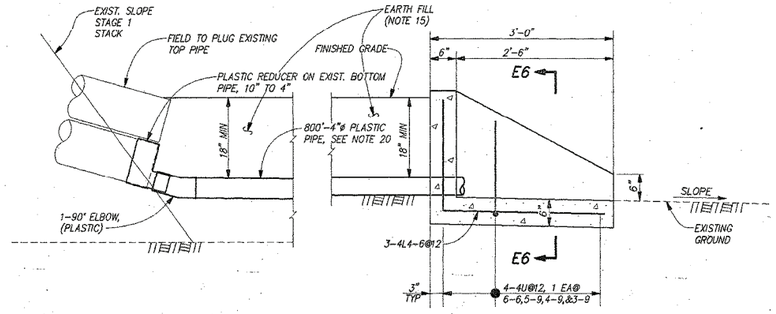
B6 – B6
1/8" = 1'-0"

NOTES: (FOR NOTES 1–12 SEE DWG. 10W293-3)

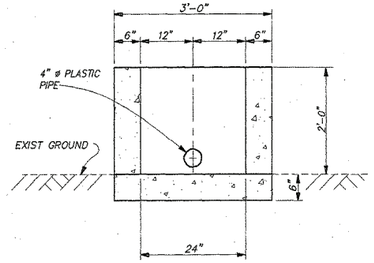
13. ALL WORK FOR THE BUFFER UNDER STAGE 2 STACK AND THE INTERFACE BETWEEN STAGE 1 SLOPE AND STAGE 2 STACK SHALL BE PERFORMED IN ACCORDANCE WITH THE REQUIREMENTS SPECIFIED IN THE OPERATIONS MANUAL PHASE II – DRY FLY ASH STACKING FACILITY TENNESSEE VALLEY AUTHORITY BULL RUN FOSSIL PLANT, TRIBBLE & RICHARDSON INC, AND LAW ENGINEERING INC.
14. FOUNDATION PREPARATION FOR EARTHFILL BUFFER MATERIAL SHALL BE STRIPPED TO REMOVE VEGETATIVE GROWTH AND ORGANIC MATERIAL AND SHALL BE SCARIFIED TO ASSURE BONDING BETWEEN EXISTING NEW FILL AND EXISTING GROUND.
15. A MINIMUM OF 3 FEET THICK EARTH BUFFER IS REQUIRED. AREAS REQUIRING ADDITIONAL FILL ARE INDICATED ON PLAN. EARTHFILL COMPACTION SHALL BE TO ACHIEVE A MAXIMUM VERTICAL HYDRAULIC CONDUCTIVITY OF 1 X 10–6 CM/SEC. FOR THE BUFFER AND 1 X 10–7 CM/SEC FOR THE INTERFACE. IN NO CASE SHALL SOIL BE COMPACTED AT MOISTURE CONTENTS LESS THAN OPTIMUM, NOR TO LESS THAN 95% OF THE MAXIMUM DRY DENSITY, AS DETERMINED BY THE STANDARD PROCTOR TEST, ASTM D698.
16. A QUALITY ASSURANCE / QUALITY CONTROL (QA/QC) CONTRACTOR WILL OVERSEE AND CERTIFY THAT THE GEOLOGIC BUFFER AND INTERFACE ARE INSTALLED ACCORDING TO DESIGN PLANS. THE CONTRACTOR SHALL BE INDEPENDENT OF THE CONTRACTOR INVOLVED IN CONSTRUCTION OF THE ASH DISPOSAL SITE. THEIR RESPONSIBILITIES SHALL BE AS STATED IN THE MANUAL.
17. EXISTING DITCH ALONG NORTH AND WEST SIDE OF STAGE 2 DRY STACK IS TO BE RESHAPED, SEEDED, AND MULCHED.
18. REMOVE AND DISPOSE OF ALL LARGE BOLDERS THAT HAVE BEEN PLACED ON THIS SITE.
19. THIS SYMBOL (● B1) REPRESENTS BORINGS TAKEN JANUARY 28,1993 BY SINGLETON LABORATORY TO CHECK DEPTH OF BUFFER.
20. THE PLASTIC PIPE SHALL BE ADS NONPERFORATED CORRUGATED POLYETHYLENE TUBING (TYPE C) OR EQUAL IN ACCORDANCE WITH ASTM F-405.



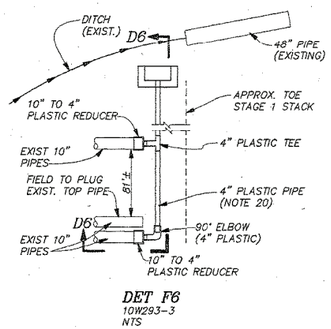
C6 – C6
TYPICAL SECTION
1/8" = 1'-0"



D6 – D6
1" = 1'-0"



E6 – E6
1" = 1'-0"



DET F6
10W293-3
NTS

BENT BAR LIST

BAR MARK	NO. REQD	BENDING DIMENSIONS a	b	c	e	f	r
4L4-6	3	2-6	EX				
4U6-6	1	2-0	2-6	EX			
4U5-9	1	1-8	2-6	EX			
4U4-9	1	1-2	2-6	EX			
4U3-9	1	0-8	2-6	EX			

REV NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	RCDD	AS CONST

SCALE: AS NOTED — EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA
NORTH OF COAL PILE
SECTIONS AND DETAILS

BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

DESIGN		DISCIPLINE INTERFACE		ENGINEERING APPROVAL
DESIGNED E.J.REED	SUPERVISED J.L.GLOVER	1	2	R.G.JOHNSON
DRAWN G.C.LAWSON	REVIEWED R.W.BURNETT	3	4	
CHECKED J.L.GLOVER				

ENGINEERING | DATE 12-16-93 | 49 | C | 10W293-6 | R 0

ISSUED BY:

BRF293-6

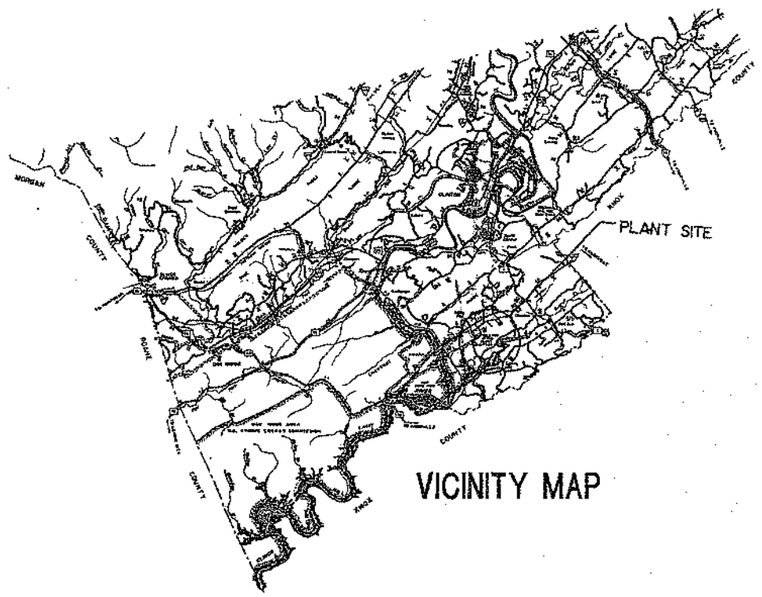
AS CONST

0 MF RD

CAD SYSTEM ORIGINAL
DO NOT CHANGE MANUALLY

TENNESSEE VALLEY AUTHORITY

BULL RUN FOSSIL PLANT
CLOSURE OF PHASE ONE
DRY STACKING AREA



VICINITY MAP

INDEX OF DRAWINGS

SHEET No.	DESCRIPTION
1	BASE CONTOURS
2	FINAL CONTOURS
3	CROSS-SECTIONS
4	CROSS-SECTIONS
5	DETAILS
6	DETENTION / SEDIMENT. POND
7	DETENTION POND DETAILS

Tribble & Richardson Inc.

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CENTURY CITY PLAZA 1 - SUITE 100
51 CENTURY BOULEVARD
NASHVILLE, TENNESSEE 37214
(615) 885-1144

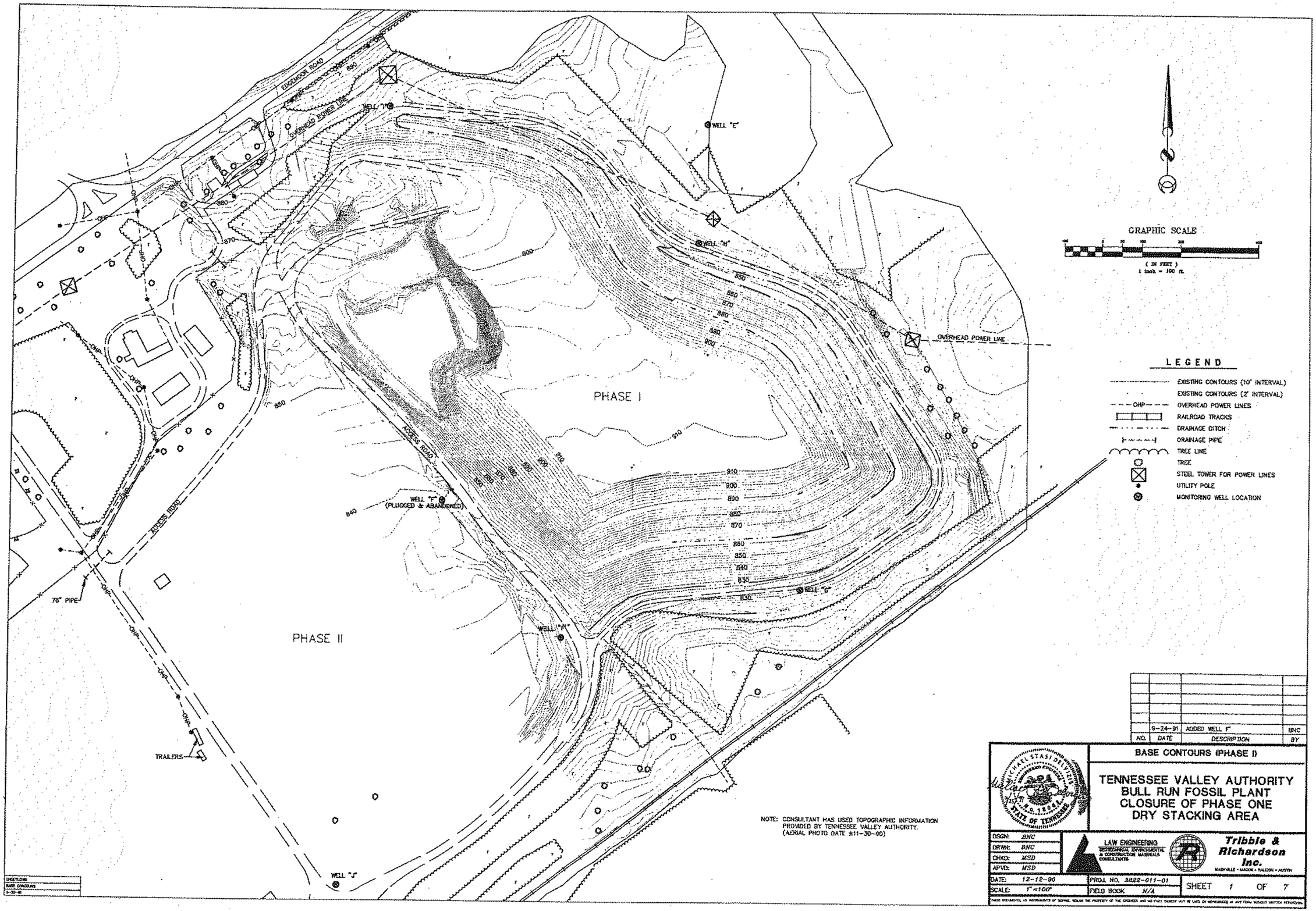
LAW ENGINEERING

GEOTECHNICAL ENVIRONMENTAL
& CONSTRUCTION MATERIALS
CONSULTANTS

T & R PROJECT No. 3822-011

PRINTED MAR 13 1992

SET No. _____



NOTE: CONSULTANT HAS USED TOPOGRAPHIC INFORMATION PROVIDED BY TENNESSEE VALLEY AUTHORITY. (AERIAL PHOTO DATE ±11-30-90)

NO.	DATE	DESCRIPTION	BY
	9-24-91	ADDED WELL F	BNC

BASE CONTOURS (PHASE I)

TENNESSEE VALLEY AUTHORITY
BULL RUN FOSSIL PLANT
CLOSURE OF PHASE ONE
DRY STACKING AREA

MICHAEL STASI DEL'215 REGISTERED ENGINEER R.S. 19041 STATE OF TENNESSEE

DSGN:	BNC
DRWN:	BNC
CHKD:	MSD
APVD:	MSD
DATE:	12-12-90
SCALE:	1"=100'

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Tribble & Richardson Inc. NASHVILLE • MACON • RALEIGH • AUSTIN

PROJ. NO. 3822-011-01

FIELD BOOK N/A

SHEET 1 OF 7

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NOTE: 1. SEE SHEET 5 FOR "TYPICAL STACKING AREA SECTION" REGARDING DETAILS FOR CONTINUATION OF STACKING BENCH AREA AND BERM DITCH CONFIGURATION.

2. CONSULTANT HAS USED TOPOGRAPHIC INFORMATION PROVIDED BY TENNESSEE VALLEY AUTHORITY. (AERIAL PHOTO DATE ±11-30-90).

BENCH MARK DESCRIPTIONS

BRDFA-1 = 831.37 — 4' x 4' concrete slab with brass cap stamped "BRFDA-1" and located at the SW corner of the Dry Fly Ash Stack Area.

BRDF-2= 845.32 — 4' x 4' concrete slab with brass cap stamped "BRFDA-2" and located on the west side of the Dry Fly Ash Stack Area.

BRDFA-3 = 848.71 — 4' x 4' concrete slab with brass cap stamped "BRFDA-3" and located on the west side of the Dry Fly Ash Stack Area. 1' east of chain link fence.

BRDFA-4 = 867.39 — 4' x 4' concrete slab with brass cap stamped "BRFDA-4" and located on the NW corner of the Dry Fly Ash Stack Area. ± 15' SE of NW corner of fence.

BRDFA-5 = 878.72 — 4' x 4' concrete slab with brass cap stamped "BRFDA-5" and located on the NE corner of the Dry Fly Ash Stack Area. ± 70' west of transmission tower leg.

BRDFA-6 = 880.24 — 4' x 4' concrete slab with brass cap stamped "BRFDA-6" and located on the east side of the Dry Fly Ash Stack Area. ± 250' SE of transmission tower (angle).

BRDFA-7 = 844.48 — 4' x 4' concrete slab with brass cap stamped "BRFDA-7" and located on the east side of the Dry Fly Ash Stack Area. ± 30' south of transmission tower, 50' east of road.

BRDFA-8 = 833.45 — 4' x 4' concrete slab with brass cap stamped "BRFDA-8" and located on the east side of the Dry Fly Ash Stack Area. 20' west of drain.

BRDFA-9 = 933.23 — 4' x 4' concrete slab with brass cap stamped "BRFDA-9" and located on the SE corner of the Dry Fly Ash Stack Area. 20' west of C.L. drain and 50' east of road.

LEGEND

- 900 — FINAL CONTOURS (10' INTERVAL)
- FINAL CONTOURS (2' INTERVAL)
- (900) — EXISTING CONTOURS (10' INTERVAL) (AS OF 11-30-90)
- EXISTING CONTOURS (2' INTERVAL) (AS OF 11-30-90)
- OHP — OVERHEAD POWER LINES
- RAILROAD TRACKS
- DRAINAGE DITCH
- DRAINAGE PIPE
- TREE LINE
- TREE
- STEEL TOWER FOR POWER LINES
- UTILITY POLE
- MONITORING WELL LOCATION
- BENCH MARK LOCATION
- SECTION LABEL; SHEET WHERE SECTION IS CUT; SHEET WHERE SECTION IS SHOWN

℄ OF NEW DITCH (NEW DITCH NOT TO BE CONSTRUCTED IN FLY ASH SIDE SLOPE.) REFER TO DETAIL ON SHEET 5

TIE IN NEW DITCH TO EXISTING DITCH

EXIST. DITCH

EDGEMOOR ROAD

OVERHEAD POWER LINE

BRDFA-5

WELL "A"

BRDFA-6

WELL "E"

BRDFA-7

WELL "H"

BRDFA-8

BRDFA-9

P.O.B. ACCESS RD. LAYOUT

N 331.22
E 4021.40

BRDFA-4

BRDFA-3

BRDFA-2

BRDFA-1

EXIST. BERM DITCH

BERM DITCH EL. 902

BERM DITCH (REFER TO NOTE 1 THIS SHEET)

BERM DITCH EL. 906

BERM DITCH EL. 912

END BERM DITCH EL. 914

ACCESS ROAD

WELL "F" (PLUGGED & ABANDENED)

WELL "G"

WELL "I"

WELL "J"

EXISTING 48" CULVERT

78" PIPE

TRAILERS

(PHASE II AREA)

DETENTION/SEDIMENTATION POND FOR PHASE I & II SEE SHEET 6

GRAPHIC SCALE

(IN FEET)
1 inch = 100 ft.

NO.	DATE	DESCRIPTION	BY
	9-24-91	ADDED WELL "F"	BNC
	5-03-91	REMOVED FRENCH DRAIN SYSTEM	BNC
	3-29-91	ADDED FRENCH DRAIN SYSTEM	BNC

FINAL CONTOURS

TENNESSEE VALLEY AUTHORITY BULL RUN FOSSIL PLANT CLOSURE OF PHASE ONE DRY STACKING AREA

DSGN: BNC
DRWN: BNC
CHKD: MSD
APVD: MSD
DATE: 12-12-90
SCALE: 1"=100'

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GEOTECHNICAL ENVIRONMENTAL & CONSTRUCTION MATERIALS CONSULTANTS

Tribble & Richardson Inc.
NASHVILLE • MACON • RALEIGH • AUSTIN

PROJ. NO. 3622-011-01
FIELD BOOK N/A

SHEET 2 OF 7

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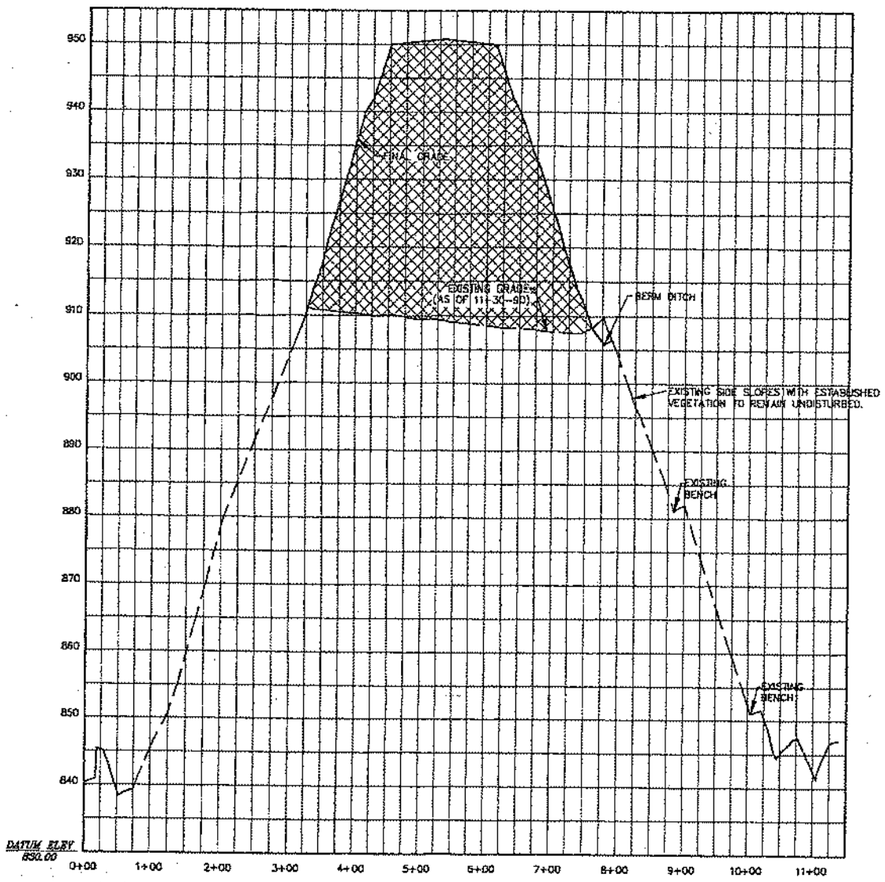
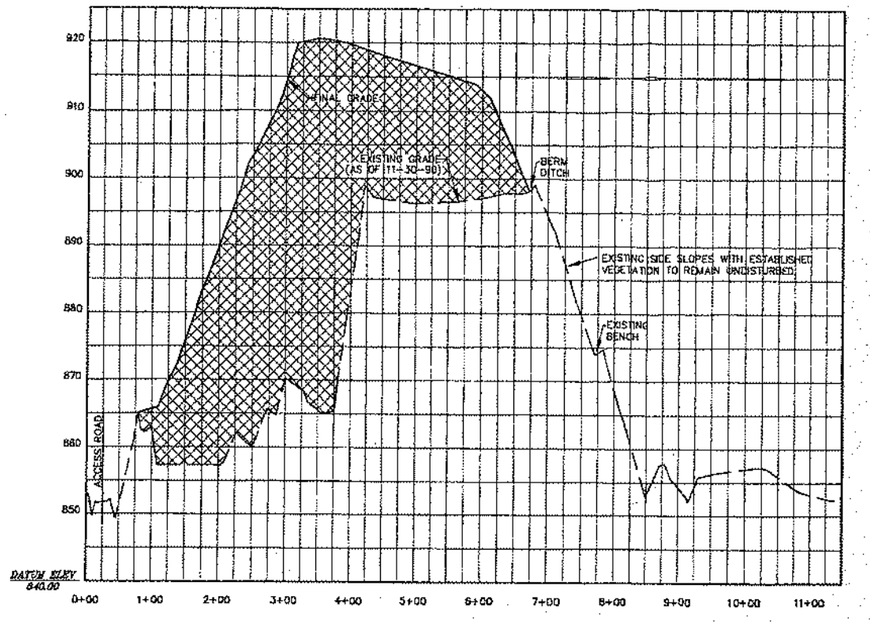


A/2/3 SECTION

NOTES:

1. FINAL GRADE IS TOP 12" OF SOIL SUITABLE FOR VEGETATIVE SUPPORT LAYER SHOWN IN TYPICAL CAP SECTION ON SHEET 5.
2. CONSULTANT HAS USED TOPOGRAPHIC INFORMATION PROVIDED BY TENNESSEE VALLEY AUTHORITY. (AERIAL PHOTO DATE ±11-30-90)
3. SEE SHEET 5 FOR "TYPICAL STACKING AREA SECTION" REGARDING DETAILS FOR CONTINUATION OF STACKING BENCH AREA AND BERM DITCH CONFIGURATION.



B/2/3 SECTION

NO.	DATE	DESCRIPTION	BY
	5-03-91	REMOVED FRENCH DRAIN SYSTEM	BNC
	3-29-91	ADDED FRENCH DRAIN SYSTEM	BNC

CROSS-SECTIONS A-A AND B-B

TENNESSEE VALLEY AUTHORITY
BULL RUN FOSSIL PLANT
CLOSURE OF PHASE ONE
DRY STACKING AREA

DSGN:	BNC
DRWN:	BNC
CHKD:	MSD
APVD:	MSD
DATE:	12-12-90
SCALE:	1"=100'
PROJ. NO.	3822-011-01
FIELD BOOK	N/A

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SHEET 3 OF 7

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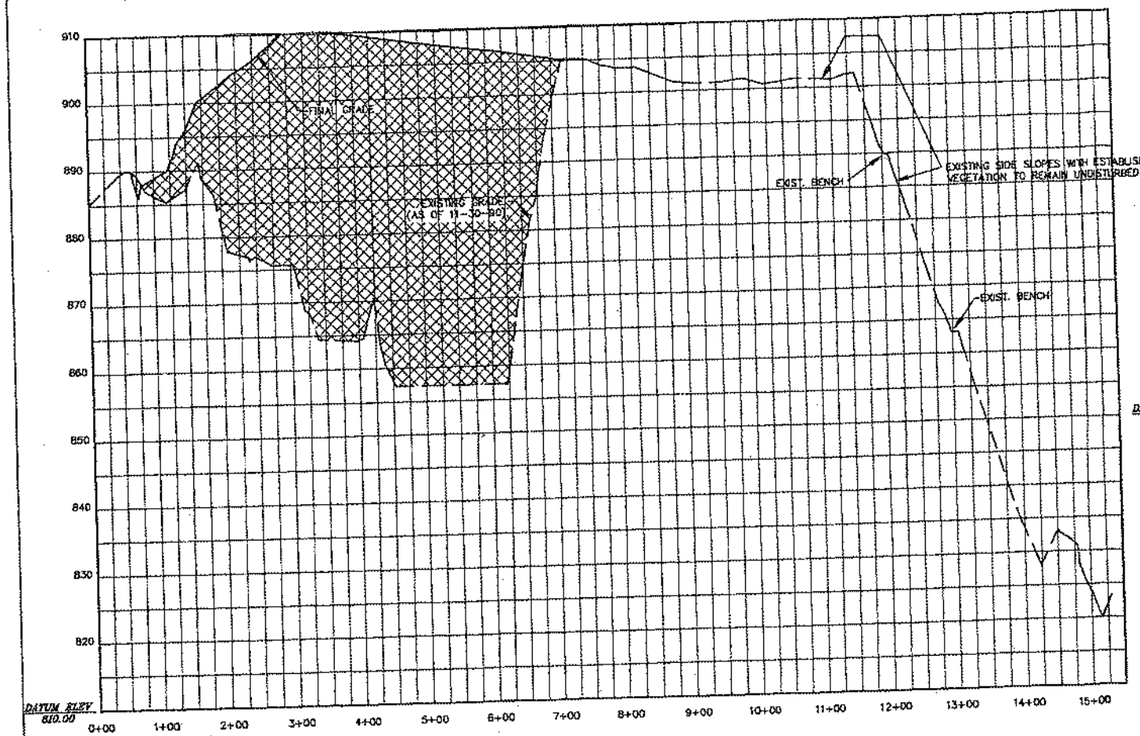
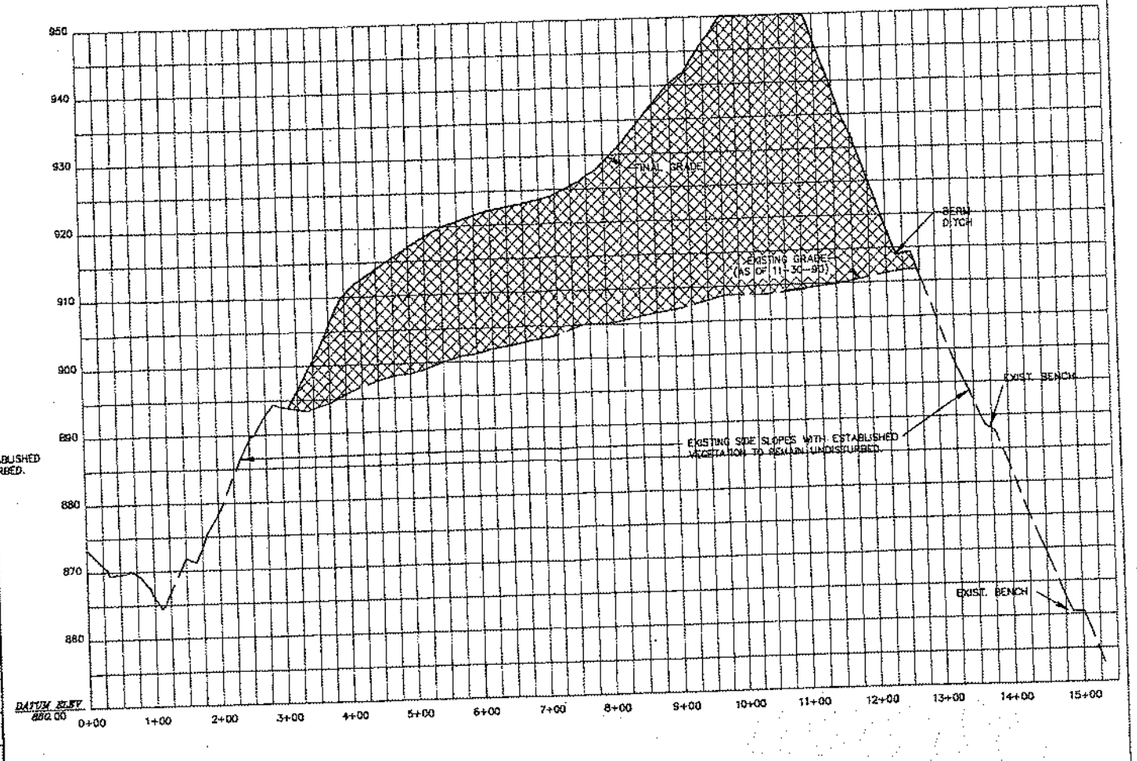
NOTES:

1. FINAL GRADE IS TOP 12" OF SOIL SUITABLE FOR VEGETATIVE SUPPORT LAYER SHOWN IN TYPICAL CAP SECTION ON SHEET 5.
2. CONSULTANT HAS USED TOPOGRAPHIC INFORMATION PROVIDED BY TENNESSEE VALLEY AUTHORITY. (AERIAL PHOTO DATE ±11-30-90)
3. SEE SHEET 5 FOR "TYPICAL STACKING AREA SECTION" REGARDING DETAILS FOR CONTINUATION OF STACKING BENCH AREA AND BERM DITCH CONFIGURATION.



C/2/4 SECTION



D/2/4 SECTION

MICHAEL STASI DEVITO
ENGINEERING CONSULTANT
No. 15064
STATE OF TENNESSEE

CROSS-SECTIONS C-C AND D-D

TENNESSEE VALLEY AUTHORITY
BULL RUN FOSSIL PLANT
CLOSURE OF PHASE ONE
DRY STACKING AREA

DSGN:	BNC
DRWN:	BNC
CHKD:	MSD
APVD:	MSD
DATE:	12-12-90
SCALE:	1"=100'

LAW ENGINEERING
GEOTECHNICAL ENVIRONMENTAL & CONSTRUCTION MATERIALS CONSULTANTS

Tribble & Richardson Inc.
NASHVILLE • MACON • RALEIGH • AUSTIN

PROJ. NO. 3822-011-01
FIELD BOOK N/A

SHEET 4 OF 7

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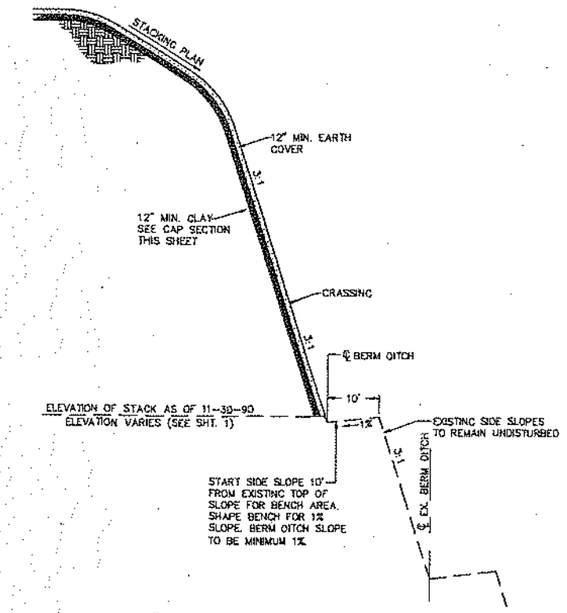
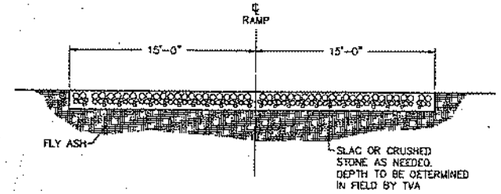
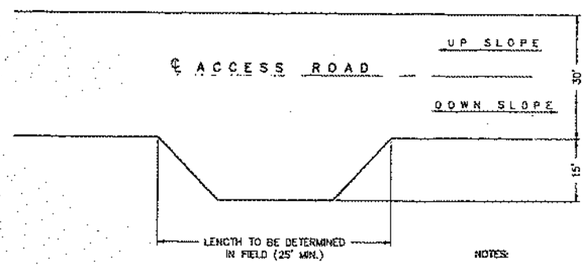


TYPICAL STACKING AREA SECTION



TYPICAL ACCESS ROAD SECTION

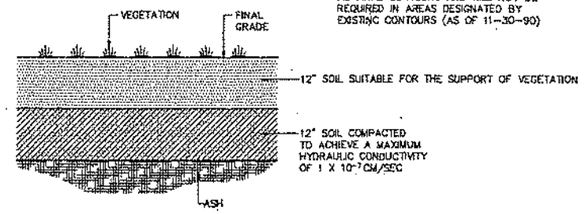


OPTIONAL TEMPORARY TRUCK TURNOUT

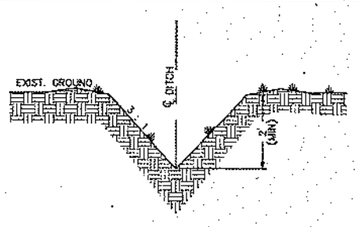
NOTES:

1. NECESSITY OF USING TEMPORARY TRUCK TURNOUT(S) TO BE DETERMINED BY TVA PERSONNEL.
2. LOCATION, LENGTH AND DEPTH OF TEMPORARY TRUCK TURNOUT(S) TO BE DETERMINED BY TVA PERSONNEL.

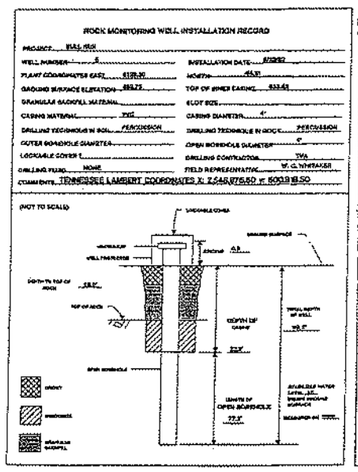
NOTE:
THE FINAL CAP WILL BE PLACED ONLY IN THE AREAS SHOWN ON SHT. 2 AS FINAL CONTOURS AND WILL NOT BE REQUIRED IN AREAS DESIGNATED BY EXISTING CONTOURS (AS OF 11-30-90)

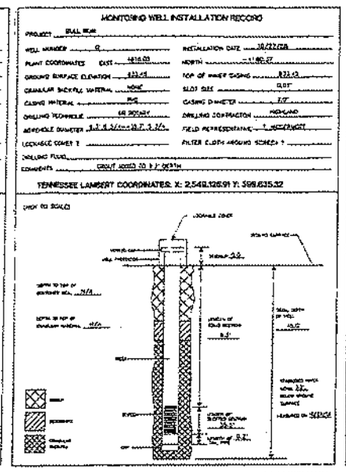


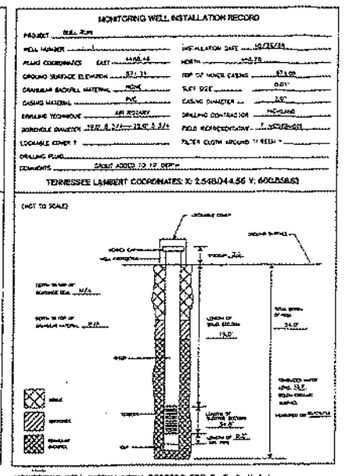
TYPICAL FINAL CAP SECTION

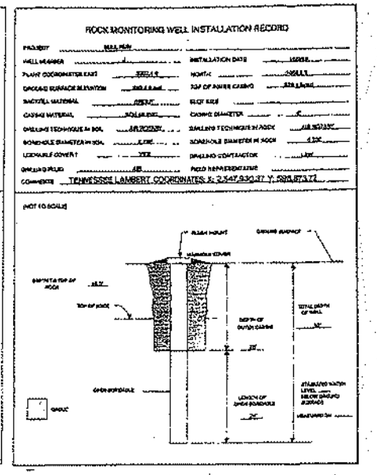


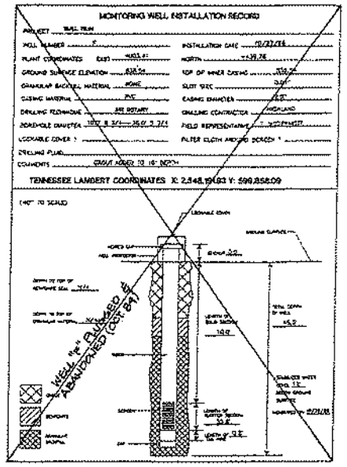
TYPICAL NEW DITCH DETAIL

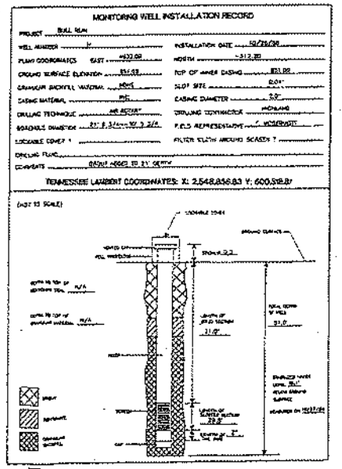












MONITORING WELL INSTALLATION RECORDS FOR E, F, G, H & I OBTAINED FROM "AN ASSESSMENT OF PHASE II FLY ASH DRY STACKING AT THE BULL RUN FOSSIL PLANT" TVA REPORT (WR28-1-40-194, R1 AUGUST 1989
WELL J DATA PROVIDED BY TVA

NO.	DATE	DESCRIPTION	BY
	5-03-91	REVISED FRESH DRAIN DETAIL	BNL
	5-29-91	ADDED TRUCK RAMP DETAIL	BNL

DETAILS

TENNESSEE VALLEY AUTHORITY BULL RUN FOSSIL PLANT CLOSURE OF PHASE ONE DRY STACKING AREA

DSGN:	BNC
DRWN:	KWK
CHKD:	MSD
APVD:	MSD
DATE:	12-12-90
SCALE:	NONE
PROJ. NO.	3822-011-01
FIELD BOOK	N/A
SHEET	5 OF 7

LAW ENGINEERING GEOTECHNICAL ENVIRONMENTAL & CONSTRUCTION MATERIALS CONSULTANTS

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TN&ZUNO
MISC. DETAILS
2-1-91

NOTES FOR BULL RUN SEDIMENTATION POND

1. Excavation for pond should extend to the grades indicated or to the top of intact rock. Intact rock will be defined as material which cannot be broken or dislodged through the use of a Caterpillar D8K dozer equipped with a single-tooth ripper operating at maximum torque.
2. The base of the completed excavation is to be observed by the geotechnical engineer to confirm the presence of intact rock and to provide input relative to subgrade preparation.
3. Soils forming the base of the pond should be tested to confirm that they have an in-situ permeability of 1 x 10-8 cm/sec or less.
4. All exposed rock shall be covered with 3 feet of compacted soil meeting the criteria as noted in note 3 above.
5. All fill soils placed in dikes or at subgrade levels shall be compacted to a minimum density of 95 percent of the maximum unit weight as determined by the Standard Proctor test (ASTM D-698).

BORING LOG

HOLE	REFUSAL DEPTH(ft)	GROUNDWATER DEPTH(ft)
B-1	17.5	17.0
B-2	6.2	DRY
B-3	16.7	DRY
B-4	5.5	DRY
B-5	14.0	DRY
B-6	15.3	15.3 (WET)
B-7	6.0	DRY
B-8	18.5	17.0

BORINGS PERFORMED BY LAW ENGINEERING 3-13-91

PHASE I AREA

PHASE II AREA

EXISTING ACCESS ROAD

EXISTING 48" RCP

EXISTING 60" CULVERT

BORE-HOLE (TYP.)

DETENTION / SEDIMENTATION POND FOR PHASE I & II

2:1 SIDE SLOPE (TYP)

OUTLET STRUCTURE SEE SHEET 7 FOR DETAILS

BERM ELEV. 824

DETENTION POND EXPANSION

DETENTION / SED. POND

TENNESSEE VALLEY AUTHORITY
BULL RUN FOSSIL PLANT
CLOSURE OF PHASE ONE
DRY STACKING AREA

DSGN:	BNC
DRWN:	BNC
CHKD:	MSD
APVD:	MSD
DATE:	3-25-91
SCALE:	1" = 50'

LAW ENGINEERING
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Tribble & Richardson Inc.
NASHVILLE • MACON • RALEIGH • AUSTIN

PROJ. NO. 3822-017-01
FIELD BOOK NA

SHEET 6 OF 7

MICHAEL STASI DESIGN 215 No. 19043 STATE OF TENNESSEE

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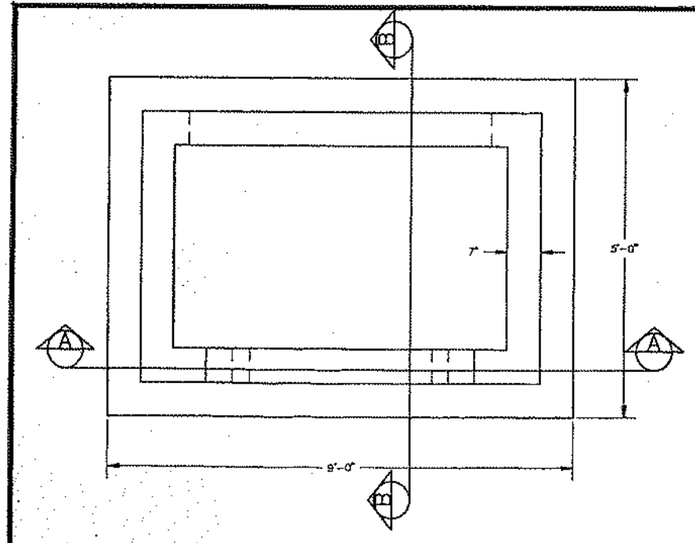
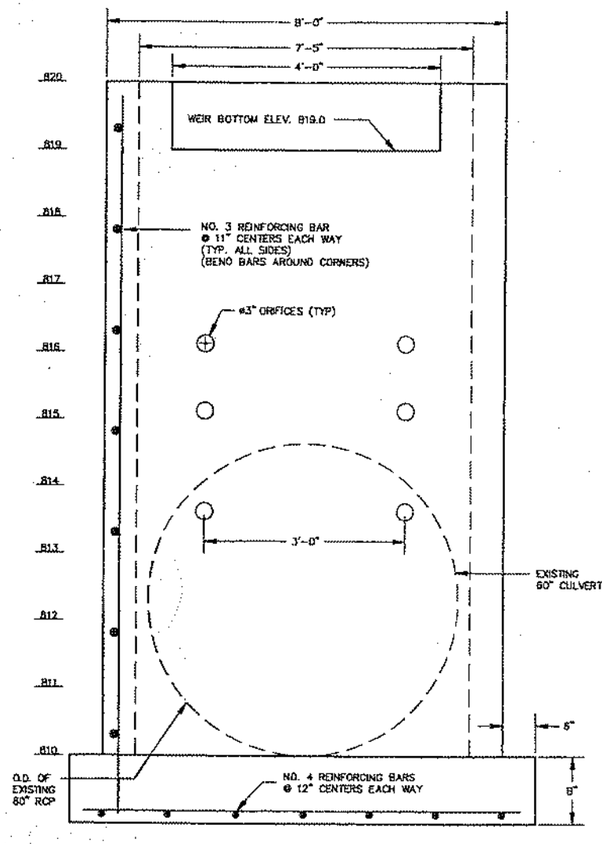
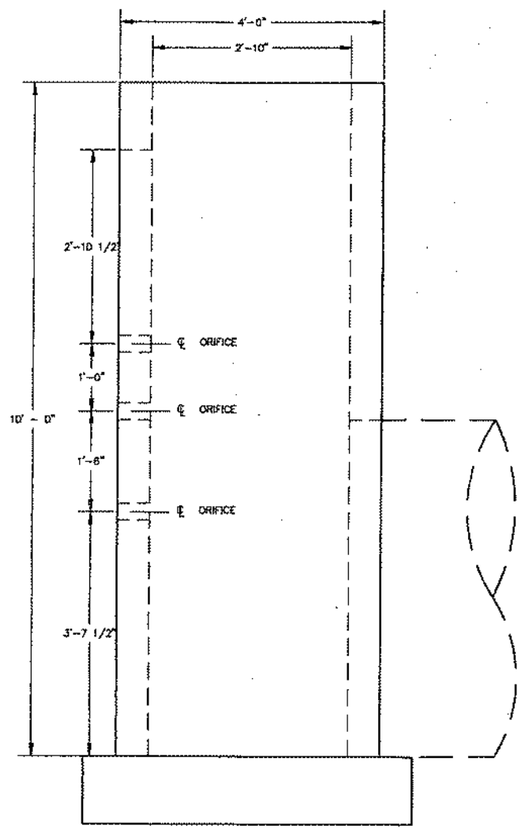


NOTES: OUTLET STRUCTURE MAY BE CAST IN PLACE OR A PRE-CAST UNIT USING 3000 PSI CLASS "A" CONCRETE AND GRADE 60 REBAR. OUTLET STRUCTURE MAY BE CONSTRUCTED OF ALTERNATE MATERIAL UPON APPROVAL OF TVA. ELEVATIONS ESTABLISHED FOR TOP OF STRUCTURE, WEIR AND ORIFICES ARE CRITICAL TO STORM WATER ROUTING THRU THE POND AND OUTLET STRUCTURE.



SECTION A



SECTION B

OUTLET STRUCTURE

OUTLET
DETENTION POND DETAILS
3-25-91

DETENTION POND DETAILS

TENNESSEE VALLEY AUTHORITY
BULL RUN FOSSIL PLANT
CLOSURE OF PHASE ONE
DRY STACKING AREA

DSGN:	BNC
DRWN:	BNC
CHKD:	MSD
APVD:	MSD
DATE:	3-25-91
SCALE:	NTS

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Tribble & Richardson Inc.
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PROJ. NO. 3822-017-01
FIELD BOOK NA

SHEET 7 OF 7

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WORK PLAN FOR GYPSUM DISPOSAL AREA 2A SUBSURFACE DRAINAGE AND SLOPE IMPROVEMENTS URSGS001 BULL RUN FOSSIL PLANT

CLINTON, ANDERSON COUNTY, TENNESSEE

PREPARED FOR

TENNESSEE VALLEY AUTHORITY

PREPARED BY

URS

INDEX OF SHEETS	
SHEET NO.	SHEET TITLE
01	COVER
02	GENERAL NOTES
03	SUBSURFACE FRENCH DRAIN AND SLOPE IMPROVEMENT PLAN
04	TYPICAL SECTIONS & DETAILS
05	FRENCH DRAIN L1 & U1 CROSS SECTIONS (1 OF 3)
06	FRENCH DRAIN L1 & U1 CROSS SECTIONS (2 OF 3)
07	FRENCH DRAIN L1 & U1 CROSS SECTIONS (3 OF 3)
08	FRENCH DRAIN L2 & U2 CROSS SECTIONS
09	FRENCH DRAIN ~~U3~~ U3 CROSS SECTIONS
10	FRENCH DRAIN U1 & U2 PROFILES
11	FRENCH DRAIN U3 PROFILE
12	FRENCH DRAIN L1 PROFILE
13	FRENCH DRAIN L2 ~~U3~~ PROFILES
AS-BUILT SURVEYS	
14	LOWER FRENCH DRAIN AS-BUILT
15	UPPER FRENCH DRAIN 1 AS-BUILT
16	UPPER FRENCH DRAIN 2 AS-BUILT
17	UPPER FRENCH DRAIN 3 AS-BUILT

FOR SUPPORTING DESIGN CALCULATIONS SEE FPGBRFFESCDX00000020110004

1. RECORD DRAWING NOTES:
   1. STRIKEOUT LINES REPRESENT PORTIONS OF THE ORIGINAL DESIGN THAT WERE NOT CONSTRUCTED. FRENCH DRAIN L3 WAS NOT CONSTRUCTED PER URS MEMO ISSUED DECEMBER 10, 2010.
   2. REFER TO SHEETS 14-17 FOR AS-BUILT INFORMATION.

RECORD DRAWING

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST
R 5	3/14/12	LPC	YRC	KMB	KMB	RBC	MST	JCK	204013	J
RECORD DRAWINGS										
R 0	5/7/10	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013	D
ISSUED FOR CONSTRUCTION										

DISCIPLINE INTERFACE

SCALE: NONE EXCEPT AS NOTED

COVER

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

KENNETH MONROE BAIRD REGISTERED ENGINEER AGRICULTURE STATE OF TENNESSEE No. 00114018 3/14/2012

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
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BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2010 | DATE 3/14/12 | 49 | C | 10W508-01 | R 5

URS CORPORATION	5
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

GENERAL NOTES

1 SUMMARY OF WORK/GENERAL PROVISIONS

1.1 PURPOSE: THE PURPOSE OF THIS WORK IS TO INSTALL FRENCH DRAINS AND PERFORM SLOPE REGRADING AT THE GYPSUM DISPOSAL AREA 2A. A TOTAL OF SIX (6) FRENCH DRAINS WILL BE INSTALLED, CONSISTING OF TRENCH EXCAVATION AND INSTALLATION OF DRAINAGE MATERIALS. SLOPE REGRADING WILL CONSIST OF THE REMOVAL OF MATERIAL FROM THE WEST FACE OF THE PERIMETER CLAY DIKE. FRENCH DRAIN INSTALLATION AND SLOPE REGRADING SHALL MEET THE SPECIFICATIONS AND REQUIREMENTS GIVEN HEREIN.

1.2 DEFINITIONS: THE OWNER IS TENNESSEE VALLEY AUTHORITY (TVA). THE ENGINEER, URS CORPORATION (URS), HAS PREPARED THE PLANS AND NOTES HEREIN. THE CONTRACTOR IS TVA OR THE ENTITY WITH WHOM TVA HAS AN AGREEMENT TO PERFORM THE CONSTRUCTION OF THE PROJECT.

1.3 PERMITTING: PERMITTING REQUIREMENTS ASSOCIATED WITH THIS WORK SHALL BE VERIFIED AND COMPLIED BY THE ENVIRONMENTAL GROUP OF TVA.

1.4 MAPPING: TOPOGRAPHIC MAPPING WAS PROVIDED BY STANTEC CONSULTING SERVICES, INC. (STANTEC) AS SHOWN IN THEIR 'REPORT OF GEOTECHNICAL EXPLORATION', DATED FEBRUARY 17, 2010. THIS TOPOGRAPHY WAS DEVELOPED BY TVA SURVEYING AND PROJECT SERVICES THROUGH AERIAL PHOTOGRAPHY OBTAINED IN APRIL, 2009. THE DATA IS PRESENTED IN THE NAD 27 DATUM.

1.5 ACCESS: VEHICULAR ACCESS TO THE SITE SHALL BE DETERMINED BY TVA. NO CONSTRUCTION ACTIVITIES SHALL BE PERFORMED THAT CAUSE AN INTERFERENCE WITH THROUGH TRAFFIC OR TVA OPERATIONS. CONTRACTOR SHALL PROVIDE APPROVED SIGNAGE, BARRIERS, AND TRAFFIC SAFETY PERSONNEL RESPONSIBLE FOR DIRECTING CONSTRUCTION AND PLANT TRAFFIC AT ALL POINTS OF INGRESS AND EGRESS.

1.6 UTILITIES: UTILITIES SHOWN ON THE ATTACHED PLANS SHALL BE CONSIDERED APPROXIMATE AND TO NOT COVER ALL EXISTING UTILITIES IN THE AREA. CONTRACTOR SHALL EXERCISE EXTREME CAUTION. SHOULD PIPING OR OTHER UTILITIES THAT ARE NOT SHOWN ON THE DRAWINGS BE ENCOUNTERED, CONTRACTOR SHALL NOTIFY TVA AND THE ENGINEER IMMEDIATELY. WHERE APPLICABLE, THE CONTRACTOR SHALL PROVIDE NECESSARY MEASURES TO PROTECT UTILITIES FROM DAMAGE BY THE CONTRACTOR'S WORK.

1.7 EXISTING DATA: BORING LOGS AND PIEZOMETRIC DATA FROM THE SITE WILL BE PROVIDED BY TVA UPON REQUEST.

2 CONTRACTOR ACTIVITIES

2.1 SAFETY: CONTRACTOR SHALL BE RESPONSIBLE FOR THE HEALTH AND SAFETY OF ITS PERSONNEL AND SHALL MEET ALL APPLICABLE LOCAL, STATE, AND FEDERAL SAFETY REGULATIONS; INCLUDING BUT NOT LIMITED TO OSHA STANDARDS AND TVA SAFETY REQUIREMENTS.

2.2 QUANTITIES: CONTRACTOR SHALL EMPLOY A COMPETENT SURVEYOR LICENSED IN THE STATE OF TENNESSEE TO ESTABLISH OR CONFIRM ALL LINES, ELEVATIONS, REFERENCE MARKS, ETC. NEEDED BY THE CONTRACTOR AND ENGINEER DURING CONSTRUCTION. THE QUANTITIES OF MATERIALS PRESENTED HEREIN SHALL BE CONSIDERED APPROXIMATE AND ARE SUBJECT TO CHANGE BASED ON FIELD CONDITIONS.

2.3 MEASUREMENTS: CONTRACTOR SHALL BASE ALL MEASUREMENTS, BOTH VERTICAL AND HORIZONTAL, FROM ESTABLISHED BENCHMARKS AND MONUMENTS. EXISTING GRADES AS WELL AS DIMENSIONS AND CONDITIONS AT THE SITE AFTER CONSTRUCTION SHALL BE VERIFIED BY PERFORMING AN AS-BUILT SURVEY.

2.4 AS-BUILT DRAWINGS: NO DEVIATIONS FROM THE PLANS SHALL BE MADE WITHOUT PRIOR APPROVAL FROM TVA AND THE ENGINEER. CONTRACTOR SHALL MAINTAIN AT THE SITE A COMPLETE SET OF PROJECT PLANS AS ISSUED WITH THE CONSTRUCTION DOCUMENTS. PROJECT PLANS SHALL BE UPDATED BY THE CONTRACTOR TO SHOW ANY AND ALL DEVIATIONS MADE DURING CONSTRUCTION. THESE PLANS SHALL BE LABELED AS-BUILT AND SUBMITTED TO THE ENGINEER AT THE COMPLETION OF THE PROJECT OR WITHIN SEVEN (7) DAYS OF THE PROJECT COMPLETION. ALL SUCH REVISIONS SHALL BE MARKED UPON EXECUTION AND AT A MINIMUM EVERY WEEK TO KEEP THE DRAWINGS SET CURRENT DURING THE CONSTRUCTION PROCESS AND PRIOR TO ANY ITEM BECOMING INACCESSIBLE FOR AN AS-BUILT DRAWING TO BE PERFORMED.

2.5 CONSTRUCTION LIMITS: CONTRACTOR SHALL CONFINE HIS EQUIPMENT, STORAGE, AND OPERATIONS TO ONLY AREAS DESIGNATED FOR THOSE USES BY TVA. WHERE TEMPORARY ENTRY IS REQUIRED, THE CONTRACTOR SHALL ENTER THOSE AREAS ONLY FOR THE DURATION OF TIME REQUIRED TO COMPLETE THE WORK. THE OWNER WILL HAVE OTHER CONTRACTORS PERFORMING WORK WITHIN THESE DEFINED CONSTRUCTION LIMITS AND AT NEARBY AREAS DURING THE TIME OF THIS WORK. THE CONTRACTOR SHALL COORDINATE WITH OTHER CONTRACTORS IN THE EXECUTION OF THE WORK AND SHALL ACCOMMODATE ACCESS ROUTE REVISIONS, MINOR DELAYS, AND SHARE WORK AREAS AND OTHER COORDINATION EFFORTS WITHOUT ADDITIONAL COST TO THE OWNER.

2.6 BLASTING: BLASTING IS PROHIBITED FOR THIS PROJECT.

2.7 EROSION AND SEDIMENT CONTROL: SILT FENCES AND OTHER EROSION AND SEDIMENT CONTROL MEASURES SHALL BE INSTALLED AT LOCATIONS AS SHOWN ON THE PROJECT PLANS AND AS DIRECTED BY THE OWNER OR ENGINEER. INSTALLATION, INSPECTION, AND MAINTENANCE OF SILT FENCES AND OTHER EROSION AND SEDIMENT CONTROL MEASURES SHALL FOLLOW REQUIREMENTS OF TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION (TDEC). IN CASE OF DUPLICATION OF SILT FENCE, LOCATIONS BETWEEN THESE PLANS AND THOSE DEVELOPED BY STANTEC, TVA, OR THEIR REPRESENTATIVE WILL DETERMINE FINAL FIELD LOCATION.

2.8 FUGITIVE DUST CONTROL: CONTRACTOR IS RESPONSIBLE FOR FUGITIVE DUST CONTROL TO PREVENT THE GENERATION OF AIRBORNE DUST DURING SITE OPERATIONS.

2.9 MATERIALS STORAGE: DELIVERED MATERIALS FOR INCORPORATION INTO THE WORK SHALL BE TEMPORARILY STORED IN AREAS DESIGNATED FOR SUCH USE BY THE OWNER.

2.10 DEBRIS DISPOSAL: ALL EXCESS CONSTRUCTION DEBRIS SHALL BE DISPOSED OFFSITE IN AREAS AS APPROVED BY THE OWNER.

2.11 SITE RECLAMATION: UPON COMPLETION OF THE PROJECT, THE CONTRACTOR SHALL REMOVE ALL PERSONNEL AND EQUIPMENT FROM THE SITE, INCLUDING ANY TEMPORARY ITEMS INSTALLED BY THE CONTRACTOR DURING THE COURSE OF THE WORK. THE SITE SHALL BE LEFT IN A SIGHTLY CONDITION WITH ALL TRASH AND RUBBISH REMOVED. ANY PARKING AND STAGING AREAS PREPARED BY THE CONTRACTOR SHALL BE REMOVED AND RESTORED TO THEIR ORIGINAL CONDITION, OR BETTER.

2.12 FIELD ADJUSTMENTS: ADJUSTMENTS WILL BE NECESSARY AS THE FIELD WORK PROGRESSES AND SHOULD BE AGREED UPON BY THE OWNER, ENGINEER AND CONTRACTOR PRIOR TO IMPLEMENTATION. IT IS RECOMMENDED THAT CONSTRUCTION MEASURES BE MONITORED BY URS PERSONNEL.

3 MATERIALS

3.1 SAND: MATERIAL USED FOR BACKFILL AROUND THE FRENCH DRAIN SHALL CONSIST OF A NATURAL SAND CONFORMING TO THE REQUIREMENTS LISTED FOR FINE AGGREGRATE FOR CONCRETE IN SECTION 903.01 OF TENNESSEE DEPARTMENT OF TRANSPORTATION (TDOT) STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, 2006 VERSION.

3.2 RIP-RAP: MATERIAL USED FOR SLOPE ARMORING AT THE FRENCH DRAIN OUTLET STRUCTURES AND AS BASE MATERIAL FOR MANHOLE INSTALLATIONS SHALL CONSIST OF A MACHINED RIP RAP CONFORMING TO THE CLASS A-1 REQUIREMENTS LISTED IN SECTION 709.03 OF TDOT STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, 2006 VERSION.

3.3 PIPE: PIPE FOR USE IN FRENCH DRAINS SHALL CONSIST OF A CORRUGATED HPDE PIPE WITH A SMOOTH INNER SURFACE AND A NOMINAL INTERNAL DIAMETER OF 6 OR 8 INCHES, AS SPECIFIED IN THE PLANS. WHERE SLOTTED PIPE IS SPECIFIED, THE PIPE SHALL HAVE A AASHTO CLASS II PERFORATION PATTERN WITH A MAXIMUM SLOT LENGTH OF 0.875 INCHES AND A MINIMUM SLOT WIDTH OF 0.125 INCHES.

3.4 CLAY: MATERIAL FOR USE AS CLAY SHALL HAVE A LIQUID LIMIT LESS THAN 40% AND A PLASTICITY INDEX OF LESS THAN 20% PER ASTM D4318.

3.5 FILTER SOCK: FILTER SOCK MATERIAL FOR USE IN WRAPPING FRENCH DRAIN PIPE SHALL CONSIST OF A NON-WOVEN GEOTEXTILE WITH AN APPARENT OPENING SIZE (O95) OF LESS THAN 0.60 MM AND GREATER THAN 0.40 MM. THE GEOTEXTILE SHOULD BE SEWN INTO A TUBE LARGE ENOUGH TO FIT OVER THE FRENCH DRAIN PIPE, AND SHOULD BE INSTALLED WITH A MINIMUM OVERLAP OF 2 FEET BETWEEN FILTER SOCK SECTIONS.

3.6 GEOTEXTILE: SEPARATOR/REINFORCING FABRIC FOR USE BETWEEN FLY ASH MATERIALS AND RIP RAP SHALL CONSIST OF A MIRAFI 600X WOVEN GEOTEXTILE, OR AN EQUIVALENT WOVEN GEOTEXTILE MATERIAL.

3.7 SILT FENCE: SILT FENCING INSTALLED FOR EROSION CONTROL SHALL CONFORM TO THE REQUIREMENTS SHOWN IN DRAWING EC-STR-3C, SILT FENCE WITH WIRE BACKING, FROM TDOT. THE DRAWING IN AVAILABLE IN ELECTRONIC FORM FROM THE FOLLOWING WEBSITE:
<HTTP://WWW.TDOT.STATE.TN.US/CHIEF_ENGINEER/ENGR_LIBRARY/DESIGN/STDDRWGENG_PDFS/ECSTR3C_040108.PDF>

3.8 MANHOLES: MANHOLES INSTALLED TO COLLECT AND DIRECT FLOW FROM VARIOUS SUBSURFACE DRAINAGE PIPES SHALL CONSIST OF REINFORCED CONCRETE MANHOLES MEETING THE ASTM C-478 STANDARD, AND CONFORMING TO THE FOLLOWING REQUIREMENTS:
A. PIPE PENETRATIONS AND INVERT ELEVATIONS SHALL MEET THE REQUIREMENTS SPECIFIED IN THE PLANS
B. CONCRETE SHALL POSSESS A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 4500 PSI
C. ALL PIPE BOOTS SHALL BE COMPLIANT WITH ASTM C-923
D. ALL SEALANT SHALL BE COMPLIANT WITH ASTM C-990
E. STEPS SHALL BE CONSTRUCTED ON 16 INCH CENTERS
F. INSIDE MANHOLE DIAMETERS SHALL BE 48 INCHES

THE CONTRACTOR SHALL DETERMINE BASE, RISER, AND ECCENTRIC CONE HEIGHTS TO ACCOMMODATE THE TOP AND PIPE INVERT ELEVATIONS SHOWN IN THE PLANS.

3.9 Y-FITTINGS: Y-FITTINGS FOR USE IN CONNECTING DRAIN CLEANOUTS TO THE MAIN FRENCH DRAIN PIPES SHALL CONSIST OF 60 DEGREE FITTINGS MADE FROM HDPE. THE FITTINGS MUST BE CONPATIBLE WITH THE PIPE USED FOR THE FRENCH DRAINS AND MUST PROVIDE A WATER AND SOIL TIGHT SEAL BETWEEN THE PIPES AND THE FITTING.

3.10 PIPE CAPS: PIPE CAPS FOR USE IN CAPPING THE FRENCH DRAIN CLEANOUTS SHALL CONSIST OF HDPE CAPS WHICH ARE COMPATIBLE WITH THE PIPE USED FOR THE FRENCH DRAINS. THE CAPS MUST BE SECURELY FASTENED THE THE FRENCH DRAIN CLEANOUT PIPES SUCH THAT THEY WILL NOT BECOME REMOVED BY ACCIDENT.

3.11 QUANTITIES: MATERIAL AND EXCAVATION QUANTITIES ARE SHOWN BELOW. NOTE: CONTRACTOR SHALL PERFORM OWN ESTIMATES OF MATERIAL QUANTITIES FOR BIDDING AND CONSTRUCTION PURPOSES. QUANTITIES LISTED ASSUME A 24 IN WIDE EXCAVATION AT AN AVERAGE DEPTH OF 9 FEET WITH A DRAINAGE PIPE AND A 1 FT THICK CLAY COVER. QUANTITIES ASSUME NEAT CONSTRUCTION AND WILL COVER ALL PAYMENTS. QUANTITIES FOR OVERBREAK OR CONSTRUCTION OUTSIDE OF THE NEAT LIMITS IS CONSIDERED TO BE INCIDENTAL.

MATERIAL	QUANTITY	UNITS
RIP-RAP	550	CY
SAND	4500	CY
CLAY COVER	700	CY
CONSTRUCTION ACCESS RAMP FILL	15,500	CY
SLOTTED FRENCH DRAIN PIPE, 6"	7500	FT
SOLID FRENCH DRAIN PIPE, 6"	150	FT
SLOTTED FRENCH DRAIN PIPE, 8"	900	FT
FILTER SOCK, 6" PIPE	1350	SY
FILTER SOCK, 8" PIPE	250	SY
GEOTEXTILE SEPARATOR/REINFORCEMENT	1400	SF
SILT FENCE	3000	FT
MANHOLES	2	EA
DEWATARING	1	LS
HORIZONTAL DRAIN	2	EA
PIPE CAP, 6"	2	EA
PIPE CAP, 8"	2	EA
Y-FITTING, 6"	2	EA
Y-FITTING, 8"	2	EA

EXCAVATION	QUANTITY	UNITS
Upper French Drain Excavation	2500	CY
Lower French Drain Excavation	3700	CY
Outfall Structure Excavation	50	CY
Slope Regrading	950	CY

4 CONSTRUCTION ACTIVITIES

4.1 EXCAVATION: EXCAVATIONS SHOULD FOLLOW THE DRAIN ALIGNMENT AND GRADE AS SHOWN IN THE DRAWINGS. FIELD ADJUSTMENT TO THE PLANS MAY BE NECESSARY AND SHOULD BE AGREED ON BETWEEN THE OWNER AND THE ENGINEER.

CUT SLOPES SHALL BE CONSTRUCTED TO THE LINE AND GRADE AS SHOWN IN THE DRAWINGS. FIELD ADJUSTMENT TO THE PLANS MAY BE NECESSARY AND SHOULD BE AGREED ON BETWEEN THE OWNER AND THE ENGINEER.

4.2 ANTICIPATED INSTALLATION METHODS: THE EXISTING GROUND IS ANTICIPATED TO BE DRIER NEAR THE TOP OF THE EXISTING BERM. IT IS ANTICIPATED THAT THE MAJORITY OF THE LENGTHS OF DRAINS U1, U2, AND U3 MAY HAVE MATERIAL WHERE THE TRENCH WILL STAY OPEN LONG ENOUGH TO USE A BACKHOE FOR EXCAVATION. DRAINS L1, L2, AND L3 ARE ANTICIPATED TO BE MAINLY IN SATURATED ASH AND ARE ANTICIPATED TO NEED SHORING TO MAINTAIN TRENCH STABILITY. THE CONTRACTOR MAY WISH TO CONSIDER USING A TRENCHER WITH SIDESHIELDS USED TO INSTALL UTILITIES IN COHESIONLESS SOILS BELOW GROUNDWATER FOR THE INSTALLATION OF DRAINS L1, L2, AND L3.

THE CONTRACTOR IS RESPONSIBLE FOR TRENCH STABILITY, DEWATERING, AND SHORING AS REQUIRED.

4.3 BACKFILL: BACKFILL SHALL BE AS SHOWN IN THE DETAILS. OVERBREAKS (SLOUGHS, ETC) ARE TO BE BACKFILLED WITH SAND. SAND SHOULD BE THE SAME AS THAT USED FOR DRAIN CONSTRUCTION.

TRENCH BACKFILL IS TO BE INSTALLED WITHIN ONE HOUR OF EXCAVATION. (THIS APPLIES TO SAND AND NOT THE CLAY COVER.) NO TRENCH IS TO BE LEFT OPEN OVERNIGHT.

4.4 COMPACTION: NO COMPACTION IS REQUIRED FOR THE SAND. THE CLAY COVER SHOULD BE COMPACTED USING A MINIMUM OF 4 PASSES OF THE TRACKS OF A DOZER, D-6 OR LARGER. SITE SHOULD THEN BE SMOOTHED AND SLOPED TO DRAIN TO SATISFY TVA.

4.5 CONSTRUCTION TOLERANCES: AS-BUILT FINAL GRADES SHALL NOT DEVIATE MORE THAN +/- 0.25 FEET FOR EARTH SURFACES AND SLOPES.

4.6 FINGER DRAINS: IT IS UNKNOWN IF AND WHERE FINGER DRAINS WILL BE ENCOUNTERED WITHIN THE GYPSUM STACK. FROM DESIGN DRAWINGS, IT APPEARS THAT THE DRAINS MIGHT BE LOCATED AT APPROXIMATELY ELEVATION 815 FEET AT A SPACING OF 250 FEET.

WHEN FINGER DRAINS ARE ENCOUNTERED IN FRENCH DRAIN CONSTRUCTION, REMEDIAL MEASURES WILL BE TAKEN AFTER THE FRENCH DRAINS ARE COMPLETED. REMEDIAL MEASURES WILL CONSIST OF THE DRILLING AND INSTALLATION OF HORIZONTAL DRAINS TO RESTORE THE FINGER DRAINS. THE HORIZONTAL DRAINS WILL BE INSTALLED AT EACH FINGER DRAIN LOCATION. THE HORIZONTAL DRAIN WILL BE INSTALLED THROUGH THE EXISTING FINGER DRAIN AND PENETRATE THROUGH THE SAND PLACED FOR THE FRENCH DRAIN. THE HORIZONTAL DRAIN WILL CONSIST OF 1.5 INCH SLOTTED PVC PIPE INSTALLED TO A MINIMUM OF 1 FOOT PAST (ON THE STACK INTERIOR) THE BACKFILL PLACED FOR THE FRENCH DRAIN INSTALLATION.

IF A FINGER DRAIN HAPPENS TO BE ENCOUNTERED AT THE DRAINAGE PIPE ELEVATION FOR THE FRENCH DRAIN, THEN A FIELD DECISION WILL BE MADE BY THE QUALITY ASSURANCE OFFICER ON WHETHER THE HORIZONTAL DRAIN WILL BE INSTALLED 1 FOOT HIGHER OR LOWER THAN THE EXISTING FINGER DRAIN LOCATION. THE INTENT IS TO PROVIDE A DRAIN (PIPING) TO RESTORE THE PATHWAY FOR WATER WITHIN ANY INDIVIDUAL FINGER DRAIN.

4.7 PIEZOMETERS AND SLOPE INCLINOMETERS: PIEZOMETERS AND SLOPE INCLINOMETERS ARE LOCATED ACROSS THE SITE AS INDICATED ON THE DRAWINGS. ALL PIEZOMETERS AND SLOPE INDICATORS SHALL BE PROTECTED FROM DAMAGE DURING CONSTRUCTION ACTIVITIES, WITH THE EXCEPTION OF PIEZOMETERS STN 41, STN 41A, STN 51, AND STN 51A.

PIEZOMETERS STN 41, STN 41A, STN 51, AND STN 51A SHALL BE CLOSED AND ABANDONED IN ACCORDANCE WITH TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION (TDEC) GUIDELINES. THE PIEZOMETERS SHALL BE GROUTED IN PLACE USING A PORTLAND CEMENT-BENTONITE GROUT (4-6% BENTONITE). THE CASING SHALL BE CUT OFF 2 FEET BELOW THE FINAL GRADE LEVEL, AND THE EXCAVATION REQUIRED TO CUT THE PIEZOMETER BELOW GRADE SHALL BE BACKFILLED WITH CLAY. THE PADS, BOLLARDS, AND OTHER SURFACE STRUCTURES RELATING TO THE PIEZOMETERS SHALL BE REMOVED.

4.8 SEEPS: CONTRACTOR SHALL NOTIFY TVA AND THE ENGINEER IF WATER SEEPS ARE OBSERVED DURING THE WORK. THIS CONDITION MAY REQUIRE ADDITIONAL MEASURES AS DIRECTED BY THE ENGINEER.

4.9 STORM WATER MANAGEMENT: CONTRACTOR SHALL HAVE A SPECIFIC TEMPORARY STORM WATER MANAGEMENT PLAN FOR THE CONSTRUCTION PHASE OF THE PROJECT. THIS PLAN SHALL BE SUBMITTED FOR APPROVAL BY TVA AND THE ENGINEER. THIS PLAN SHALL ALSO BE IN ACCORDANCE WITH THE STORMWATER POLLUTION PREVENTION PLAN PRODUCED BY STANTEC FOR THE SITE. THE CONTRACTOR SHALL MAINTAIN THE SITE SUCH THAT WATER DOES NOT ACCUMULATE WITHIN CONSTRUCTION AREAS.

4.10 SPOIL DISPOSAL: EXCAVATED MATERIALS SHALL BE STOCKPILED OR DISPOSED OF IN AREAS TO BE DETERMINED BY TVA.

4.11 SEEDING: VEGETATION SHALL BE ESTABLISHED ON AREAS INDICATED IN THE PLANS BY SPRAYING THE AREAS WITH FLEXTERRA FGM AND HYDROSEEDING.

4.12 PIPE RESTRAINT FRENCH DRAINS U2 AND L2 HAVE SECTIONS OF PIPE WHICH ARE TO BE TEMPORARILY LOCATED ON THE EXISTING GROUND SURFACE RATHER THAN BELOW IT. THE CONTRACTOR SHALL SECURE THESE ABOVE-GROUND SECTIONS OF PIPE SUCH THAT THEY ARE RESTRAINED AND DO NOT SHIFT DUE TO WIND, SITE ACTIVITIES, ETC. THE PIPES SHALL BE SECURED EVERY 20 FEET USING RESTRAINTS SUCH AS POSTS OR STAKES, PILES OF GRAVEL, OR OTHER METHODS AGREED UPON BY THE CONTRACTOR AND THE ENGINEER.

5 CONSTRUCTION SEQUENCING

GIVEN THAT MULTIPLE ITEMS ARE TO BE CONSTRUCTED AT THE ASH POND COMPLEX AT BULL RUN, THE FOLLOWING CONSTRUCTION SCHEDULE SHALL BE FOLLOWED:

5.1 THE CONSTRUCTION OF THE BUTTRESS ALONG THE SOUTHERN BERM OF THE GYPSUM STACK HAS PRIORITY AND SHOULD BE CONSTRUCTED FIRST. SEE DRAWINGS 10W506-01 THROUGH 10W506-07.

5.2 THE LOWER FRENCH DRAINS (L1, L2, AND L3) HAVE PRIORITY OVER THE UPPER FRENCH DRAINS (U1, U2, AND U3). DRAIN L1 HAS THE HIGHEST PRIORITY OF ANY OF THE FRENCH DRAINS AND SHOULD BE INSTALLED FIRST AND AS SOON AS PRACTICAL. SEE DRAWINGS 10W508-03 THROUGH 09.

5.3 FRENCH DRAINS L1, L2, U1, AND U2 SHALL BE CONSTRUCTED BEFORE THE SLOPE REPAIR AND REGRADING OF THE WEST AND NORTH SLOPES OF THE GYPSUM STACK. SEE DRAWINGS 10W501-04, 10W501-06, 10W501-13, 10W501-14 AND 10W508-03 THROUGH 06.

5.4 FRENCH DRAINS L3 AND U3 MAY BE CONSTRUCTED EITHER BEFORE OF AFTER THE REGRADING OF THE EAST SLOPE OF THE GYPSUM STACK. SEE DRAWINGS 10W501-05 AND 10W508-03 AND 09.

5.5 DRAINAGE PIPING FROM THE REVERSE FILTER ON THE WESTERN SLOPE OF THE GYPSUM STACK WILL BE INSTALLED TO MANHOLE NO. 1 AFTER FRENCH DRAIN L1 HAS BEEN INSTALLED. SEE DRAWINGS 10W501-04, 10W501-13, AND 10W508-03 THROUGH 07 AND 10W508-12.

5.6 THE PIPE FOR FRENCH DRAIN U1 WILL BE INSTALLED TO MANHOLE NO. 2 AFTER FRENCH DRAIN L1 HAS BEEN INSTALLED. SEE DRAWINGS 10W508-03.

5.7 FRENCH DRAIN L2 AND U2 WILL NEED TO HAVE A TEMPORARY OUTFALL CONSTRUCTED UNTIL SLOPE REPAIR AND REGRADING IS COMPLETED. THE TEMPORARY OUTFALL SHALL BE AS SHOWN ON DRAWING 10W508-03 AND 10W508-04. ALSO SEE DRAWINGS 10W501-06 AND 10W501-13.

FOR SUPPORTING DESIGN CALCULATIONS SEE
FPGBRFFESCDX00000020110004

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT IS	AS CONST
R 5	3/14/12	LPC	YRC	KMB	KMB	RBC	MST	JCK	204013	
RECORD DRAWINGS										
R 0 1	5/7/10	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013	
ISSUED FOR CONSTRUCTION										

DISCIPLINE INTERFACE

KENNETH MONROE MARTIN — REGISTERED ENGINEER — AGRICULTURE — COMMONWEALTH OF KENTUCKY — No. 19114076 — STATE OF TENNESSEE — 3/14/2012

SCALE: NONE EXCEPT AS NOTED

GENERAL NOTES

WORK PLAN FOR GYPSUM STACK 2A URSGS001

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RECORD DRAWING

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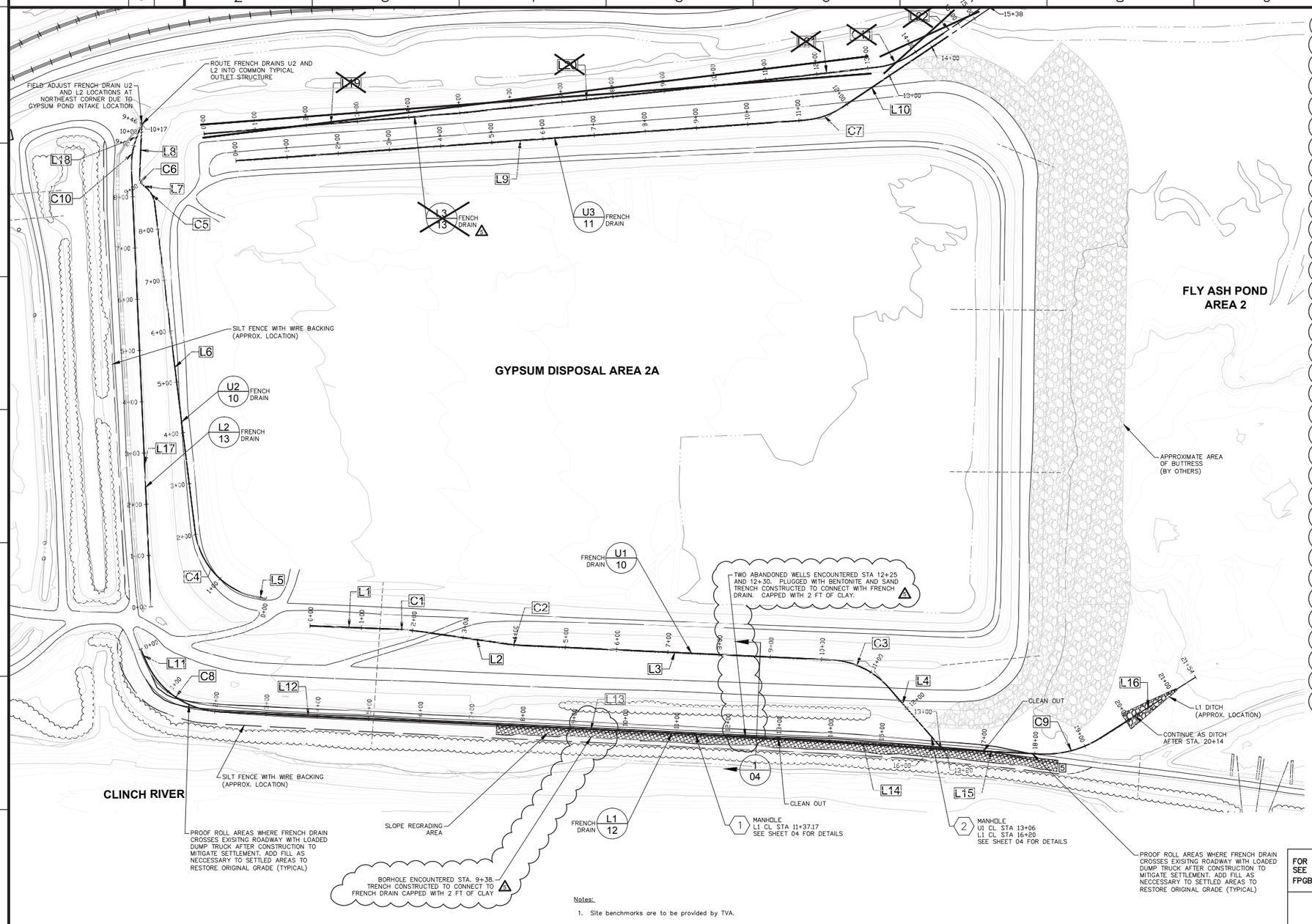

FRENCH DRAIN U1

Number	Start Station	End Station	Length	Radius	Line/Chord Direction	Start Easting	Start Northing	End Easting	End Northing
C1	1+51.99	2+29.18	77.186	750.000	S13° 22' 14.99"E	2545386.82	592603.19	2545404.67	592528.13
C2	3+89.61	4+08.80	19.183	200.000	S13° 10' 13.00"E	2545433.69	592370.34	2545438.06	592351.67
C3	10+17.96	11+47.02	129.053	160.000	S7° 11' 19.75"W	2545605.13	591765.86	2545589.41	591641.27
L1	0+00.00	1+51.99	151.995	N/A	S16° 19' 08.78"E	2545344.12	592749.06	2545386.82	592603.1904
L2	2+29.18	3+89.61	160.435	N/A	S10° 25' 21.20"E	2545404.67	592528.13	2545433.69	592370.3426
L3	4+08.80	10+17.96	609.165	N/A	S15° 55' 04.80"E	2545438.06	592351.67	2545605.13	591765.8648
L4	11+47.02	13+20.00	172.984	N/A	S30° 17' 44.31"W	2545589.41	591641.27	2545502.15	591491.9085

FRENCH DRAIN U2

Number	Start Station	End Station	Length	Radius	Line/Chord Direction	Start Easting	Start Northing	End Easting	End Northing
C4	0+19.07	2+07.27	188.192	150.000	N28° 25' 26.38"E	2545363.80	592865.45	2545447.62	593020.31
C5	8+50.00	8+89.27	39.270	50.000	N41° 51' 57.66"E	2546027.09	593298.37	2546052.63	593326.87
C6	8+92.98	9+11.98	19.001	20.000	N46° 34' 59.31"E	2546053.86	593330.37	2546067.15	593342.94
L5	0+00.00	0+19.07	19.075	N/A	N7° 31' 04.91"W	2545366.30	592846.54	2545363.80	592865.4527
L6	2+07.27	8+50.00	642.733	N/A	N64° 21' 57.66"E	2545447.62	593020.31	2546027.09	593298.3745
L7	8+89.27	8+92.98	3.707	N/A	N19° 21' 57.66"E	2546052.63	593326.87	2546053.86	593330.3703
L8	9+11.98	10+16.92	104.940	N/A	N73° 48' 00.95"E	2546067.15	593342.94	2546167.93	593372.2212

FRENCH DRAIN U3

Number	Start Station	End Station	Length	Radius	Line/Chord Direction	Start Easting	Start Northing	End Easting	End Northing
C7	11+11.48	11+89.40	77.913	150.000	S37° 34' 01.85"E	2546585.98	592149.64	2546632.95	592088.57
L9	0+00.00	11+11.48	1111.484	N/A	S22° 41' 12.97"E	2546157.29	593175.12	2546585.98	592149.6383
L10	11+89.40	15+37.64	348.245	N/A	S52° 26' 50.74"E	2546632.95	592088.57	2546909.04	591876.3216

FRENCH DRAIN L1

Number	Start Station	End Station	Length	Radius	Line/Chord Direction	Start Easting	Start Northing	End Easting	End Northing
C8	0+27.95	2+08.02	180.067	162.687	S15° 44' 57.21"W	2545175.17	593028.49	2545128.75	592863.90
C9	18+10.39	19+34.20	123.810	200.000	S33° 26' 39.94"E	2545561.06	591320.98	2545628.21	591219.32
L11	0+00.00	0+27.95	27.950	N/A	S47° 27' 27.48"W	2545195.76	593047.39	2545175.17	593028.4940
L12	2+08.02	5+56.94	348.920	N/A	S15° 57' 33.07"E	2545128.75	592863.90	2545224.69	592528.4273
L13	5+56.94	13+11.17	754.236	N/A	S15° 50' 28.69"E	2545224.69	592528.43	2545430.57	591802.8357
L14	13+11.17	16+19.84	308.664	N/A	S14° 48' 27.41"E	2545430.57	591802.84	2545509.46	591504.4223
L15	16+19.84	18+10.39	190.556	N/A	S15° 42' 35.91"E	2545509.46	591504.42	2545561.06	591320.9844
L16	19+34.20	21+54.14	219.936	N/A	S51° 10' 43.97"E	2545628.21	591219.32	2545799.56	591081.4409

FRENCH DRAIN L2

Number	Start Station	End Station	Length	Radius	Line/Chord Direction	Start Easting	Start Northing	End Easting	End Northing
C10	8+54.42	9+13.79	59.367	150.000	N80° 11' 16.51"E	2546077.13	593363.04	2546135.24	593373.09
L17	0+00.00	8+54.42	854.419	N/A	N68° 50' 59.05"E	2545280.26	593054.75	2546077.13	593363.0407
L18	9+13.79	9+46.48	32.693	N/A	S88° 28' 26.04"E	2546135.24	593373.09	2546167.93	593372.2212

FRENCH DRAIN L3

Number	Start Station	End Station	Length	Radius	Line/Chord Direction	Start Easting	Start Northing	End Easting	End Northing
C11	13+18.48	13+90.16	71.675	150.000	S38° 45' 30.74"E	2546266.76	592048.72	2546773.21	591993.36
L19	0+00.00	4+96.41	496.412	N/A	S23° 11' 29.70"E	2546187.33	593250.77	2546383.08	592794.5778
L20	4+96.41	10+00.80	504.386	N/A	S24° 44' 17.08"E	2546383.08	592794.58	2546594.15	592336.4789
L21	10+00.80	13+18.48	317.685	N/A	S25° 04' 10.74"E	2546594.15	592336.48	2546728.76	592048.7221
L22	13+90.16	15+66.54	176.386	N/A	S52° 26' 50.74"E	2546773.21	591993.36	2546913.05	591866.8556

Notes:

1. Site benchmarks are to be provided by TVA.

LEGEND

- AREA OF PROPOSED SLOPE REGRADE
- WATER LEVELS AT TIME OF SURVEY
- SILT FENCE (APPROX. LOCATION)
- CONSTRUCTION ACCESS RAMPS

RECORD DRAWING NOTES:

1. STRIKEOUT LINES REPRESENT PORTIONS OF THE ORIGINAL DESIGN THAT WERE NOT CONSTRUCTED. FRENCH DRAIN L3 WAS NOT CONSTRUCTED PER URS MEMO ISSUED DECEMBER 10, 2010.
2. REFER TO SHEETS 14-17 FOR AS-BUILT INFORMATION. (A)

RECORD DRAWING

FOR SUPPORTING DESIGN CALCULATIONS SEE FPGBRFFESCDX00000020110004

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST
R 5	3/14/12	LPC	YRC	KMB	KMB	RBC	MST	JCK	204013	
RECORD DRAWINGS										
R 0 1	5/7/10	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013	
ISSUED FOR CONSTRUCTION										

SCALE: NONE EXCEPT AS NOTED

SUBSURFACE FRENCH DRAIN AND SLOPE IMPROVEMENT PLAN

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
LPC	YRC	KMB	KMB	RBC	MST	JCK

URS CORPORATION
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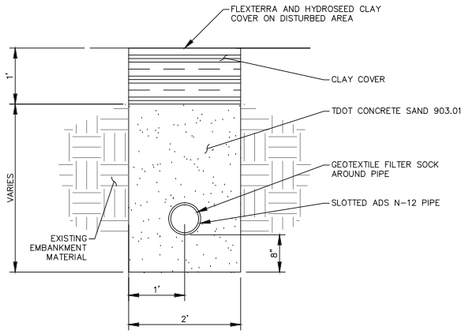
BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2010 | DATE 3/14/12 | 49 | C | 10W508-03 | R 5

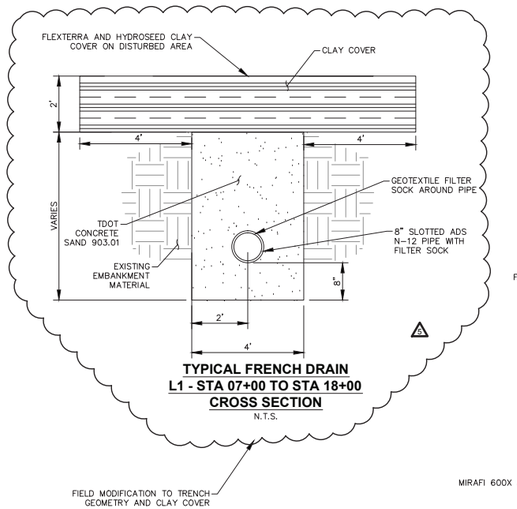
URS CORPORATION	5
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

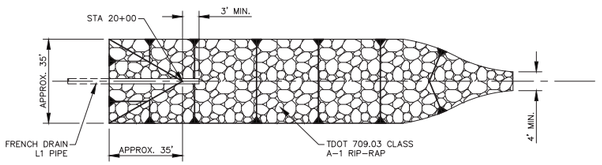
C.A.D. DRAWING
DO NOT ALTER MANUALLY



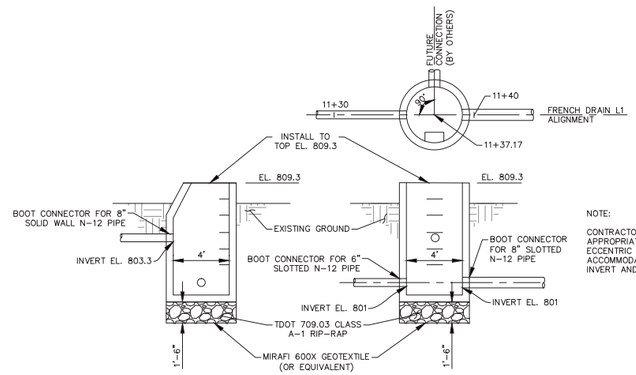
TYPICAL FRENCH DRAIN CROSS SECTION
N.T.S.



TYPICAL FRENCH DRAIN L1 - STA 07+00 TO STA 18+00 CROSS SECTION
N.T.S.

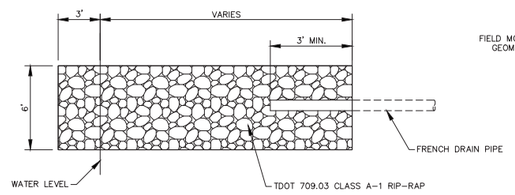


PIPE OUTFALL PLAN
N.T.S.

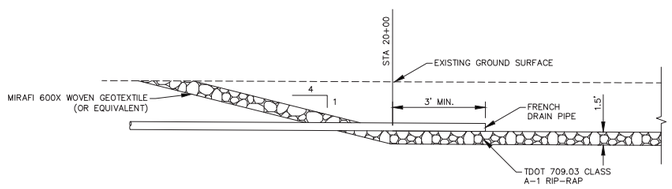


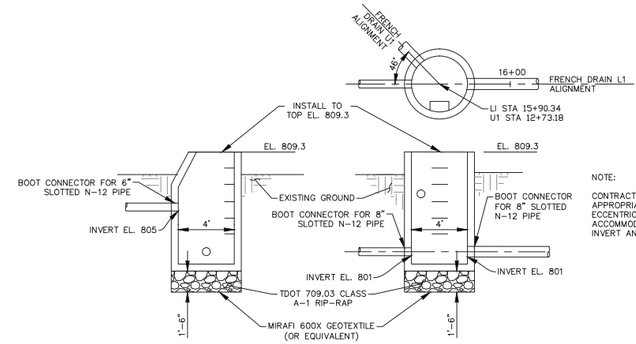
NOTE:
CONTRACTOR TO SELECT APPROPRIATE BASE, RISER, & ECCENTRIC CONE HEIGHTS TO ACCOMMODATE SPECIFIED INVERT AND TOP ELEVATIONS

MANHOLE 1 DETAILS
N.T.S.



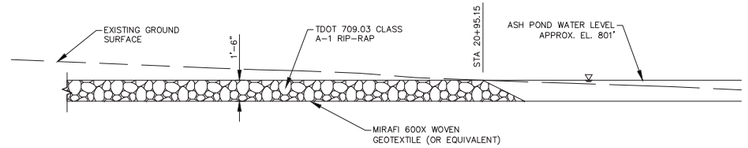
TYPICAL FRENCH DRAIN OUTFALL PLAN
N.T.S.





NOTE:
CONTRACTOR TO SELECT APPROPRIATE BASE, RISER, & ECCENTRIC CONE HEIGHTS TO ACCOMMODATE SPECIFIED INVERT AND TOP ELEVATIONS

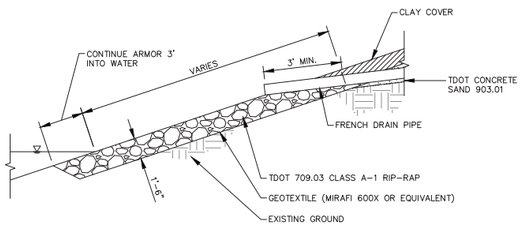
MANHOLE 2 DETAILS
N.T.S.



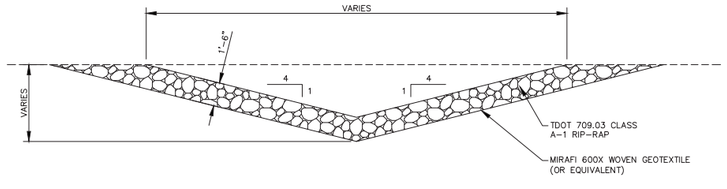
NOTES:

1. MAINTAIN MINIMUM TRENCH WIDTH OF 4 FT. EXCAVATE BELOW GRADE SHOWN TO MAINTAIN TRENCH WIDTH & 4:1 SLOPES IF NECCESSARY
2. CONTINUE GEOTEXTILE & RIP-RAP 3' INTO WATER ALONG EXISTING GROUND SURFACE

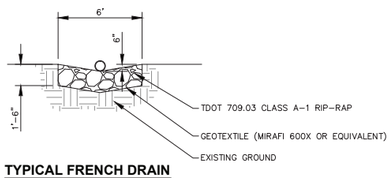
PIPE OUTFALL PROFILES
N.T.S.



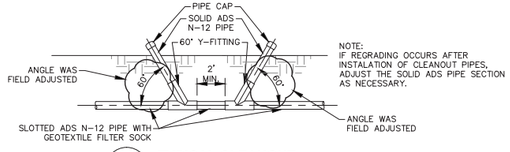
TYPICAL FRENCH DRAIN OUTFALL PROFILE
N.T.S.



PIPE OUTFALL SECTION
N.T.S.

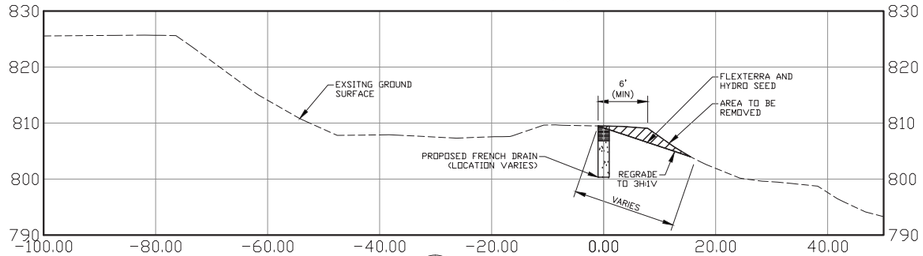


TYPICAL FRENCH DRAIN OUTFALL SECTION
N.T.S.



NOTE:
IF REGRADING OCCURS AFTER INSTALATION OF CLEANOUT PIPES, ADJUST THE SOLID ADS PIPE SECTION AS NECESSARY.

D1/12 **TYPICAL CLEANOUT**
N.T.S.



1/03 **TYPICAL SECTION**
0 10'

2/03 **FRENCH DRAIN L1 OUTFALL DETAILS**

RECORD DRAWING

FOR SUPPORTING DESIGN CALCULATIONS SEE FPGBRFFESCDX00000020110004

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST
R 5	3/14/12	LPC	YRC	KMB	KMB	RBC	MST	JCK	204013	
RECORD DRAWINGS										
R 0	5/7/10	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013	
ISSUED FOR CONSTRUCTION										

DISCIPLINE INTERFACE: D

KENNETH MONROE BERRY, REGISTERED ENGINEER, AGRICULTURE & BIOSYSTEMS, No. 0011401B, STATE OF TENNESSEE, 3/14/2012

SCALE: NONE EXCEPT AS NOTED

TYPICAL SECTIONS & DETAILS

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
LPC	YRC	KMB	KMB	RBC	MST	JCK

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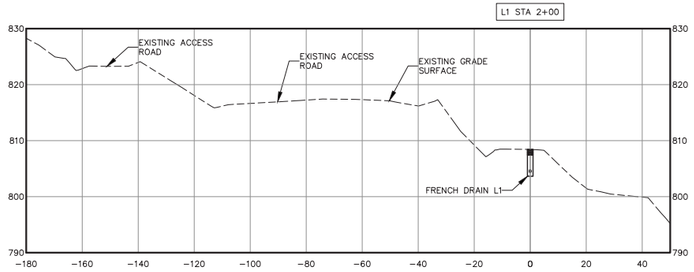
BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

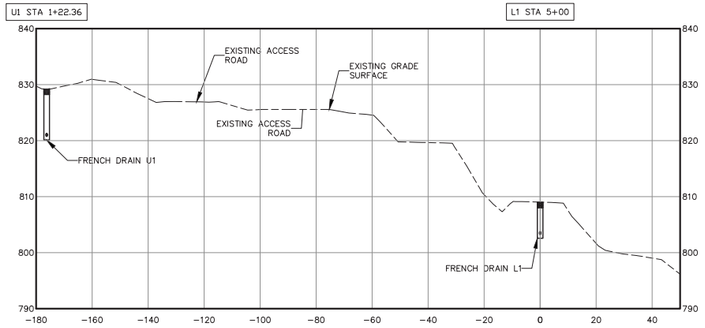
AUTOCAD R2010 | DATE 3/14/12 | 49 | C | 10W508-04 | R 5

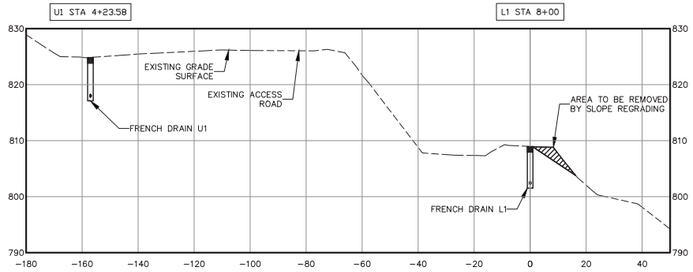
URS CORPORATION	5
TASK COMPLETED BY:	REV NO.

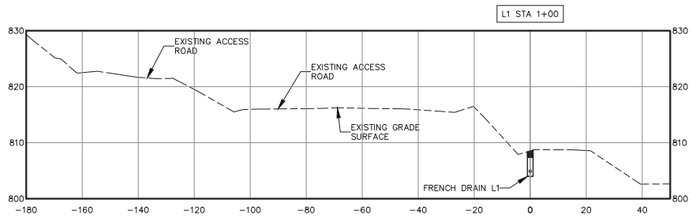
PLOT FACTOR:XX
W_TVA

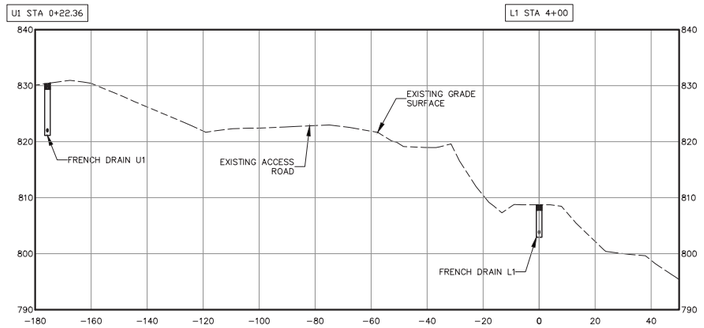
C.A.D. DRAWING DO NOT ALTER MANUALLY

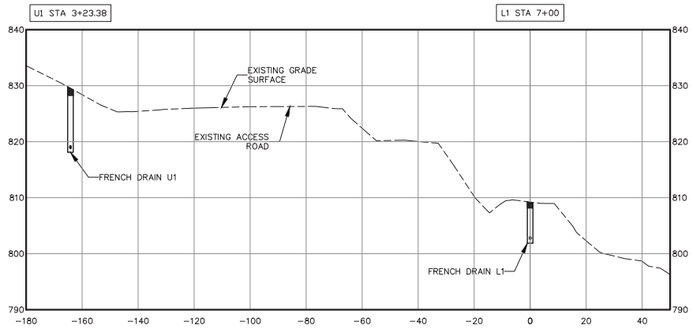


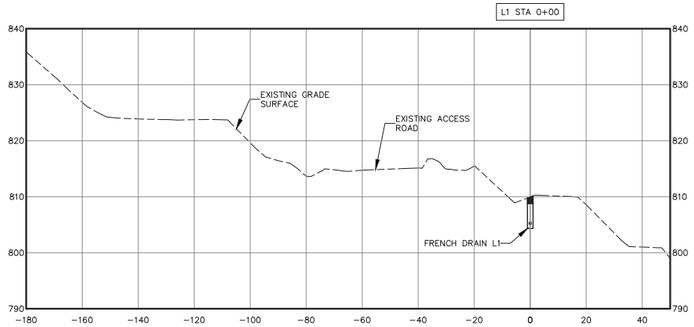


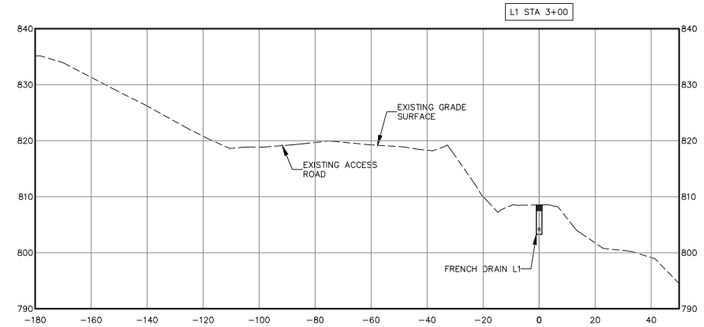


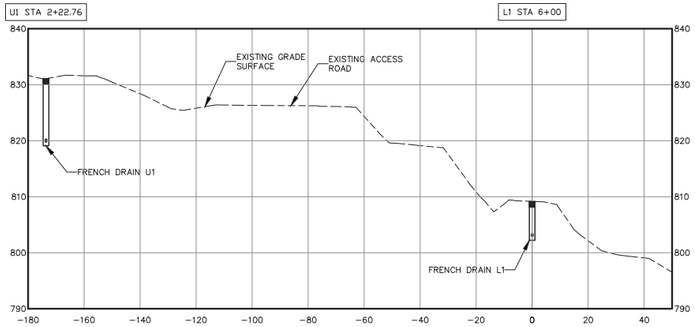












0 20
1"=20' HORZ.

0 10
1"=10' VERT.

RECORD DRAWING NOTES:

1. REFER TO SHEETS 14-17 FOR AS-BUILT INFORMATION. (1)

RECORD DRAWING

FOR SUPPORTING DESIGN CALCULATIONS SEE
FPGBRFFESCDX000000020110004

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV. CD
R 5	3/14/12	LPC	YRC	KMB	KMB	RBC	MST	JCK	204013		J
RECORD DRAWINGS											
R 0	5/7/10	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013		D
ISSUED FOR CONSTRUCTION											

DISCIPLINE INTERFACE

SCALE: NONE EXCEPT AS NOTED

FRENCH DRAIN L1 & U1 CROSS SECTIONS (1 OF 3)

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

KENNETH MONROE BERRY — REGISTERED ENGINEER — AGRICULTURE — COMMERCE — No. 20114018 — STATE OF TENNESSEE — 3/14/2012

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
LPC	YRC	KMB	KMB	RBC	MST	JCK

URS CORPORATION
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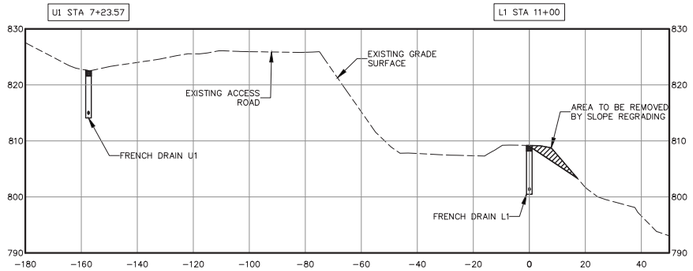
BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

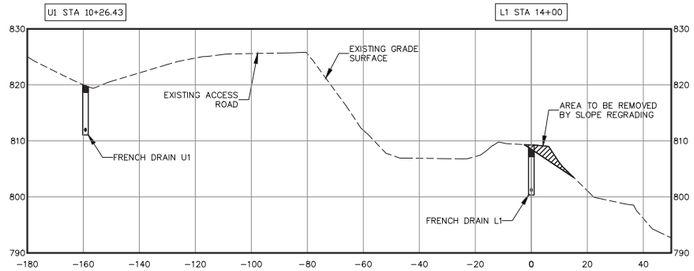
AUTOCAD R2010 | DATE 3/14/12 | 49 | C | 10W508-05 | R 5

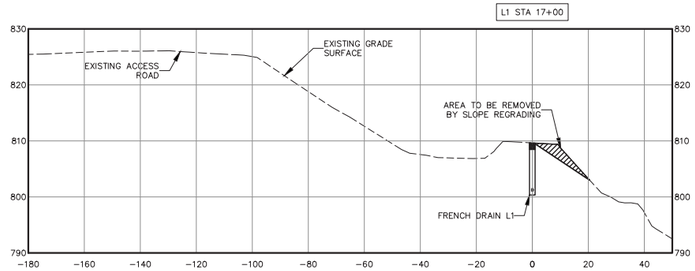
URS CORPORATION	5
TASK COMPLETED BY:	REV NO.

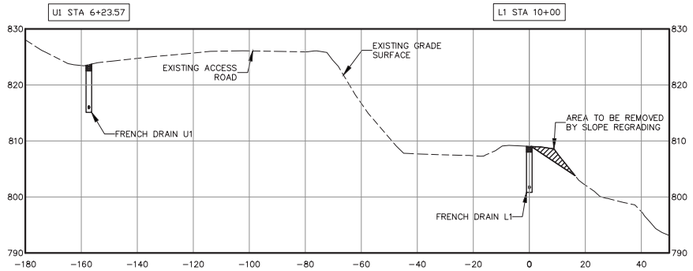
PLOT FACTOR:XX
W_TVA

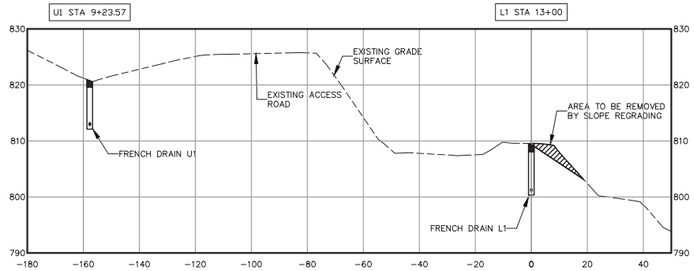
C.A.D. DRAWING
DO NOT ALTER MANUALLY

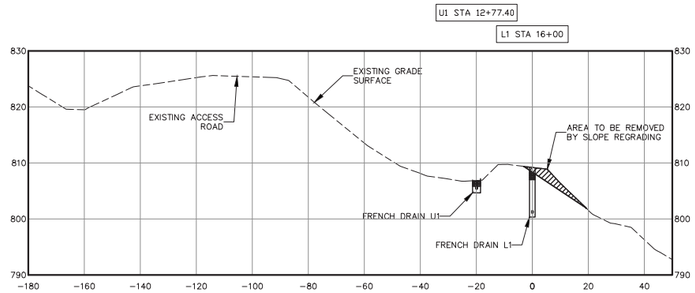


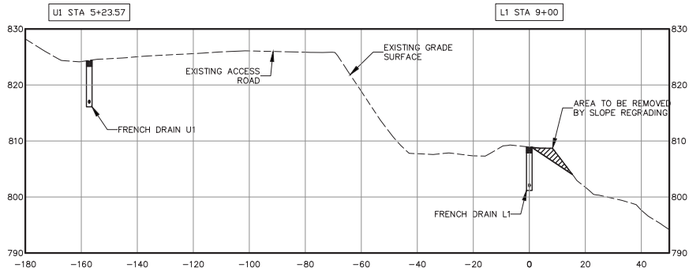


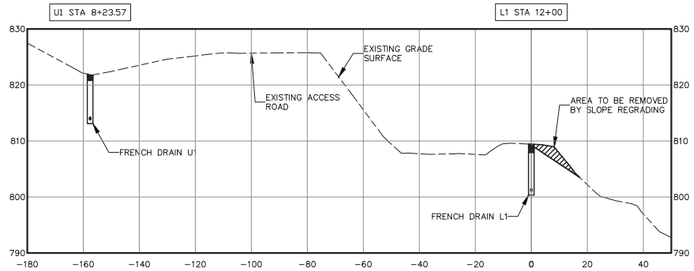


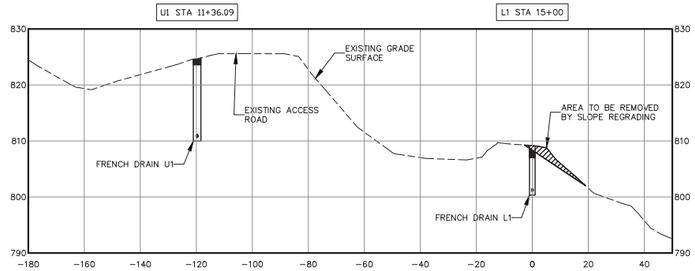












0 20
1"=20' HORZ.

0 10
1"=10' VERT.

RECORD DRAWING NOTES:

1. REFER TO SHEETS 14-17 FOR AS-BUILT INFORMATION.

RECORD DRAWING

FOR SUPPORTING DESIGN CALCULATIONS SEE FPGBRFFESCDX00000020110004

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
R 5	3/14/12	LPC	YRC	KMB	KMB	RBC	MST	JCK	204013		J
RECORD DRAWINGS											
R 0	5/7/10	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013		D
ISSUED FOR CONSTRUCTION											

DISCIPLINE INTERFACE
1 CE
2
3
4

SCALE: NONE EXCEPT AS NOTED

KENNETH MONROE BERRY REGISTERED ENGINEER STATE OF TENNESSEE AGRICULTURE COMMERCE No. 0011614 3/14/2012

FRENCH DRAIN L1 & U1 CROSS SECTIONS (2 OF 3)

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
LPC	YRC	KMB	KMB	RBC	MST	JCK

URS CORPORATION
1001 HIGHLANDS PLAZA DR. WEST
SUITE 300
ST. LOUIS, MISSOURI 63110
PHONE (314) 429-0100
FAX (314) 429-0462
WWW.URSCORP.COM

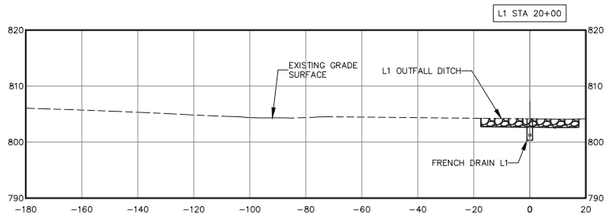
BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

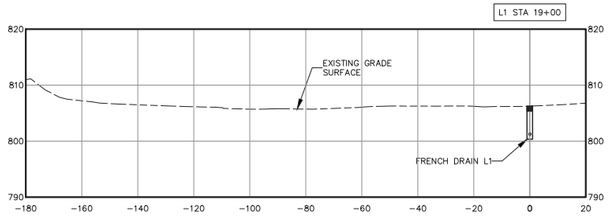
AUTOCAD R2010	DATE 3/14/12	49	C	10W508-06	R 5

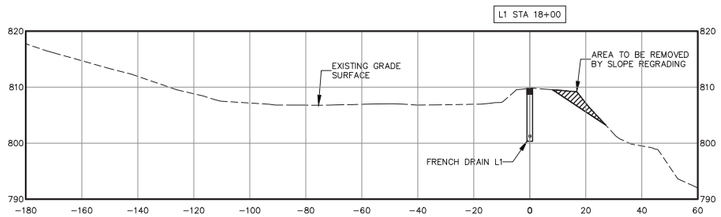
URS CORPORATION	5
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY







RECORD DRAWING NOTES:

1. REFER TO SHEETS 14–17 FOR AS–BUILT INFORMATION.

△5

RECORD DRAWING

0 20
1"=20' HORZ.

0 10
1"=10' VERT.

FOR SUPPORTING DESIGN CALCULATIONS SEE
FPGBRFFESCDX00000020110004

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ENGR	AS CONST	REV. CTR
R 5	3/14/12	LPC	YRC	KMB	KMB	RBC	MST	JCK	204013		J
RECORD DRAWINGS											
R 0	5/7/10	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013		D
ISSUED FOR CONSTRUCTION											

DISCIPLINE INTERFACE

KENNETH MONROE BURT — REGISTERED ENGINEER — AGRICULTURE — STATE OF TENNESSEE — 3/14/2012

SCALE: NONE — EXCEPT AS NOTED

FRENCH DRAIN L1 & U1 CROSS SECTIONS (3 OF 3)

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
LPC	YRC	KMB	KMB	RBC	MST	JCK

URS CORPORATION
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WWW.URSCORP.COM

BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

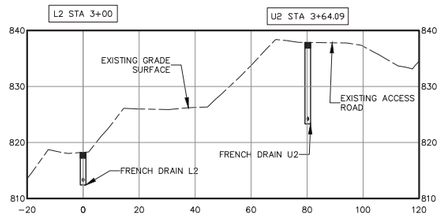
AUTOCAD R2010	DATE 3/14/12	49	C	10W508–07	R 5

URS CORPORATION	5
TASK COMPLETED BY:	REV NO.

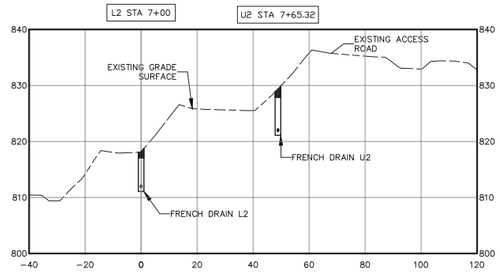
PLOT FACTOR: XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

L2 STA 3+00 / U2 STA 3+64.09



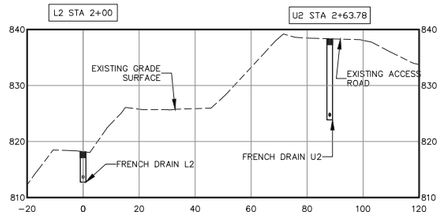
L2 STA 7+00 / U2 STA 7+65.32



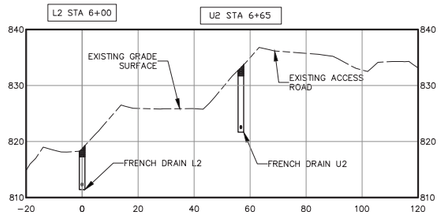
RECORD DRAWING NOTES:

1. REFER TO SHEETS 14–17 FOR AS–BUILT INFORMATION. (1)

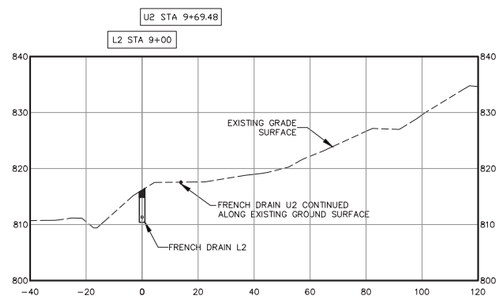
L2 STA 2+00 / U2 STA 2+63.78



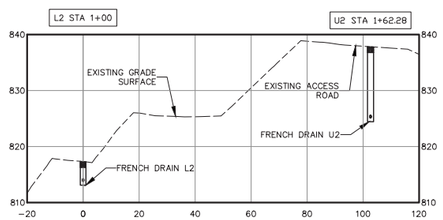
L2 STA 6+00 / U2 STA 6+65



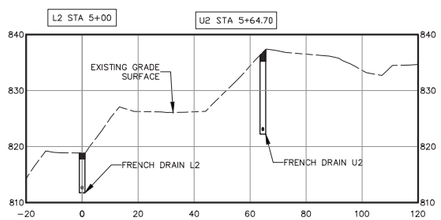
U2 STA 9+69.48 / L2 STA 9+00



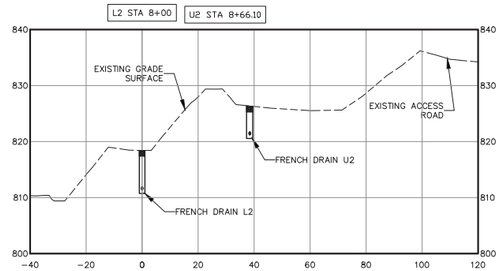
L2 STA 1+00 / U2 STA 1+62.28



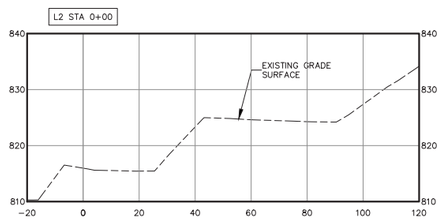
L2 STA 5+00 / U2 STA 5+64.70



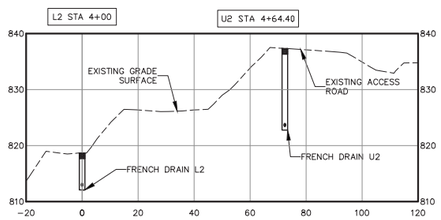
L2 STA 8+00 / U2 STA 8+66.10



L2 STA 0+00



L2 STA 4+00 / U2 STA 4+64.40



RECORD DRAWING

0 20
1"=20' HORZ.

0 10
1"=10' VERT.

FOR SUPPORTING DESIGN CALCULATIONS SEE FPGBRFFESCDX00000020110004

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ENGR	AS CONST
R 5	3/14/12	LPC	YRC	KMB	KMB	RBC	MST	JCK	204013	
RECORD DRAWINGS										
R 0	5/7/10	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013	
ISSUED FOR CONSTRUCTION										

DISCIPLINE INTERFACE: 1 2 3 4

SCALE: NONE — EXCEPT AS NOTED

KENNETH MONROE BRENT — REGISTERED ENGINEER — AGRICULTURE — STATE OF TENNESSEE — No. 00114016 — 3/14/2012

FRENCH DRAIN L2 & U2 CROSS SECTIONS

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
LPC	YRC	KMB	KMB	RBC	MST	JCK

URS CORPORATION
1001 HIGHLANDS PLAZA DR. WEST
SUITE 300
ST. LOUIS, MISSOURI 63110
PHONE (314) 429-0100
FAX (314) 429-0462
WWW.URSCORP.COM

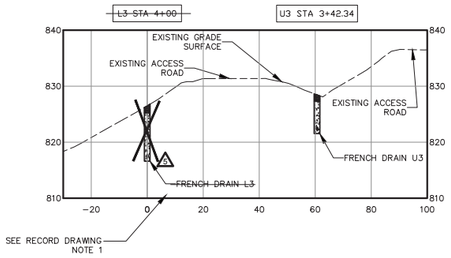
BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

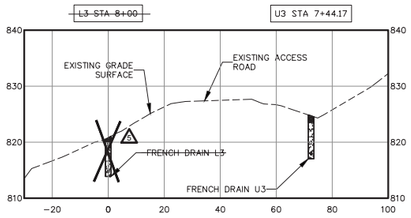
AUTOCAD R2010 | DATE 3/14/12 | 49 | C | 10W508–08 | R 5

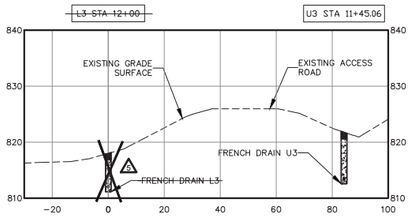
URS CORPORATION	5
TASK COMPLETED BY:	REV NO.

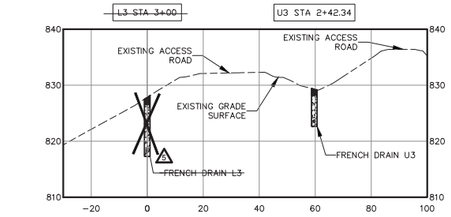
PLOT FACTOR:XX
W_TVA

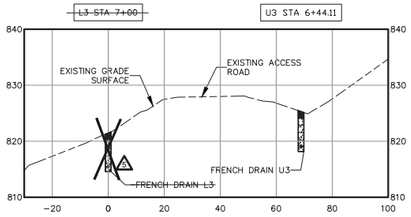
C.A.D. DRAWING
DO NOT ALTER MANUALLY

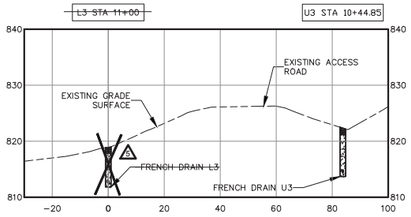


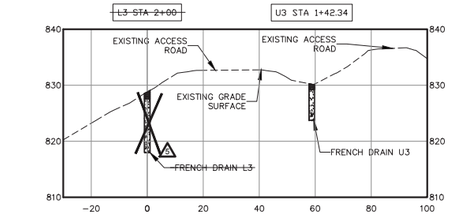


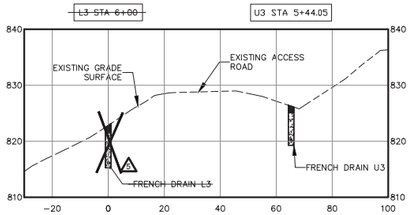


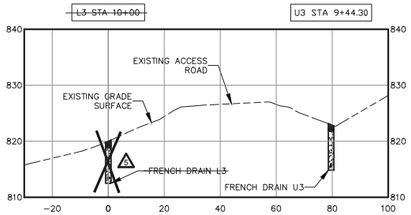


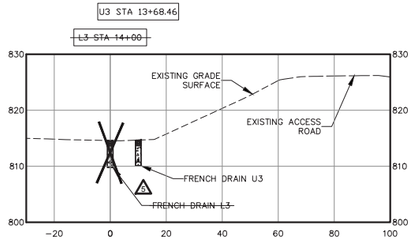


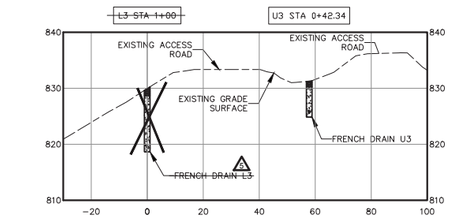


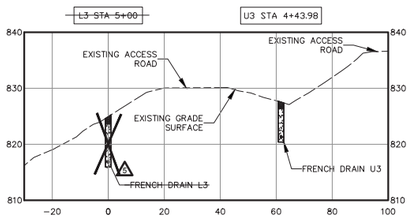


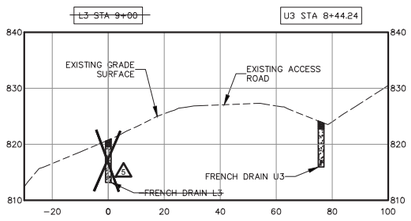


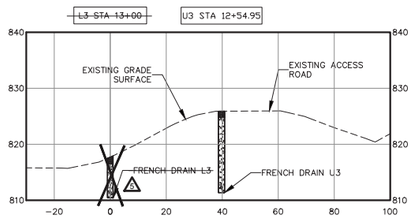












0 20
1"=20' HORZ.

0 10
1"=10' VERT.

RECORD DRAWING NOTES:

1. STRIKEOUT LINES REPRESENT PORTIONS OF THE ORIGINAL DESIGN THAT WERE NOT CONSTRUCTED. FRENCH DRAIN L3 WAS NOT CONSTRUCTED PER URS MEMO ISSUED DECEMBER 10, 2010.
2. REFER TO SHEETS 14-17 FOR AS-BUILT INFORMATION.

RECORD DRAWING

FOR SUPPORTING DESIGN CALCULATIONS SEE
FPGBRFFESCDX00000020110004

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV. CLK
R 5	3/14/12	LPC	YRC	KMB	KMB	RBC	MST	JCK	204013		J
RECORD DRAWINGS											
R 0	5/7/10	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013		D
ISSUED FOR CONSTRUCTION											

DISCIPLINE INTERFACE

SCALE: NONE EXCEPT AS NOTED

FRENCH DRAIN ~~L3 &~~ U3 CROSS SECTIONS

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

KENNETH MONROE BERRY — REGISTERED ENGINEER — STATE OF TENNESSEE — 3/14/2012

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
LPC	YRC	KMB	KMB	RBC	MST	JCK

URS CORPORATION
1001 HIGHLANDS PLAZA DR. WEST
SUITE 300
ST. LOUIS, MISSOURI 63110
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FAX (314) 429-0462
WWW.URSCORP.COM

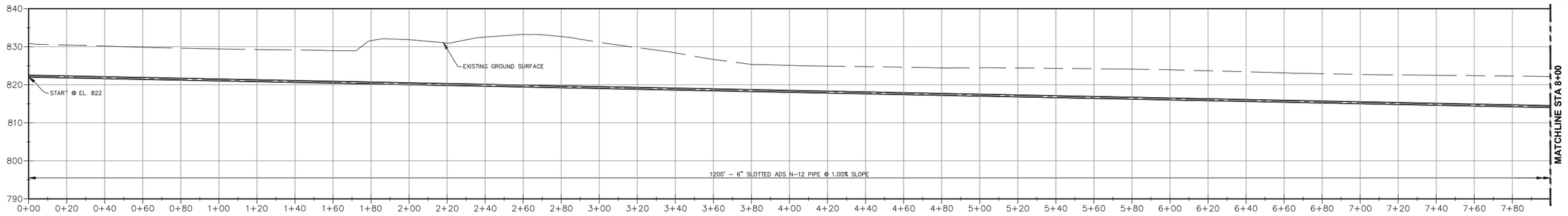
BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2010	DATE 3/14/12	49	C	10W508-09	R 5

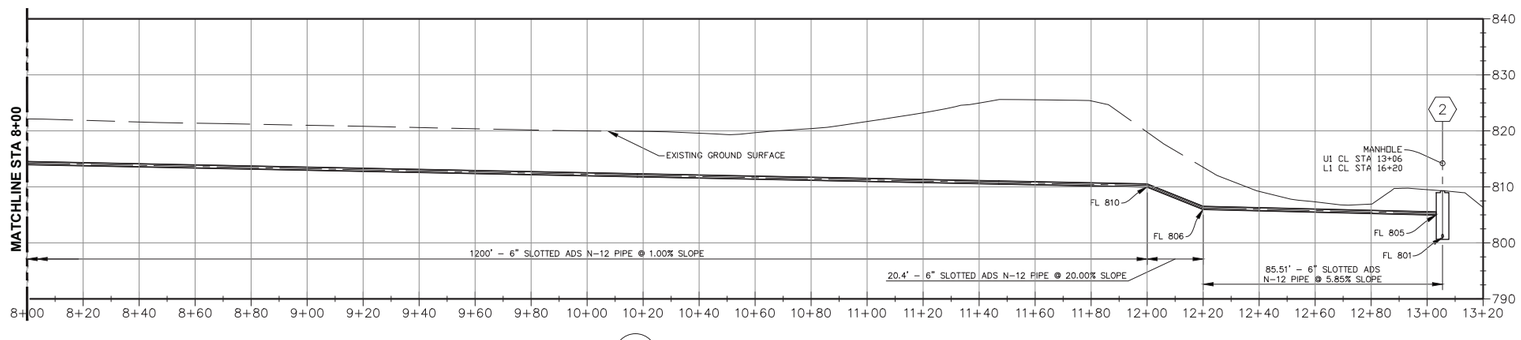
URS CORPORATION	5
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

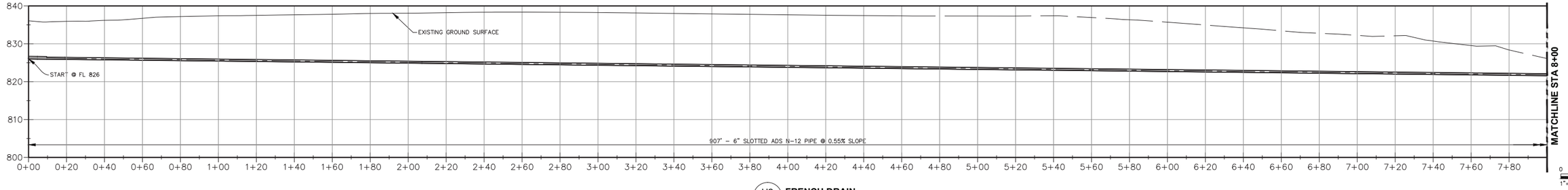
C.A.D. DRAWING
DO NOT ALTER MANUALLY



U1 03 **FRENCH DRAIN**



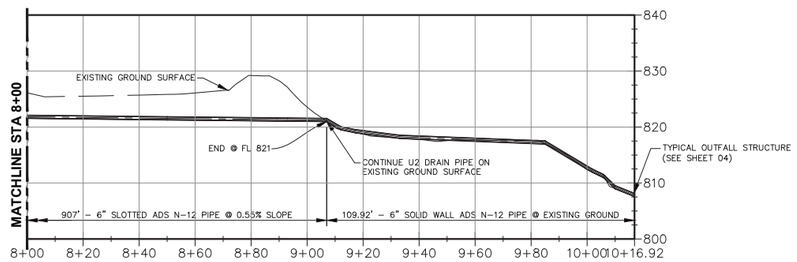
U1 03 **FRENCH DRAIN**



U2 03 **FRENCH DRAIN**

0 20
1"=20' HORZ.

0 10
1"=10' VERT.



U2 03 **FRENCH DRAIN**

RECORD DRAWING NOTES:

1. REFER TO SHEETS 14–17 FOR AS–BUILT INFORMATION. (A)

RECORD DRAWING

FOR SUPPORTING DESIGN CALCULATIONS SEE FPGBRFFESCDX00000020110004

KENNETH MONROE BARR — REGISTERED ENGINEER — AGRICULTURAL — No. 091140181 — STATE OF TENNESSEE — 3/14/2012

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT IS	AS CONST	REV. CD
R 5	3/14/12	LPC	YRC	KMB	KMB	RBC	MST	JCK	204013		J
RECORD DRAWINGS											
R 0	5/7/10	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013		D
ISSUED FOR CONSTRUCTION											

DISCIPLINE INTERFACE

SCALE: NONE — EXCEPT AS NOTED

FRENCH DRAIN U1 & U2 PROFILES

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
LPC	YRC	KMB	KMB	RBC	MST	JCK

URS CORPORATION
1001 HIGHLANDS PLAZA DR. WEST
SUITE 300
ST. LOUIS, MISSOURI 63110
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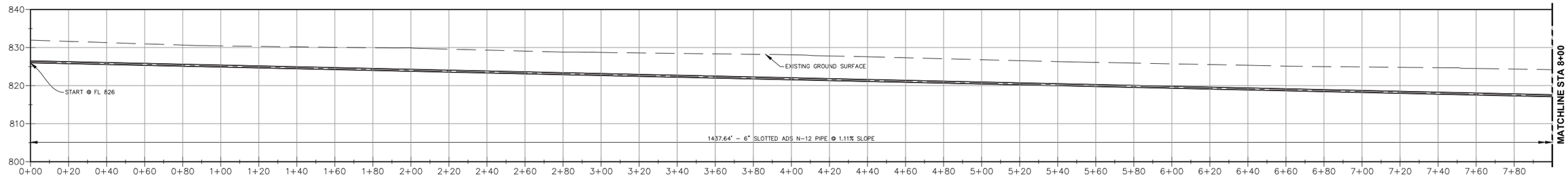
BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2010 | DATE 3/14/12 | 49 | C | 10W508-10 | R 5

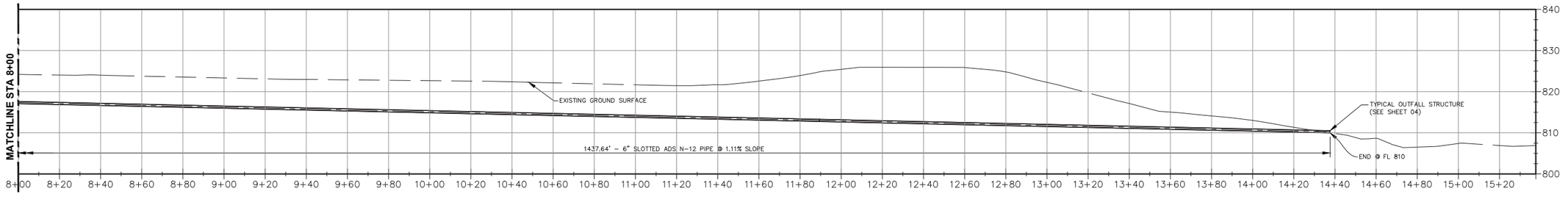
URS CORPORATION	5
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING DO NOT ALTER MANUALLY



U3/03 **FRENCH DRAIN**



U3/03 **FRENCH DRAIN**

RECORD DRAWING NOTES:

1. REFER TO SHEETS 14–17 FOR AS–BUILT INFORMATION. (A)

RECORD DRAWING

0 20
1"=20' HORZ.

0 10
1"=10' VERT.

FOR SUPPORTING DESIGN CALCULATIONS SEE
FPGBRFFESCDX00000020110004

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST
R 5	3/14/12	LPC	YRC	KMB	KMB	RBC	MST	JCK	204013	
RECORD DRAWINGS										
R 0	5/7/10	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013	
ISSUED FOR CONSTRUCTION										

KENNETH MONROE BERRY — REGISTERED ENGINEER — AGRICULTURE — COMMENTS — No. 091140116 — STATE OF TENNESSEE
3/14/2012

SCALE: NONE EXCEPT AS NOTED

FRENCH DRAIN U3 PROFILE

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
LPC	YRC	KMB	KMB	RBC	MST	JCK

URS CORPORATION
1001 HIGHLANDS PLAZA DR. WEST
SUITE 300
ST. LOUIS, MISSOURI 63110
PHONE (314) 429-0100
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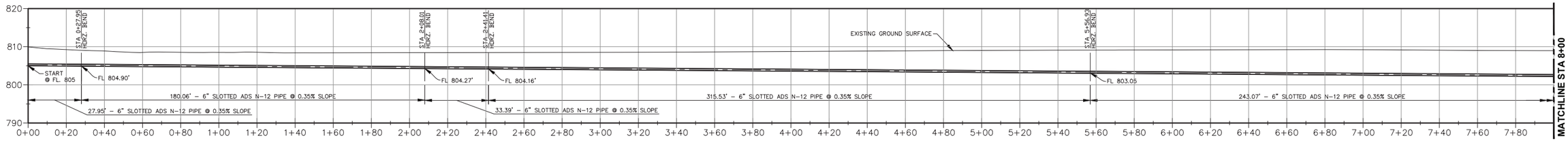
BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2010 | DATE 3/14/12 | 49 | C | 10W508–11 | R 5

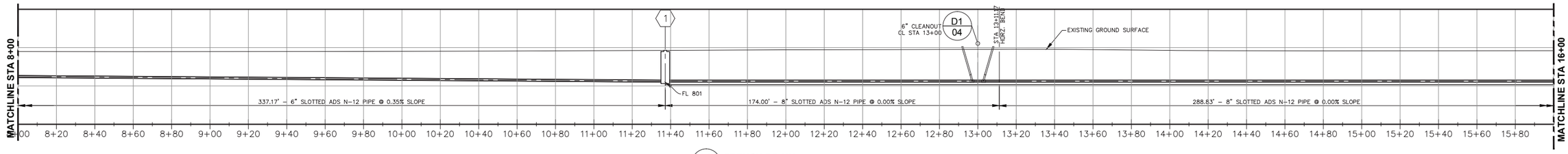
URS CORPORATION	5
TASK COMPLETED BY:	REV NO.

PLOT FACTOR: XX
W_TVA

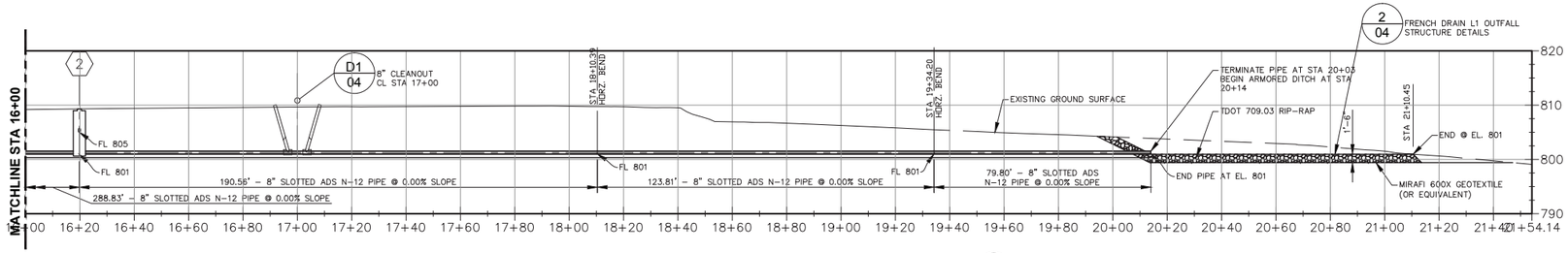
C.A.D. DRAWING
DO NOT ALTER MANUALLY



L1 / 03 **FRENCH DRAIN**



L1 / 03 **FRENCH DRAIN**



L1 / 03 **FRENCH DRAIN**

2 / 04 FRENCH DRAIN L1 OUTFALL STRUCTURE DETAILS

0 20 1"=20' HORZ.

0 10 1"=10' VERT.

RECORD DRAWING NOTES:

1. REFER TO SHEETS 14–17 FOR AS–BUILT INFORMATION. (A)

RECORD DRAWING

FOR SUPPORTING DESIGN CALCULATIONS SEE FPGBRFFESCDX00000020110004

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST
R 5	3/14/12	LPC	YRC	KMB	KMB	RBC	MST	JCK	204013	J
RECORD DRAWINGS										
R 0	5/7/10	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013	D
ISSUED FOR CONSTRUCTION										

DISCIPLINE INTERFACE

SCALE: NONE EXCEPT AS NOTED

FRENCH DRAIN L1 PROFILE

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
LPC	YRC	KMB	KMB	RBC	MST	JCK

URS CORPORATION
1001 HIGHLANDS PLAZA DR. WEST
SUITE 300
ST. LOUIS, MISSOURI 63110
PHONE (314) 429-0100
FAX (314) 429-0462
WWW.URSCORP.COM

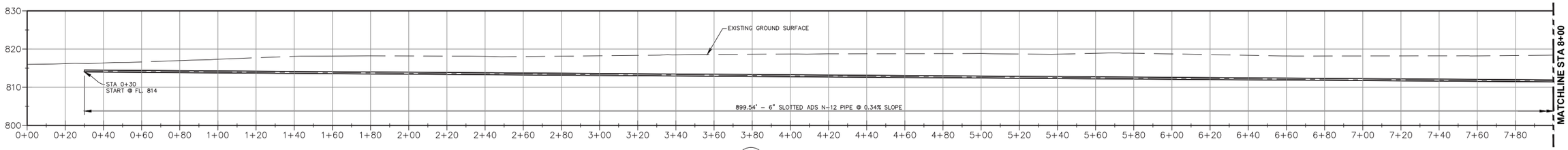
BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2010 | DATE 3/14/12 | 49 | C | 10W508–12 | R 5

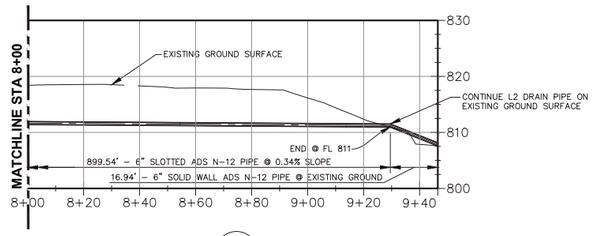
URS CORPORATION	5
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

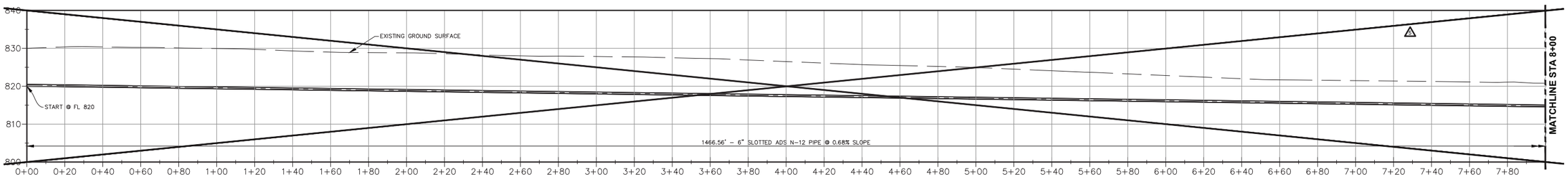
C.A.D. DRAWING DO NOT ALTER MANUALLY



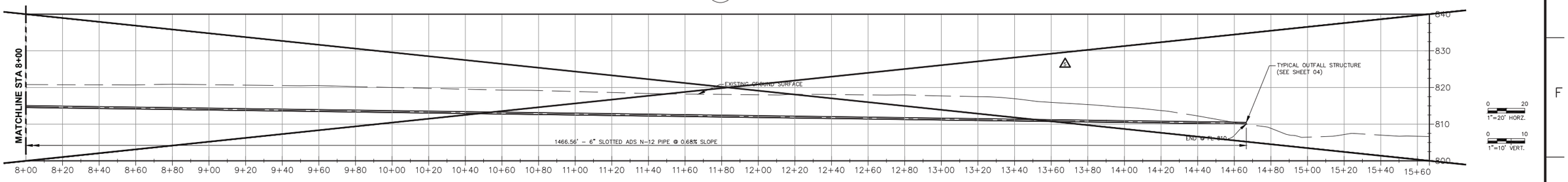
L2 03 **FRENCH DRAIN**



L2 03 **FRENCH DRAIN**



L3 03 **FRENCH DRAIN**



L3 03 **FRENCH DRAIN**

A RECORD DRAWING NOTES:

1. STRIKEOUT LINES REPRESENT PORTIONS OF THE ORIGINAL DESIGN THAT WERE NOT CONSTRUCTED. FRENCH DRAIN L3 WAS NOT CONSTRUCTED PER URS MEMO ISSUED DECEMBER 10, 2010.
2. REFER TO SHEETS 14-17 FOR AS-BUILT INFORMATION.

RECORD DRAWING

FOR SUPPORTING DESIGN CALCULATIONS SEE FPGBRFFESCDX00000020110004

KENNETH MONROE BEARY — REGISTERED ENGINEER — AGRICULTURE — CIVIL — STRUCTURES — COMMERCE — No. 0019407 — STATE OF TENNESSEE — 3/14/2012

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
R 5	3/14/12	LPC	YRC	KMB	KMB	RBC	MST	JCK	204013		J
RECORD DRAWINGS											
R 0	5/7/10	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013		D
ISSUED FOR CONSTRUCTION											

DISCIPLINE INTERFACE

SCALE: NONE EXCEPT AS NOTED

FRENCH DRAIN L2 ~~& L3~~ PROFILES

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
LPC	YRC	KMB	KMB	RBC	MST	JCK

URS CORPORATION
1001 HIGHLANDS PLAZA DR. WEST
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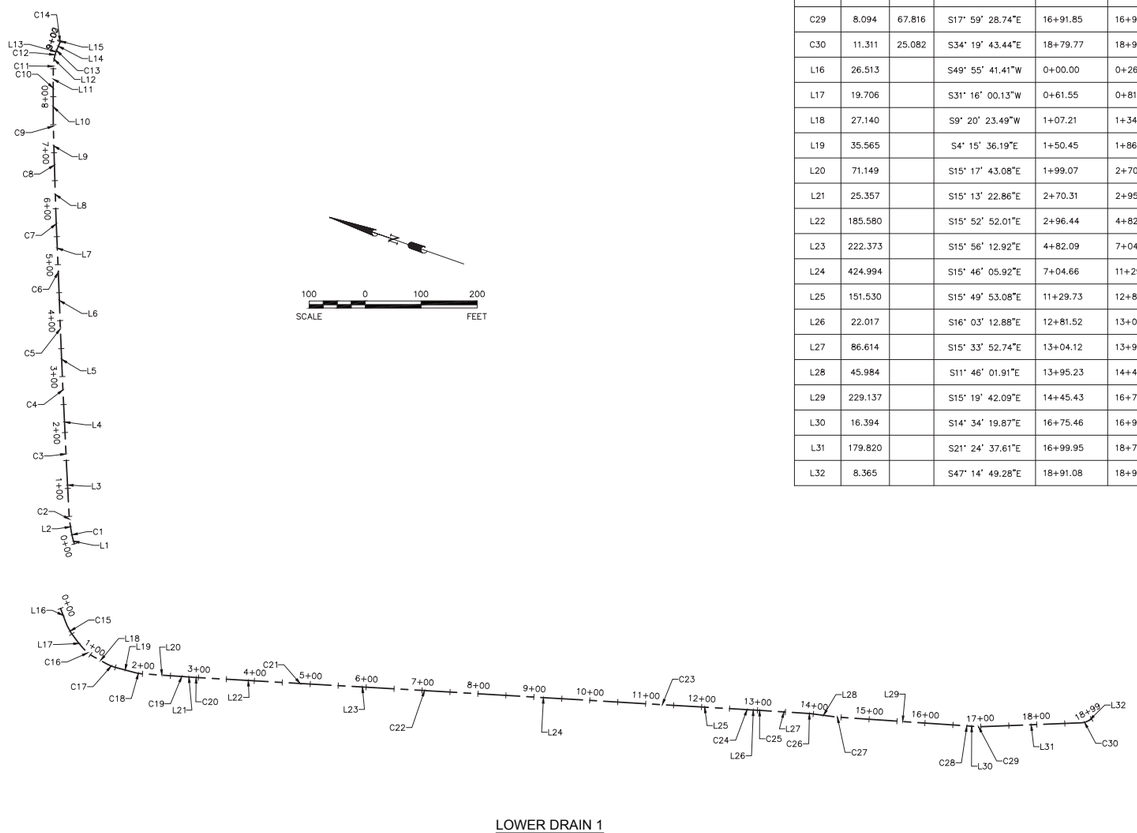
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R2010 | DATE 3/14/12 | 49 | C | 10W508-13 | R 5

URS CORPORATION	5
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY



LOWER DRAIN 1

LOWER DRAIN 1

Number	Length	Radius	Line/Chord Direction	Start Station	End Station	Start Northing	Start Easting	End Northing	End Easting
C15	35.038	107.576	S40° 35' 50.77"W	0+26.51	0+61.55	593025.0513	2545173.3653	592998.5646	2545150.6655
C16	25.953	67.816	S20° 18' 11.81"W	0+81.26	1+07.21	592981.7210	2545140.4378	592957.5290	2545131.4873
C17	16.097	67.816	S2° 32' 23.65"W	1+34.35	1+50.45	592930.7485	2545127.0827	592914.7051	2545126.3711
C18	13.061	67.816	S9° 46' 39.64"E	1+86.01	1+99.07	592879.2387	2545129.0129	592866.3869	2545131.2277
C19	0.086	67.816	S15° 15' 32.97"E	2+70.22	2+70.31	592797.7578	2545149.9964	592797.6753	2545150.0189
C20	0.779	67.816	S15° 33' 07.44"E	2+95.66	2+96.44	592773.2080	2545156.6771	592772.4576	2545156.8860
C21	0.066	67.816	S15° 54' 32.47"E	4+82.02	4+82.09	592593.9609	2545207.6685	592593.8974	2545207.6866
C22	0.200	67.816	S15° 51' 09.42"E	7+04.46	7+04.66	592380.0713	2545268.7455	592379.8793	2545268.8001
C23	0.075	67.816	S15° 47' 59.50"E	11+29.66	11+29.73	591970.8788	2545384.2913	591970.8069	2545384.3116
C24	0.263	67.816	S15° 56' 32.98"E	12+81.26	12+81.52	591825.0248	2545425.6501	591824.7720	2545425.7223
C25	0.579	67.816	S15° 48' 32.81"E	13+03.54	13+04.12	591803.6139	2545431.8108	591803.0570	2545431.9684
C26	4.495	67.816	S13° 39' 57.33"E	13+90.73	13+95.23	591719.6193	2545455.2092	591715.2527	2545456.2709
C27	4.215	67.816	S13° 32' 52.00"E	14+41.21	14+45.43	591670.2355	2545465.6486	591666.1385	2545466.6358
C28	0.895	67.816	S14° 57' 00.98"E	16+74.56	16+75.46	591445.1530	2545527.2081	591444.2883	2545527.4390
C29	8.094	67.816	S17° 59' 28.74"E	16+91.85	16+99.95	591428.4219	2545531.5637	591420.7284	2545534.0622
C30	11.311	25.082	S34° 19' 43.44"E	18+79.77	18+91.08	591253.3175	2545599.7050	591244.0560	2545606.0296
L16	26.513		S49° 55' 41.41"W	0+00.00	0+26.51	593042.1191	2545193.6542	593025.0513	2545173.3653
L17	19.706		S31° 16' 00.13"W	0+61.55	0+81.26	592998.5646	2545150.6655	592981.7210	2545140.4378
L18	27.140		S9° 20' 23.49"W	1+07.21	1+34.35	592957.5290	2545131.4873	592930.7485	2545127.0827
L19	35.565		S4° 15' 36.19"E	1+50.45	1+86.01	592914.7051	2545126.3711	592879.2387	2545129.0129
L20	71.149		S15° 17' 43.08"E	1+99.07	2+70.22	592866.3869	2545131.2277	592797.7578	2545149.9964
L21	25.357		S15° 13' 22.86"E	2+70.31	2+95.66	592797.6753	2545150.0189	592773.2080	2545156.6771
L22	185.580		S15° 52' 52.01"E	2+96.44	4+82.02	592772.4576	2545156.8860	592593.9609	2545207.6685
L23	222.373		S15° 56' 12.92"E	4+82.09	7+04.46	592593.8974	2545207.6866	592380.0713	2545268.7455
L24	424.994		S15° 46' 05.92"E	7+04.66	11+29.66	592379.8793	2545268.8001	591970.8788	2545384.2913
L25	151.530		S15° 49' 53.08"E	11+29.73	12+81.26	591970.8069	2545384.3116	591825.0248	2545425.6501
L26	22.017		S16° 03' 12.88"E	12+81.52	13+03.54	591824.7720	2545425.7223	591803.6139	2545431.8108
L27	86.614		S15° 33' 52.74"E	13+04.12	13+90.73	591803.0570	2545431.9684	591719.6193	2545455.2092
L28	45.984		S11° 46' 01.91"E	13+95.23	14+41.21	591715.2527	2545456.2709	591670.2355	2545465.6486
L29	229.137		S15° 19' 42.09"E	14+45.43	16+74.56	591666.1385	2545466.6358	591445.1530	2545527.2081
L30	16.394		S14° 34' 19.87"E	16+75.46	16+91.85	591444.2883	2545527.4390	591428.4219	2545531.5637
L31	179.820		S21° 24' 37.61"E	16+99.95	18+79.77	591420.7284	2545534.0622	591253.3175	2545599.7050
L32	8.365		S47° 14' 49.28"E	18+91.08	18+99.44	591244.0560	2545606.0296	591238.3776	2545612.1718

LOWER DRAIN 2

Number	Length	Radius	Line/Chord Direction	Start Station	End Station	Start Northing	Start Easting	End Northing	End Easting
C1	13.321	108.470	N58° 21' 32.41"E	0+10.00	0+23.32	593062.3940	2545318.7562	593069.3775	2545330.0897
C2	11.392	108.470	N64° 53' 09.35"E	0+39.38	0+50.78	593076.9474	2545344.2531	593081.7803	2545354.5637
C3	0.366	108.470	N67° 59' 29.21"E	1+61.59	1+61.96	593123.4818	2545457.2352	593123.6190	2545457.5747
C4	0.583	108.470	N68° 14' 31.70"E	2+75.86	2+76.45	593166.1261	2545563.2511	593166.3422	2545563.7926
C5	0.621	108.470	N68° 33' 36.66"E	3+85.14	3+85.76	593206.3630	2545664.8536	593206.5901	2545665.4318
C6	0.635	108.470	N68° 33' 23.64"E	4+86.29	4+86.93	593243.0672	2545759.1078	593243.2993	2545759.6987
C7	1.265	108.470	N68° 43' 23.00"E	5+72.20	5+73.46	593274.7039	2545838.9730	593275.1631	2545840.1520
C8	0.301	108.470	N69° 08' 12.59"E	6+77.71	6+78.02	593312.4271	2545937.5188	593312.5345	2545937.8005
C9	2.713	108.470	N69° 55' 59.11"E	7+46.02	7+48.73	593336.6651	2546001.3798	593337.5961	2546003.9284
C10	0.581	108.470	N70° 48' 11.09"E	8+15.17	8+15.75	593359.6103	2546066.6147	593359.8012	2546067.1630
C11	14.473	108.470	N74° 46' 43.55"E	8+47.12	8+61.59	593370.0347	2546096.8098	593373.8316	2546110.7643
C12	6.643	27.055	N85° 38' 04.91"E	8+71.64	8+78.28	593375.8177	2546120.6152	593376.3220	2546127.2218
C13	0.269	27.055	S87° 36' 59.23"E	8+83.42	8+83.15	593376.0952	2546132.0892	593376.0840	2546132.3578
C14	1.140	15.392	N89° 58' 35.53"E	8+99.84	9+00.98	593375.4828	2546148.7619	593375.4833	2546149.9018
L1	10.003		N54° 50' 27.21"E	0+00.00	0+10.00	593056.6337	2545310.5781	593062.3940	2545318.7562
L2	16.059		N61° 52' 37.60"E	0+23.32	0+39.38	593069.3775	2545330.0897	593076.9474	2545344.2531
L3	110.817		N67° 53' 41.09"E	0+50.78	1+61.59	593081.7803	2545354.5637	593123.4818	2545457.2352
L4	113.905		N68° 05' 17.33"E	1+61.96	2+75.86	593123.6190	2545457.5747	593166.1261	2545563.2511
L5	108.697		N68° 23' 46.07"E	2+76.45	3+85.14	593166.3422	2545563.7926	593206.3630	2545664.8536
L6	100.527		N68° 43' 27.25"E	3+85.76	4+86.29	593206.5901	2545665.4318	593243.0672	2545759.1078
L7	85.268		N68° 23' 20.02"E	4+86.93	5+72.20	593243.2993	2545759.6987	593274.7039	2545838.9730
L8	104.254		N69° 03' 25.97"E	5+73.46	6+77.71	593275.1631	2545840.1520	593312.4271	2545937.5188
L9	68.005		N69° 12' 59.21"E	6+78.02	7+46.02	593312.5345	2545937.8005	593336.6651	2546001.3798
L10	66.439		N70° 38' 59.02"E	7+48.73	8+15.17	593337.5961	2546003.9284	593359.6103	2546066.6147
L11	31.363		N70° 57' 23.17"E	8+15.75	8+47.12	593359.8012	2546067.1630	593370.0347	2546096.8098
L12	10.049		N78° 36' 03.92"E	8+61.59	8+71.64	593373.8316	2546110.7643	593375.8177	2546120.6152
L13	4.873		S87° 19' 54.10"E	8+78.28	8+83.15	593376.3220	2546127.2218	593376.0952	2546132.0892
L14	16.415		S87° 54' 04.37"E	8+83.42	8+99.84	593376.0840	2546132.3578	593375.4828	2546148.7619
L15	0.856		N87° 51' 15.43"E	9+00.98	9+01.83	593375.4833	2546149.9018	593375.5153	2546150.7568

NOTE:

SOURCE DRAWING:
VAUGHN & MELTON, LOWER DRAIN AS-BUILT DRAWING, DRAWING NO. 1, MARCH 2011

RECORD DRAWING

FOR SUPPORTING DESIGN CALCULATIONS SEE
FPGBRFFESCDX00000020110004

KENNETH MONROE BRENT
REGISTERED ENGINEER
AGRICULTURE
LICENCE
No. 091140
STATE OF TENNESSEE
3/14/2012

R										
R 0	3/14/12	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013	.
RECORD DRAWING										

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV CD
											1
											2
											3
											4

DISCIPLINE INTERFACE

SCALE: NONE EXCEPT AS NOTED

LOWER FRENCH DRAINS 1 & 2 AS-BUILT

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
LPC	DAB	KMB	KMB	RBC	MST	JCK

BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

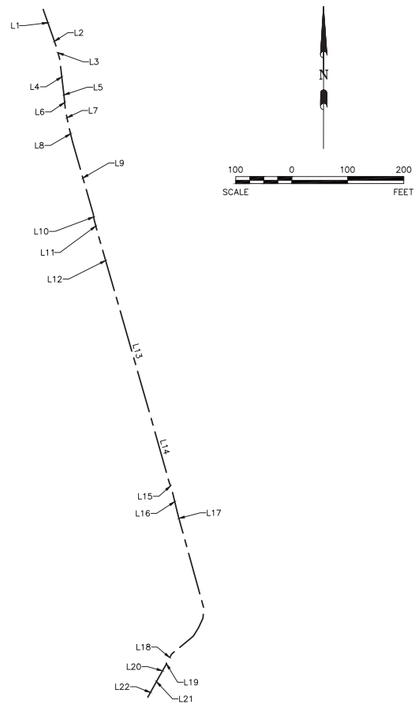
AUTOCAD	2010	DATE 3/14/12	49	C	10W508-14	R 5

URS	5
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
W_TVA

C.A.D. DRAWING
DO NOT ALTER MANUALLY

K:\Projects\T\TVA\31854100\DOCs\Construction\French Drain Cert Report\App G-1 - Record Drawings\Record Drawings\V4 LOWER FRENCH DRAINS 1 & 2 AS-BUILT.dwg User:yng-ru_chen Mar 19, 2012 - 4:03pm



UPPER DRAIN 1

UPPER DRAIN 1									
Number	Length	Radius	Line/Chord direction	Start Station	End Station	Start Northing	Start Easting	End Northing	End Easting
L1	50.564		S19° 23' 32.83"E	0+00.00	0+50.56	592752.1850	2545340.1450	592704.4900	2545356.9340
L2	19.767		S18° 40' 13.85"E	0+50.56	0+70.33	592704.4900	2545356.9340	592685.7630	2545363.2620
L3	22.641		S16° 01' 08.72"E	0+70.33	0+92.97	592685.7630	2545363.2620	592664.0010	2545369.5100
L4	64.996		S6° 42' 22.06"E	0+92.97	1+57.97	592664.0010	2545369.5100	592599.4500	2545377.1000
L5	0.006		S17° 02' 45.29"E	1+57.97	1+57.97	592599.4500	2545377.1000	592599.4441	2545377.1018
L6	26.615		S5° 30' 56.25"E	1+57.97	1+84.59	592599.4441	2545377.1018	592572.9520	2545379.6600
L7	29.123		S11° 45' 01.99"E	1+84.59	2+13.71	592572.9520	2545379.6600	592544.4390	2545385.5910
L8	29.410		S13° 35' 41.72"E	2+13.71	2+43.12	592544.4390	2545385.5910	592515.8530	2545392.5040
L9	134.604		S15° 58' 50.14"E	2+43.12	3+77.73	592515.8530	2545392.5040	592386.4510	2545429.5620
L10	9.764		S9° 27' 20.05"E	3+77.73	3+87.49	592386.4510	2545429.5620	592376.8200	2545431.1660
L11	23.451		S14° 24' 00.31"E	3+87.49	4+10.94	592376.8200	2545431.1660	592354.1060	2545436.9980
L12	104.638		S16° 11' 25.05"E	4+10.94	5+15.58	592354.1060	2545436.9980	592253.6180	2545466.1740
L13	237.879		S16° 04' 25.91"E	5+15.58	7+53.46	592253.6180	2545466.1740	592025.0390	2545532.0370
L14	118.503		S15° 44' 28.23"E	7+53.46	8+71.96	592025.0390	2545532.0370	591910.9800	2545564.1860
L15	20.441		S18° 21' 50.54"E	8+71.96	8+92.40	591910.9800	2545564.1860	591891.5800	2545570.6260
L16	37.592		S13° 30' 52.72"E	8+92.40	9+29.99	591891.5800	2545570.6260	591855.0290	2545579.4110
L17	23.983		S15° 03' 13.53"E	9+29.99	9+53.98	591855.0290	2545579.4110	591831.8690	2545585.6400
L18	14.757		S28° 49' 16.21"W	12+12.66	12+27.41	591601.4700	2545569.6160	591588.5410	2545562.5020
L19	10.297		S27° 15' 24.58"W	12+27.41	12+37.71	591588.5410	2545562.5020	591579.3870	2545557.7860
L20	18.496		S30° 00' 49.82"W	12+37.71	12+56.21	591579.3870	2545557.7860	591563.3710	2545548.5340
L21	25.622		S28° 48' 31.45"W	12+56.21	12+81.83	591563.3710	2545548.5340	591540.9200	2545536.1870
L22	19.013		S28° 54' 13.93"W	12+81.83	13+00.84	591540.9200	2545536.1870	591524.2750	2545526.9970

FOR SUPPORTING DESIGN CALCULATIONS SEE
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NOTE:
SOURCE DRAWING:
VAUGHN & MELTON, UPPER DRAIN 1 AS-BUILT DRAWING, DRAWING NO. 1, MAY 2011

RECORD DRAWING

REV. NO.	DATE	DSGN	DRAWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST
R 0	3/14/12	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013	.

RECORD DRAWING

SCALE: NONE EXCEPT AS NOTED

UPPER FRENCH DRAIN 1 AS-BUILT

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
LPC	DAB	KMB	KMB	RBC	MST	JCK

BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD	2010	DATE 3/14/12	49	C	10W508-15	R 5

URS	5
TASK COMPLETED BY:	REV NO.

PLOT FACTOR:XX
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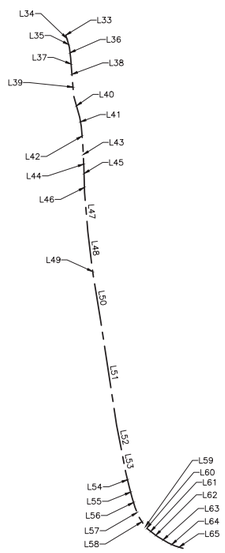

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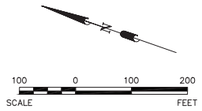

UPPER DRAIN-2

Number	Length	Radius	Line/Chord Direction	Start Station	End Station	Start Northing	Start Easting	End Northing	End Easting
L33	0.595		S50° 10' 55.56"W	0+00.00	0+00.59	593369.9540	2546157.8070	593369.5730	2546157.3500
L34	11.177		S52° 32' 22.38"W	0+00.59	0+11.77	593369.5730	2546157.3500	593362.7750	2546148.4780
L35	11.688		S55° 51' 30.81"W	0+11.77	0+23.46	593362.7750	2546148.4780	593356.2150	2546138.8040
L36	18.426		S64° 29' 30.73"W	0+23.46	0+41.89	593356.2150	2546138.8040	593348.2800	2546122.1740
L37	21.806		S66° 09' 43.55"W	0+41.89	0+63.69	593348.2800	2546122.1740	593339.4670	2546102.2280
L38	14.984		S66° 03' 57.07"W	0+63.69	0+78.68	593339.4670	2546102.2280	593333.3880	2546088.5320
L39	30.864		S66° 30' 20.62"W	0+78.68	1+09.54	593333.3880	2546088.5320	593321.0840	2546060.2270
L40	40.189		S55° 05' 41.13"W	1+09.54	1+49.73	593321.0840	2546060.2270	593298.0870	2546027.2680
L41	16.590		S61° 08' 43.18"W	1+49.73	1+66.32	593298.0870	2546027.2680	593290.0810	2546012.7380
L42	34.488		S66° 04' 00.09"W	1+66.32	2+00.81	593290.0810	2546012.7380	593276.0900	2545981.2150
L43	31.574		S68° 15' 49.05"W	2+00.81	2+32.38	593276.0900	2545981.2150	593264.3970	2545951.8860
L44	2.532		S63° 21' 50.76"W	2+32.38	2+34.91	593264.3970	2545951.8860	593263.2620	2545949.6230
L45	31.186		S69° 28' 18.87"W	2+34.91	2+66.10	593263.2620	2545949.6230	593252.3260	2545920.4170
L46	18.425		S69° 03' 59.50"W	2+66.10	2+84.53	593252.3260	2545920.4170	593245.7430	2545903.2080
L47	70.013		S65° 59' 33.21"W	2+84.53	3+54.54	593245.7430	2545903.2080	593217.2580	2545839.2520
L48	61.960		S64° 02' 15.00"W	3+54.54	4+16.50	593217.2580	2545839.2520	593190.1330	2545783.5450
L49	19.352		S62° 56' 42.10"W	4+16.50	4+35.85	593190.1330	2545783.5450	593181.3310	2545766.3110

UPPER DRAIN-2

Number	Length	Radius	Line/Chord Direction	Start Station	End Station	Start Northing	Start Easting	End Northing	End Easting
L50	79.988		S61° 29' 30.12"W	4+35.85	5+15.84	593181.3310	2545766.3110	593143.1540	2545696.0220
L51	187.848		S62° 08' 13.98"W	5+15.84	7+03.69	593143.1540	2545696.0220	593055.3620	2545529.9510
L52	48.804		S59° 48' 25.91"W	7+03.69	7+52.49	593055.3620	2545529.9510	593030.8180	2545487.7680
L53	37.799		S60° 03' 10.81"W	7+52.49	7+90.29	593030.8180	2545487.7680	593011.9490	2545455.0160
L54	25.496		S57° 15' 37.63"W	7+90.29	8+15.78	593011.9490	2545455.0160	592998.1600	2545433.5700
L55	20.343		S55° 47' 17.22"W	8+15.78	8+36.13	592998.1600	2545433.5700	592986.7220	2545416.7470
L56	18.233		S53° 57' 37.37"W	8+36.13	8+54.36	592986.7220	2545416.7470	592975.9950	2545402.0040
L57	19.570		S48° 32' 39.97"W	8+54.36	8+73.93	592975.9950	2545402.0040	592963.0390	2545387.3370
L58	17.866		S37° 29' 01.43"W	8+73.93	8+91.80	592963.0390	2545387.3370	592948.8620	2545376.4650
L59	3.471		S28° 12' 40.77"W	8+91.80	8+95.27	592948.8620	2545376.4650	592945.8030	2545374.8240
L60	4.140		S27° 32' 56.68"W	8+95.27	8+99.41	592945.8030	2545374.8240	592942.1320	2545372.9090
L61	13.943		S18° 28' 40.20"W	8+99.41	9+13.35	592942.1320	2545372.9090	592928.9080	2545368.4900
L62	8.948		S17° 05' 32.54"W	9+13.35	9+22.30	592928.9080	2545368.4900	592920.3550	2545365.8600
L63	21.943		S11° 21' 05.08"W	9+22.30	9+44.24	592920.3550	2545365.8600	592898.8410	2545361.5410
L64	13.130		S4° 24' 57.99"W	9+44.24	9+57.37	592898.8410	2545361.5410	592885.7500	2545360.5300
L65	14.602		S2° 10' 13.18"E	9+57.37	9+71.97	592885.7500	2545360.5300	592871.1580	2545361.0830

NOTE:

SOURCE DRAWING:
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R 0	3/14/12	LPC	DAB	KMB	KMB	RBC	MST	JCK	204013	.	.
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DISCIPLINE INTERFACE

SCALE: NONE EXCEPT AS NOTED

UPPER FRENCH DRAIN 2 AS-BUILT

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

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LPC	DAB	KMB	KMB	RBC	MST	JCK

BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD 2010 | DATE 3/14/12 | 49 | C | 10W508-16 | R 5

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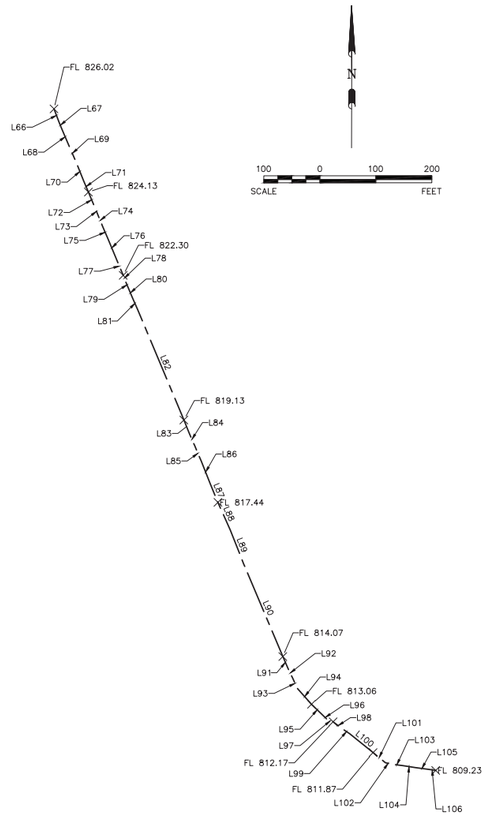

UPPER DRAIN 3

UPPER DRAIN 3									
Number	Length	Radius	Line/Chord Direction	Start Station	End Station	Start Northing	Start Easting	End Northing	End Easting
L66	24.969		S20° 55' 15.72"E	0+00.00	0+24.97	593159.7040	2546164.6280	593136.3810	2546173.5440
L67	12.705		S22° 05' 58.29"E	0+24.97	0+37.67	593136.3810	2546173.5440	593124.6090	2546178.3240
L68	31.910		S23° 04' 52.25"E	0+37.67	0+69.58	593124.6090	2546178.3240	593095.2530	2546190.8340
L69	32.859		S23° 26' 25.34"E	0+69.58	1+02.44	593095.2530	2546190.8340	593065.1060	2546203.9050
L70	37.220		S21° 55' 01.85"E	1+02.44	1+39.66	593065.1060	2546203.9050	593030.5760	2546217.7980
L71	21.139		S22° 59' 21.56"E	1+39.66	1+60.80	593030.5760	2546217.7980	593011.1160	2546226.0540
L72	29.938		S22° 45' 34.46"E	1+60.80	1+90.74	593011.1160	2546226.0540	592983.5090	2546237.6360
L73	14.884		S22° 25' 59.94"E	1+90.74	2+05.63	592983.5090	2546237.6360	592969.7510	2546243.3160
L74	19.793		S22° 23' 43.47"E	2+05.63	2+25.42	592969.7510	2546243.3160	592951.4510	2546250.8570
L75	26.077		S23° 17' 38.71"E	2+25.42	2+51.49	592951.4510	2546250.8570	592927.5000	2546261.1690
L76	34.656		S22° 23' 39.31"E	2+51.49	2+86.15	592927.5000	2546261.1690	592895.4580	2546274.3720
L77	35.749		S22° 51' 42.75"E	2+86.15	3+21.90	592895.4580	2546274.3720	592862.5170	2546288.2610
L78	10.953		S20° 53' 14.21"E	3+21.90	3+32.85	592862.5170	2546288.2610	592852.2840	2546292.1660
L79	14.561		S22° 43' 01.31"E	3+32.85	3+47.41	592852.2840	2546292.1660	592838.8530	2546297.7890
L80	16.652		S22° 39' 57.31"E	3+47.41	3+64.06	592838.8530	2546297.7890	592823.4870	2546304.2060
L81	24.122		S23° 49' 01.43"E	3+64.06	3+88.19	592823.4870	2546304.2060	592801.4190	2546313.9470
L82	213.784		S22° 43' 54.52"E	3+88.19	6+01.97	592801.4190	2546313.9470	592604.2410	2546396.5570
L83	25.389		S21° 56' 38.00"E	6+01.97	6+27.36	592604.2410	2546396.5570	592580.6910	2546406.0450
L84	23.973		S23° 43' 53.29"E	6+27.36	6+51.33	592580.6910	2546406.0450	592558.7450	2546415.6930
L85	30.403		S22° 57' 07.66"E	6+51.33	6+81.74	592558.7450	2546415.6930	592530.7490	2546427.5490
L86	42.061		S21° 44' 28.34"E	6+81.74	7+23.80	592530.7490	2546427.5490	592491.6800	2546443.1290

UPPER DRAIN 3									
Number	Length	Radius	Line/Chord Direction	Start Station	End Station	Start Northing	Start Easting	End Northing	End Easting
L87	37.278		S22° 22' 03.64"E	7+23.80	7+61.08	592491.6800	2546443.1290	592457.2070	2546457.3150
L88	54.228		S24° 05' 11.03"E	7+61.08	8+15.30	592457.2070	2546457.3150	592407.7010	2546479.4460
L89	65.388		S21° 34' 21.48"E	8+15.30	8+80.69	592407.7010	2546479.4460	592346.8930	2546503.4880
L90	178.985		S22° 55' 18.33"E	8+80.69	10+59.68	592346.8930	2546503.4880	592182.0410	2546573.1980
L91	23.073		S23° 19' 05.73"E	10+59.68	10+82.75	592182.0410	2546573.1980	592160.8530	2546582.3310
L92	18.443		S25° 46' 58.20"E	10+82.75	11+01.19	592160.8530	2546582.3310	592144.2460	2546590.3530
L93	22.225		S25° 12' 32.70"E	11+01.19	11+23.42	592144.2460	2546590.3530	592124.1380	2546599.8190
L94	36.799		S41° 53' 41.49"E	11+23.42	11+60.22	592124.1380	2546599.8190	592096.7460	2546624.3920
L95	28.301		S46° 05' 22.05"E	11+60.22	11+88.52	592096.7460	2546624.3920	592077.1180	2546644.7810
L96	11.367		S45° 31' 26.16"E	11+88.52	11+99.88	592077.1180	2546644.7810	592069.1540	2546652.8920
L97	10.826		S69° 42' 01.41"E	11+99.88	12+10.71	592069.1540	2546652.8920	592065.3980	2546663.0460
L98	22.524		S53° 01' 23.75"E	12+10.71	12+33.23	592065.3980	2546663.0460	592051.8500	2546681.0400
L99	14.056		S56° 03' 52.58"E	12+33.23	12+47.29	592051.8500	2546681.0400	592044.0030	2546692.7020
L100	53.416		S51° 11' 34.00"E	12+47.29	13+00.71	592044.0030	2546692.7020	592010.5270	2546734.3270
L101	28.198		S50° 33' 58.32"E	13+00.71	13+28.90	592010.5270	2546734.3270	591992.6160	2546756.1060
L102	10.232		S74° 41' 37.70"E	13+28.90	13+39.14	591992.6160	2546756.1060	591989.9150	2546765.9750
L103	21.757		S83° 04' 51.92"E	13+39.14	13+60.89	591989.9150	2546765.9750	591987.2940	2546787.5740
L104	22.346		S80° 57' 46.77"E	13+60.89	13+83.24	591987.2940	2546787.5740	591983.7840	2546809.6430
L105	23.986		S82° 17' 06.27"E	13+83.24	14+07.23	591983.7840	2546809.6430	591980.5640	2546833.4120
L106	12.888		S81° 41' 51.47"E	14+07.23	14+20.11	591980.5640	2546833.4120	591978.7030	2546846.1650

NOTE:

SOURCE DRAWING:
VAUGHN & MELTON, UPPER DRAIN AS-BUILT DRAWING, DRAWING NO. 1, JUNE 2011

RECORD DRAWING

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KENNETH MONROE BERRY — REGISTERED ENGINEER — DEPARTMENT OF AGRICULTURE — STATE OF TENNESSEE — 3/14/2012

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RECORD DRAWING

REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST	REV'S CO

DISCIPLINE INTERFACE

SCALE: NONE EXCEPT AS NOTED

UPPER FRENCH DRAIN 3 AS-BUILT

WORK PLAN FOR GYPSUM STACK 2A URSGS001

SUBSURFACE DRAINAGE IMPROVEMENTS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
LPC	DAB	KMB	KMB	RBC	MST	JCK

BULL RUN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD	2010	DATE 3/14/12	49	C	10W508-17	R 5

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TASK COMPLETED BY:	REV NO.

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APPENDIX M
EXPLORATORY DRILLING SAP

Exploratory Drilling
Sampling and Analysis Plan
Bull Run Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Bull Run Fossil Plant
Clinton, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 17, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	October 27, 2017
2	Addresses January 29, 2018 TDEC Review Comments and Issued for TDEC Review	March 30, 2018
3	Addresses May 22, 2018 TDEC Review Comments and Issued for TDEC Review	July 13, 2018
4	Addresses TDEC Comments, Applicable Programmatic Revisions, and Issued for TDEC Approval	December 17, 2018

EXPLORATORY DRILLING
SAMPLING AND ANALYSIS PLAN
BULL RUN FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Exploratory Drilling
Sampling and Analysis Plan
Bull Run Fossil Plant
Tennessee Valley Authority
Clinton, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 17, 2018 Revision 4

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 McClung, Nicholas Anthony Digitally signed by McClung, Nicholas Anthony Date: 2018.12.07 09:52:13 -05'00'	12/13/18 Date
TVA Investigation Field Lead	Date
Health, Safety, and Environmental (HSE) Manager	12/12/18 Date
Investigation Project Manager	12/6/2018 Date
QA Oversight Manager Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.12.11 12:57:02 -05'00'	Date
Laboratory Project Manager	12/6/2018 Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

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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 Bull Run Fossil Plant (BRF) on July 13-14, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at BRF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference.

On September 13, 2016, TDEC issued 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 January 9, 2017, TVA submitted BRF 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 exploratory borings at BRF (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 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 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 BRF. Rationale for individual cone penetration test (CPT), borings, and borings with temporary well locations are discussed below. Refer to Figures 1 through 4 in Attachment A for a layout of proposed locations.

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 performing CPTs and installing multi-purpose borings and temporary wells at locations shown on Figures 1 through 4 in 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 88 CPTs and 17 borings are proposed. Table 1 provides the number of CPTs, borings, and temporary wells proposed in each CCR unit. Table 2 lists the borings and 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. Exploratory Drilling Proposed in each CCR Unit

CCR Unit	Total No. of Proposed CPT	Total No. of Proposed Borings	No. of Borings with Temporary Wells	No. of Borings with Rock Coring
Main Ash Pond	28	1	1	1
Gypsum Disposal Area 2A	21	6	6	3
Bottom Ash Disposal Area	14	3	3	3
Former Disposal Area	0	2	0	2
Railroad Loop Disposal Area	11	2	2	2
Dry Fly Ash Stack Phases 1 and 2	14	3	3	0
Total	**88**	**17**	**15**	**11**

Table 2. Detailed Boring and CPT Descriptions

Boring No.	CCR Unit	Deepest Material Encountered	Temporary Well Screen Location	Boring Purpose[1]
TW01	Railroad Loop Disposal Area	Bedrock	Sluiced Ash	PZ, PW, Geo
TW02	Railroad Loop Disposal Area	Bedrock	Sluiced Ash	PZ, PW, Geo
TW03	Main Ash Pond	Bedrock	Sluiced Ash	PZ, PW, Geo
TW04	Gypsum Disposal Area 2A	Bedrock	Sluiced Ash	PZ, PW, Geo
TW05	Gypsum Disposal Area 2A	Gypsum	Gypsum	PZ, PW, Geo
TW06	Gypsum Disposal Area 2A	Bedrock	Sluiced Ash	PZ, PW, Geo
TW07	Gypsum Disposal Area 2A	Gypsum	Gypsum	PZ, PW, Geo
TW08	Gypsum Disposal Area 2A	Bedrock	Sluiced Ash	PZ, PW, Geo
TW09	Gypsum Disposal Area 2A	Gypsum	Gypsum	PZ, PW, Geo
TW10	Bottom Ash Disposal Area	Bedrock	Sluiced Ash	PZ, PW, Geo
TW11	Bottom Ash Disposal Area	Bedrock	Sluiced Ash	PZ, PW, Geo
TW12	Bottom Ash Disposal Area	Bedrock	Sluiced Ash	PZ, PW, Geo
TW13	Dry Fly Ash Stack Phase 1	Clayey Fill	Stacked Fly Ash	PZ, PW, Geo
TW14	Dry Fly Ash Stack Phase 1	Clayey Fill	Stacked Fly Ash	PZ, PW, Geo
TW15	Dry Fly Ash Stack Phase 2	Clayey Fill	Stacked Fly Ash	PZ, PW, Geo
B01	Former Disposal Area	Bedrock	--	Geo
B02	Former Disposal Area	Bedrock	--	Geo
CPT01	Railroad Loop Disposal Area	Bedrock	--	Geo
CPT02	Railroad Loop Disposal Area	Bedrock	--	Geo
CPT03	Railroad Loop Disposal Area	Bedrock	--	Geo
CPT04	Railroad Loop Disposal Area	Bedrock	--	Geo
CPT05	Railroad Loop Disposal Area	Bedrock	--	Geo
CPT06	Railroad Loop Disposal Area	Bedrock	--	Geo

Table 2. Detailed Boring and CPT Descriptions

Boring No.	CCR Unit	Deepest Material Encountered	Temporary Well Screen Location	Boring Purpose[1]
CPT07	Railroad Loop Disposal Area	Bedrock	--	Geo
CPT08	Railroad Loop Disposal Area	Bedrock	--	Geo
CPT09	Railroad Loop Disposal Area	Bedrock	--	Geo
CPT10	Railroad Loop Disposal Area	Bedrock	--	Geo
CPT11	Railroad Loop Disposal Area	Bedrock	--	Geo
CPT12	Bottom Ash Disposal Area	Bedrock	--	Geo
CPT13	Bottom Ash Disposal Area	Bedrock	--	Geo
CPT14	Bottom Ash Disposal Area	Bedrock	--	Geo
CPT15	Bottom Ash Disposal Area	Bedrock	--	Geo
CPT16	Bottom Ash Disposal Area	Bedrock	--	Geo
CPT17	Bottom Ash Disposal Area	Bedrock	--	Geo
CPT18	Bottom Ash Disposal Area	Bedrock	--	Geo
CPT19	Bottom Ash Disposal Area	Bedrock	--	Geo
CPT20	Bottom Ash Disposal Area	Bedrock	--	Geo
CPT21	Bottom Ash Disposal Area	Bedrock	--	Geo
CPT22	Bottom Ash Disposal Area	Bedrock	--	Geo
CPT23	Bottom Ash Disposal Area	Bedrock	--	Geo
CPT24	Bottom Ash Disposal Area	Bedrock	--	Geo
CPT25	Bottom Ash Disposal Area	Bedrock	--	Geo
CPT26	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT27	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT28	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT29	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT30	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT31	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT32	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT33	Gypsum Disposal Area 2A	Bedrock	--	Geo

Table 2. Detailed Boring and CPT Descriptions

Boring No.	CCR Unit	Deepest Material Encountered	Temporary Well Screen Location	Boring Purpose[1]
CPT34	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT35	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT36	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT37	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT38	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT39	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT40	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT41	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT42	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT43	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT44	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT45	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT46	Gypsum Disposal Area 2A	Bedrock	--	Geo
CPT47	Main Ash Pond	Bedrock	--	Geo
CPT48	Main Ash Pond	Bedrock	--	Geo
CPT49	Main Ash Pond	Bedrock	--	Geo
CPT50	Main Ash Pond	Bedrock	--	Geo
CPT51	Main Ash Pond	Bedrock	--	Geo
CPT52	Main Ash Pond	Bedrock	--	Geo
CPT53	Main Ash Pond	Bedrock	--	Geo
CPT54	Main Ash Pond	Bedrock	--	Geo
CPT55	Main Ash Pond	Bedrock	--	Geo
CPT56	Main Ash Pond	Bedrock	--	Geo
CPT57	Main Ash Pond	Bedrock	--	Geo
CPT58	Main Ash Pond	Bedrock	--	Geo

Table 2. Detailed Boring and CPT Descriptions

Boring No.	CCR Unit	Deepest Material Encountered	Temporary Well Screen Location	Boring Purpose[1]
CPT59	Main Ash Pond	Bedrock	--	Geo
CPT60	Main Ash Pond	Bedrock	--	Geo
CPT61	Main Ash Pond	Bedrock	--	Geo
CPT62	Main Ash Pond	Bedrock	--	Geo
CPT63	Main Ash Pond	Bedrock	--	Geo
CPT64	Main Ash Pond	Bedrock	--	Geo
CPT65	Main Ash Pond	Bedrock	--	Geo
CPT66	Main Ash Pond	Bedrock	--	Geo
CPT67	Main Ash Pond	Bedrock	--	Geo
CPT68	Main Ash Pond	Bedrock	--	Geo
CPT69	Main Ash Pond	Bedrock	--	Geo
CPT70	Main Ash Pond	Bedrock	--	Geo
CPT71	Main Ash Pond	Bedrock	--	Geo
CPT72	Main Ash Pond	Bedrock	--	Geo
CPT73	Main Ash Pond	Bedrock	--	Geo
CPT74	Main Ash Pond	Bedrock	--	Geo
CPT75	Dry Fly Ash Stack Phase 1	Bedrock	--	Geo
CPT76	Dry Fly Ash Stack Phase 1	Bedrock	--	Geo
CPT77	Dry Fly Ash Stack Phase 1	Bedrock	--	Geo
CPT78	Dry Fly Ash Stack Phase 1	Bedrock	--	Geo
CPT79	Dry Fly Ash Stack Phase 1	Bedrock	--	Geo
CPT80	Dry Fly Ash Stack Phase 1	Bedrock	--	Geo
CPT81	Dry Fly Ash Stack Phase 1	Bedrock	--	Geo
CPT82	Dry Fly Ash Stack Phase 1	Bedrock	--	Geo
CPT83	Dry Fly Ash Stack Phase 1	Bedrock	--	Geo
CPT84	Dry Fly Ash Stack Phase 1	Bedrock	--	Geo
CPT85	Dry Fly Ash Stack Phase 1	Bedrock	--	Geo

Table 2. Detailed Boring and CPT Descriptions

Boring No.	CCR Unit	Deepest Material Encountered	Temporary Well Screen Location	Boring Purpose[1]
CPT86	Dry Fly Ash Stack Phase 1	Bedrock	--	Geo
CPT87	Dry Fly Ash Stack Phase 1	Bedrock	--	Geo
CPT88	Dry Fly Ash Stack Phase 1	Bedrock	--	Geo

[1] PZ = Piezometric (Water) Levels in CCR; PW = Pore Water Sampling; Geo = Geotechnical Data

As shown in Figure 1, ten (10) of the proposed borings are located within the footprint of the Main Ash Pond, Gypsum Disposal Area 2A, and Bottom Ash Disposal Area. The borings will allow installation of temporary wells (labeled TW03 through TW12) and improve spatial coverage for CCR thickness, water levels, foundation soil type and thickness, top of bedrock elevations, and shallow bedrock characterization for each of the units.

The temporary wells in the Main Ash Pond (TW03) and Bottom Ash Disposal Area (TW10 through TW12), will be screened near the bottom of the sluiced ash after the portion of the borehole that penetrated the foundation soils and bedrock is sealed and grouted to the bottom of the ash. These temporary wells will allow water level readings and pore water sampling in the sluiced ash.

Six borings are proposed in the interior of the Gypsum Disposal Area 2A. Borings are arranged in three pairs, to allow for installation of pairs of shallow and deep temporary wells. The deep temporary wells (TW04, TW06, TW08) will be screened near the bottom of the sluiced ash, after the portion of the borehole is sealed that penetrated the foundation soils and bedrock. These deeper temporary wells will allow water level readings and pore water sampling in the sluiced ash.

The shallower temporary wells (TW05, TW07, TW09) will be screened at the bottom of the gypsum, just above the expected elevation of the bottom drainage collection system. These shallow temporary wells will allow water level readings and pore water sampling in the gypsum (if it is saturated). The paired water level readings will help understand potential vertical seepage gradients.

Two (2) borings are proposed in the Former Disposal Area. The borings (labeled B01 and B02) will improve spatial coverage for CCR thickness, water levels, foundation soil type and thickness, top of bedrock elevations, and shallow bedrock characterization.

As shown in Figure 2, two borings (TW01 and TW02) and eleven CPT soundings (CPT01 through CPT11) are proposed in the interior of the Railroad Loop Disposal Area. The borings will allow installation of temporary wells and improve spatial coverage for CCR thickness, water levels, foundation soil type and thickness, top of bedrock elevations, and shallow bedrock characterization for the unit. The temporary wells will allow water level readings and pore water sampling in the sluiced fly ash and improve subsurface characterization of the CCR in this vicinity.

The in-situ penetration resistance measured by the CPT will be used to differentiate CCR from foundation soil and to support material quantity estimating. Additional companion borings may be performed after CPT soundings are completed if encountered subsurface conditions differ significantly from anticipated conditions, or if supplemental samples are needed for laboratory testing.

As shown in Figure 3, two (2) borings (TW13 and TW14) are proposed in the interior of the Phase 1 Dry Fly Ash Stack and one boring (TW15) is proposed in the interior of the Phase 2 Dry Fly Ash Stack. Undisturbed tube sampling (Shelby tubes) of the clayey fill directly beneath the CCR materials may be performed in selected borings. The borings will allow installation of temporary wells and improve spatial coverage for CCR thickness, water levels, and foundation soil type for both phases of the unit. The temporary wells will allow water level readings and pore water sampling in the stacked fly ash and improve subsurface characterization of the CCR in this vicinity.

Additionally, 14 CPT soundings (CPT75 through CPT88) are proposed along the perimeter of the Dry Fly Ash Stack Phase 1. These CPTs are proposed to better characterize the uppermost foundation soils in the immediate vicinity of the mapped, pre-construction channels of an unnamed tributary to Worthington Branch. At each of the stream crossing locations along the perimeter dike system, a series of seven closely spaced Cone Penetration Test (CPT) soundings is proposed. The CPT data, correlated to existing nearby boring logs, can be used to differentiate relatively sandy (i.e., more pervious) foundation soils, if present. Pore pressure dissipation tests will be performed in select soundings and in select depth intervals. Additional CPT soundings may be added while in the field, if further delineation becomes necessary.

As shown in Figure 4, 63 CPT soundings (CPT12 through CPT74) are proposed along the perimeters of the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, and Main Ash Pond. These CPTs are proposed to better characterize the uppermost foundation soils in the immediate vicinity of the mapped, pre-construction channels of Bull Run Creek and Worthington Branch. At each stream crossing location along the perimeter dike system (total of nine locations), a series of closely spaced Cone Penetration Test (CPT) soundings is proposed. The CPT data, correlated to existing nearby boring logs, can be used to differentiate relatively sandy (i.e., more pervious) foundation soils, if present. Pore pressure dissipation tests will be performed in select soundings and in select depth intervals. Additional CPT soundings may be added while in the field, if further delineation becomes necessary.

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) may be collected for possible 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. Note that the exploratory drilling program at BRF does not necessitate downhole testing in rock.

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 and Standard Operating Procedures (SOPs), Quality Assurance Project Plan (QAPP; Appendix D of the EIP), SAPs, and HASP.
- Complete required health and safety paperwork and 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 Global Positioning System (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 (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 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 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:

- Assessment of suitability of areas and access to borings, including clearing and grubbing, 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 (2017). "Tennessee Valley Authority, Stability Assessment, Supplemental Site Exploration, Bull Run Fossil Plant, Bottom Ash Disposal Area, Gypsum Disposal Area, and Fly Ash Pond, Final Report." Prepared for Tennessee Valley Authority. September.

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 Geotechnical Borings
Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Fly Ash Stilling Pond 2C & Main Ash Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175568274

Prepared by MB on 2018-12-13
Technical Review by TG on 2018-12-13

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Proposed Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, and Geotechnical Data) (Screened Interval)
- Proposed Geotechnical Boring
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

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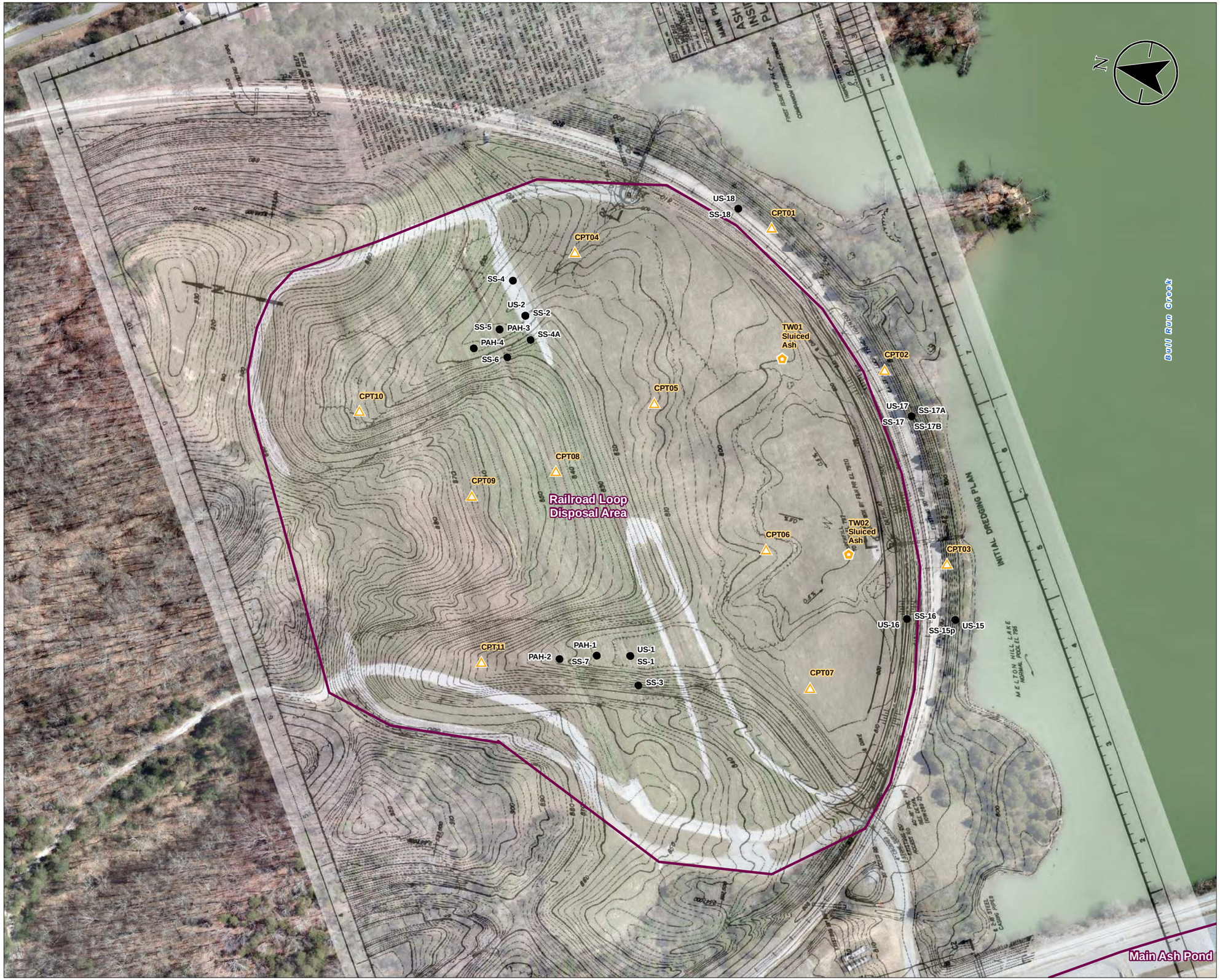

Figure No.

2

Title

Proposed Geotechnical Borings
Railroad Loop Disposal Area

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by TKR on 2018-06-14
Technical Review by TG on 2018-06-14

0 80 160 240 320 Feet

1:960 (At original document size of 22x34)

Legend

- Proposed Cone Penetration Test
- Proposed Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, and Geotechnical Data) (Screened Interval)
- Existing Boring
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Historical TVA Drawing 10W289-1 R0 (1981) is shown.

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Figure No.
3

Title
Proposed Geotechnical Borings
Dry Fly Ash Stack

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175568274
Prepared by MB on 2018-12-13
Technical Review by TG on 2018-12-13

0 150 300 450 600 Feet
1:1,800 (At original document size of 22x34)

Legend

- Proposed Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, and Geotechnical Data) (Screened Interval)
- Proposed Cone Penetration Test
- Existing Boring
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Historical TVA Drawing 10W293-1 R2 (1993) is shown.
4. CPT borings on 5 feet spacing along historical unnamed tributary alignment.

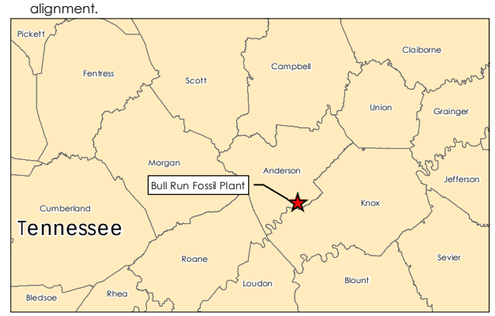

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Figure No.
4

Title
Proposed Cone Penetration Testing - Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Fly Ash Stilling Pond 2C, and Main Ash Pond

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175568274
Prepared by TKR on 2018-12-13
Technical Review by TG on 2018-12-13

0 300 600 900 1,200 Feet
1:3,600 (At original document size of 22x34)

Legend

- Proposed Cone Penetration Test
- Historic Creek Alignment
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Historical TVA Drawing 10N213-14 (1977) is shown.
4. CPT borings on 20 feet spacing at historical Bull Run Creek alignment.
5. CPT borings on 5 feet spacing at historical Worthington Branch alignment.

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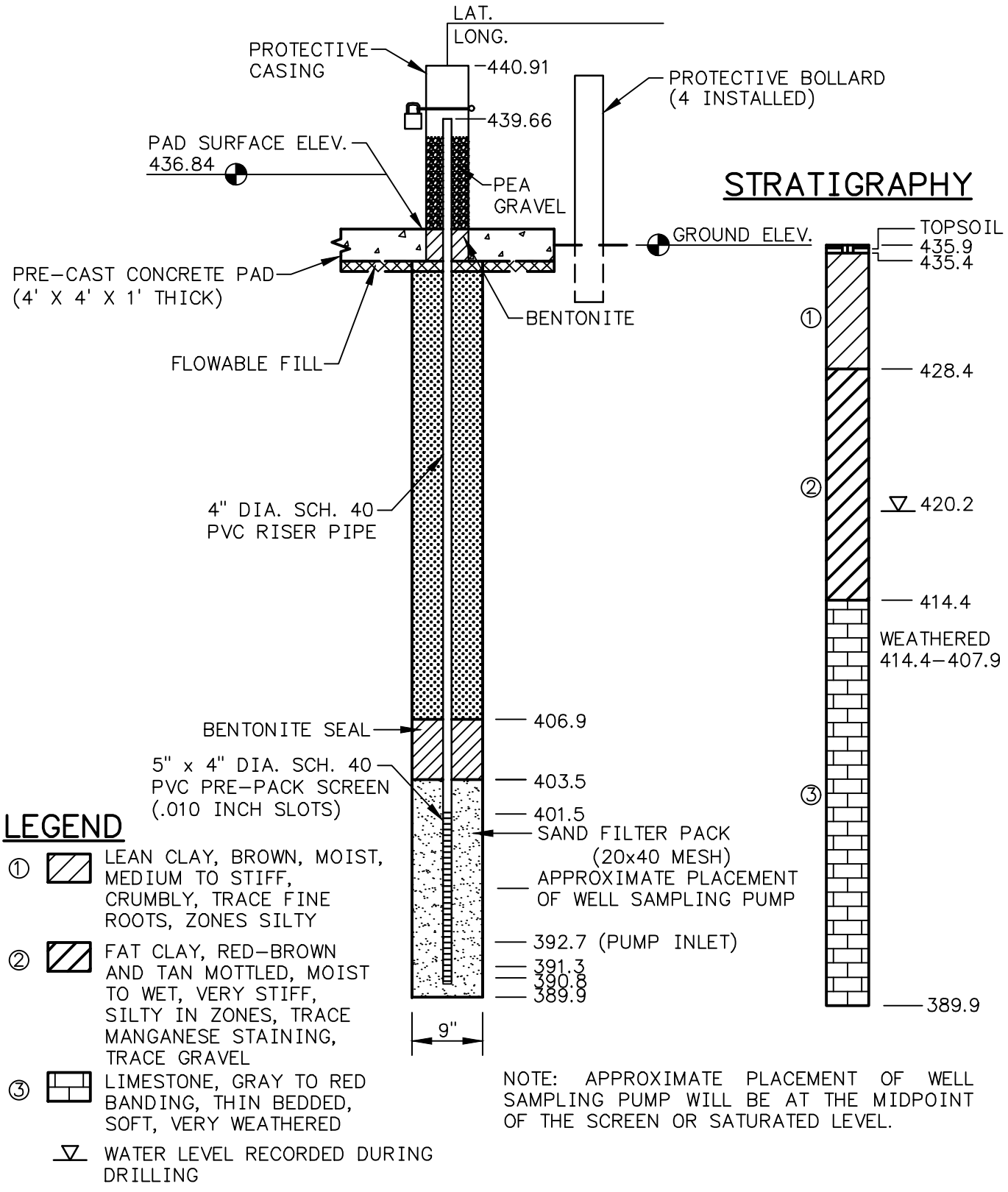
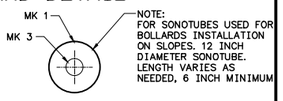
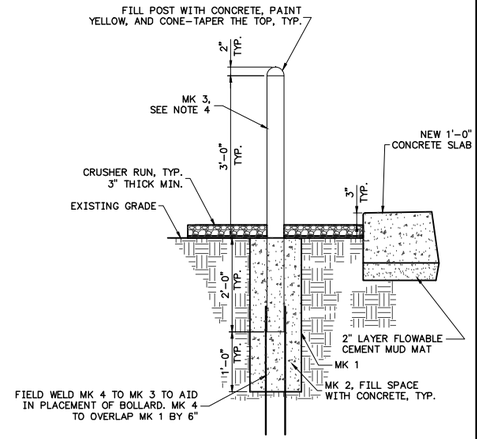


Figure 5. Temporary Well Installation Schematic

BOLLARD DETAIL

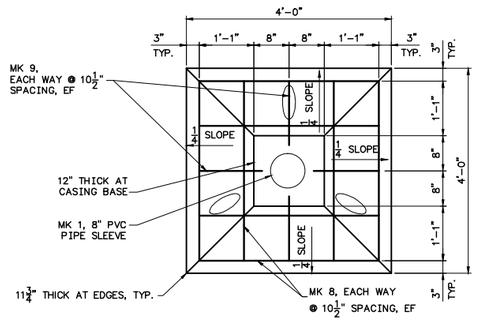


PLAN – BOLLARD

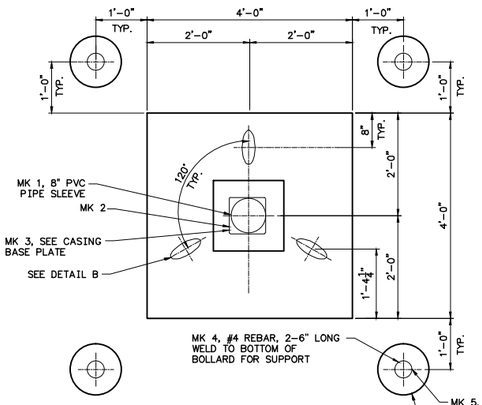


ELEVATION – BOLLARD

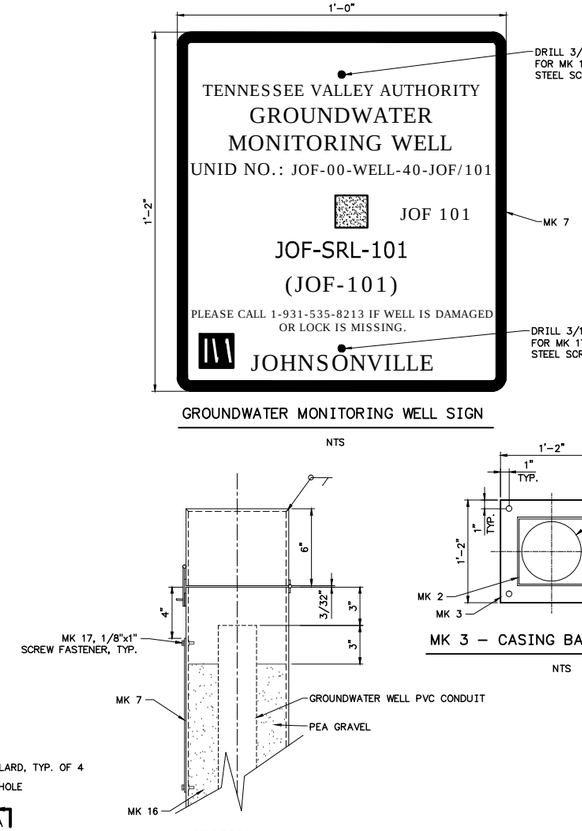
BOLLARD DETAIL			
MARK NUMBERS AND MATERIAL LIST			
MARK NO.	QUANTITY	DESCRIPTION	PROCURE
1	1 EA	12" SONOTUBE CONCRETE FORM	CONT
2	AS–REQ	CONCRETE, 3000PSI	CONT
3	1 EA	TS 3/16"TX4"DIA.X5'L, CARBON STEEL	CONT
4	2 EA	#4 REBAR, 2–6" LONG	CONT



CONCRETE PAD PLAN & DETAILS



PLAN



GROUNDWATER MONITORING WELL SIGN

NTS

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

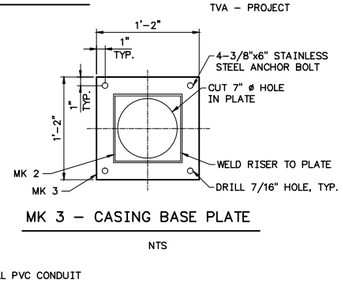
ABBREVIATIONS:

CONT – CONTRACTOR

TVA – PROJECT

SECTION A–A

PEDESTAL COVER
3" = 1'–0"

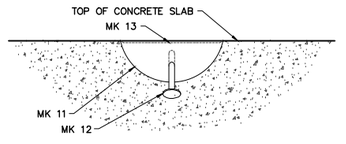


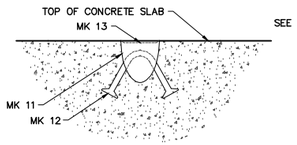
MK 3 – CASING BASE PLATE

NTS

NOTES:

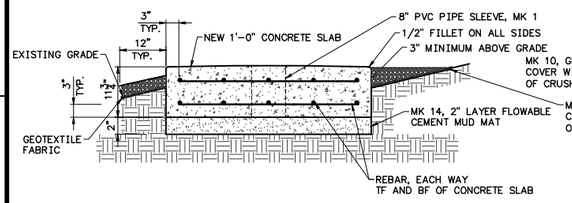
1. ALL STAINLESS STEEL TO BE GRADE 303 UNLESS NOTED OTHERWISE.
2. IMPLEMENT BEST MANAGEMENT PRACTICES PRIOR TO STARTING WORK.
3. PROVIDE TEMPORARY SPILL CONTAINMENT DEVICES IF CONTRACTOR WILL REFUEL EQUIPMENT ONSITE.
4. BOLLARDS PAINTING REQUIREMENTS:
   A. SURFACE PREPARATION:
      CLEAN SURFACES PRIOR TO APPLYING THE PAINT IN ACCORDANCE WITH THE STEEL STRUCTURES PAINTING COUNCIL (SSPC) SP–2 & –3 STANDARDS, "HAND AND POWER TOOL CLEANING". ALL LOSE RUST, LOOSE PAINT, AND OTHER LOOSE DETRIMENTAL FOREIGN MATTER SHALL BE REMOVED. FEATHER THE EDGES OF ANY REMAINING OLD PAINT SO THAT THE REPAINTED SURFACES CAN HAVE A REASONABLY SMOOTH APPEARANCE.
   B. PAINT AND PRIMER – SHERWIN WILLIAMS COATINGS SYSTEM OR AN APPROVED EQUEAL:
      PRIMER
      SHERWIN WILLIAMS DURA PLATE 235 @ 3–5 MILS DFT FOR BARE STEEL OR RUST.
      SHERWIN WILLIAMS POLYSILOXANE 1K @ 1.5–2.5 MILS DFT PER COAT FOR THE PREVIOUSLY PRIMED OR PAINTED SURFACES.
      FINISH COLOR
      SHERWIN WILLIAMS SUNSPOT YELLOW (SW) 1672.
   C. BOLLARDS SHALL RECEIVE ONE COAT OF PRIMER AND TWO COATS OF PAINT.
5. CONCRETE PAD TO HAVE A BROOM FINISH.
6. BENTONITE SHALL BE CETCO C/S OR AN APPROVED EQUAL.
7. PEA GRAVEL SHALL BE WASHED 3/8" SIZE OR AN APPROVED EQUAL.
8. GROUNDWATER MONITORING WELL SIGN SHALL BE PAINTED BLUE, FEDERAL STANDARD NO. 15187.
9. PROVIDE A MASTER LOCK ON THE GROUND WATER MONITORING WELL PROTECTIVE COVER THAT WILL ACCEPT TVA GROUND WATER MONITORING WELL KEY NUMBER 0896 ONLY. LOCKS NOT ACCEPTING KEY 0896 WILL NOT BE ALLOWED UNLESS PRIOR APPROVAL IS OBTAINED FROM TVA. CONTACT THE PLANT'S ENVIRONMENTAL SCIENTIST FOR ASSISTANCE IN OBTAINING THE PROPER LOCK.





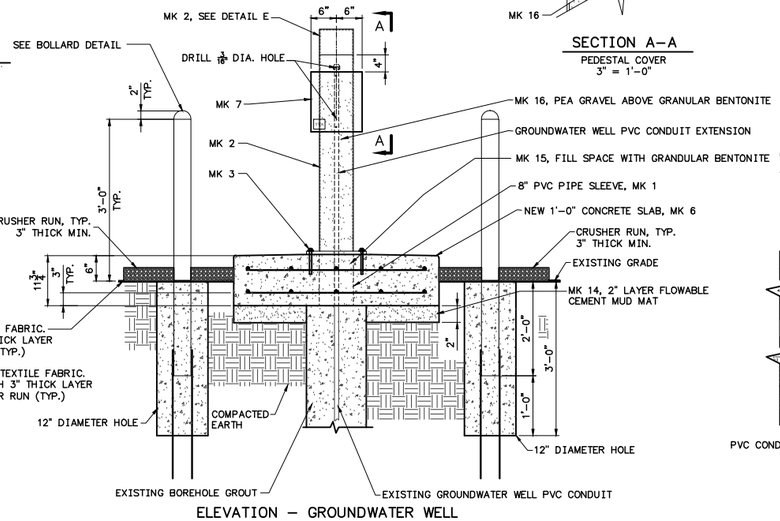
DETAIL B – LIFTING ANCHOR

3" = 1'–0"

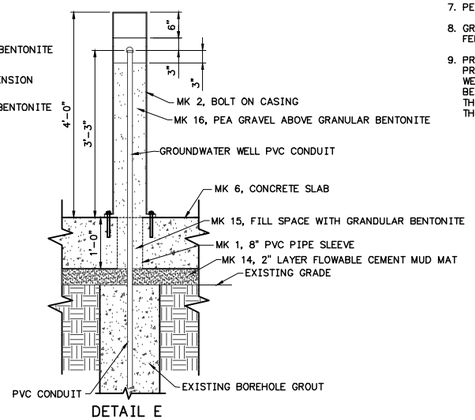


4'–0"X4'–0" CONCRETE PAD FOUNDATION

ON SLOPE AREA



ELEVATION – GROUNDWATER WELL



DETAIL E

R														
R 0	05–05–2016	JLG	CWH	JLG			SEB	MST					D	DISCIPLINE INTERFACE
INITIAL ISSUE														
REV. NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	PROJECT ID	AS CONST				
SCALE: 1" = 1'–0"									EXCEPT AS NOTED					

YARD
GROUNDWATER INSTRUMENTATION

TYPICAL GROUNDWATER MONITORING WELL CONCRETE PAD & BOLLARDS PLAN ELEVATION & CONSTRUCTION DETAILS

DESIGNED BY:	DRAWN BY:	CHECKED BY:	SUPERVISED BY:	REVIEWED BY:	APPROVED BY:	ISSUED BY:
J.L. GRAY	C.W. HENSLEY	J.L. GRAY			S.E. BENNETT	M.S. TUPPAW

JOHNSONVILLE FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY
FOSSIL AND HYDRO ENGINEERING

AUTOCAD R 2008	DATE	30	C	10W858–08	R 0

TASK COMPLETED BY: | REV NO.

PLOT FACTOR: W_TVA

C.A.D. DRAWING DO NOT ALTER MANUALLY

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
Acoustic Televiewer
Rubber packers
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 N
CCR MATERIAL CHARACTERISTICS SAP

CCR Material Characteristics Sampling and Analysis Plan Bull Run Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Bull Run Fossil Plant
Clinton, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 17, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	October 27, 2017
2	Addresses January 29, 2018 TDEC Review Comments and Issued for TDEC Review	March 30, 2018
3	Addresses May 22, 2018 TDEC Review Comments and Issued for TDEC Review	July 13, 2018
4	Addresses TDEC Comments, Applicable Programmatic Revisions, and Issued for TDEC Approval	December 17, 2018

CCR MATERIAL CHARACTERISTICS
SAMPLING AND ANALYSIS PLAN
BULL RUN FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: CCR Material Characteristics
Sampling and Analysis Plan
Bull Run Fossil Plant
Tennessee Valley Authority
Clinton, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 17, 2018 Revision 4

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 McClung, Nicholas Anthony Digitally signed by McClung, Nicholas Anthony Date: 2018.12.07 09:52:57 -05'00'	12/13/18 Date
TVA Investigation Field Lead	Date
Health, Safety, and Environmental (HSE) Manager	12/13/18 Date
Investigation Project Manager	12/6/2018 Date
QA Oversight Manager Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.12.11 12:57:27 -05'00'	Date
Laboratory Project Manager	12.12.18 Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

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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 Bull Run Fossil Plant (BRF) on July 13-14, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at BRF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference.

On September 13, 2016, TDEC issued 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 January 9, 2017, TVA submitted BRF 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 BRF 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 PORE WATER SAMPLING LOCATIONS

The Study Area for this CCR Material Characteristics SAP consists of the Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, Railroad Loop Area, and Dry Fly Ash Stack Phases 1 and 2. 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). Fifteen sample locations were selected based on TDEC's request to characterize the leachability of constituents from the material in each CCR unit. 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.

In temporary wells TW05, TW07, and TW09, pore water samples will be taken above the drainage layer in the Gypsum Disposal Area 2A, but within the phreatic zone, to characterize the pore water constituents in the stacked gypsum. In temporary wells TW04, TW06 and TW08, pore water samples will be taken below the drainage layer at the base of the unit, in the original sluiced ash, placed there when the Ash Disposal Area was one single unit. In temporary wells TW03, TW10, TW11, and TW12, pore water samples will be taken at the base of the unit in the original sluiced ash. In temporary wells TW01-02 and TW13-15, pore water samples will be taken at the base of the unit.

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.

Maps showing all pore water/CCR material sampling locations are provided as Figures 1-3 in Attachment A. Installation and construction specifications for the temporary wells are provided in the BRF 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	Railroad Loop Disposal Area – northeastern edge
TW02	Railroad Loop Disposal Area – southeastern edge
TW03	Main Ash Pond
TW04	Gypsum Disposal Area 2A – eastern edge
TW05	Gypsum Disposal Area 2A – eastern edge
TW06	Gypsum Disposal Area 2A – SW corner
TW07	Gypsum Disposal Area 2A – SW corner
TW08	Gypsum Disposal Area 2A – northern edge
TW09	Gypsum Disposal Area 2A – northern edge
TW10	Bottom Ash Disposal Area – southern corner
TW11	Bottom Ash Disposal Area – between TW08/TW10
TW12	Bottom Ash Disposal Area – northern corner
TW13	Dry Fly Ash Stack Phase 1 – northwestern corner
TW14	Dry Fly Ash Stack Phase 1 – center of stack
TW15	Dry Fly Ash Stack Phase 2 – center of stack

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
- Complete required health and safety paperwork and confirm field team members have completed required training
- Coordinate field activities with the Laboratory Coordinator to ensure 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 totals 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. Sample analyses are described in greater detail in Section 5.2.6.

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% µS/cm;
- Dissolved oxygen (DO) - ±10% for > 0.5 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. 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 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 Quality Assurance Project Plan (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. 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, based on the final reading collected at completion of purging and directly before the sample was collected, 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-05.80.50, *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 ensure 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) to be used 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 ensure 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 BRF EI 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 ensure the label is not removed. 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	20 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:

- Approved sampling methods and protocols may have to be substituted in the EIP based on changing field conditions.

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 Geotechnical Borings
Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Fly Ash Stilling Pond 2C & Main Ash Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175568274

Prepared by MB on 2018-12-13
Technical Review by TG on 2018-12-13

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Proposed Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, and Geotechnical Data) (Screened Interval)
- Proposed Geotechnical Boring
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

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TVA

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I:\TVA-EP\175568274_BRF_Phase2\gis\mxd\BRF_Proposed_GeoTech_Borings_South.mxd Revised: 2018-12-13 By: mbough

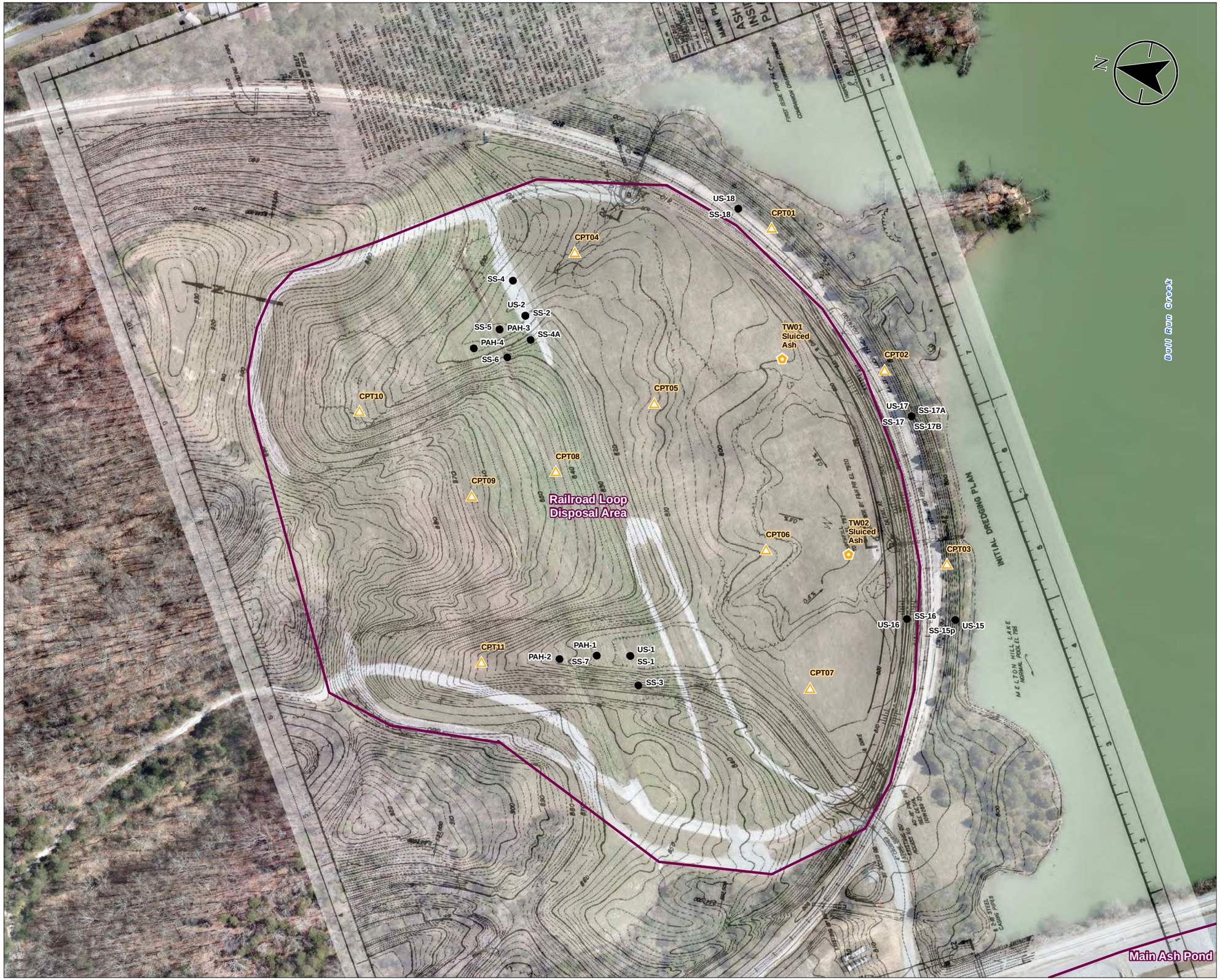

Figure No.

2

Title

Proposed Geotechnical Borings
Railroad Loop Disposal Area

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by TKR on 2018-06-14
Technical Review by TG on 2018-06-14

0 80 160 240 320 Feet

1:960 (At original document size of 22x34)

Legend

- Proposed Cone Penetration Test
- Proposed Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, and Geotechnical Data) (Screened Interval)
- Existing Boring
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Historical TVA Drawing 10W289-1 R0 (1981) is shown.

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U:\TVA-EIP\175566346\gis\mxds\BRF_Proposed_Geotech_Borings_RailLoop.mxd Revised: 2018-06-14 By: mbough

Figure No.
3

Title
Proposed Geotechnical Borings
Dry Fly Ash Stack

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175568274
Prepared by MB on 2018-12-13
Technical Review by TG on 2018-12-13

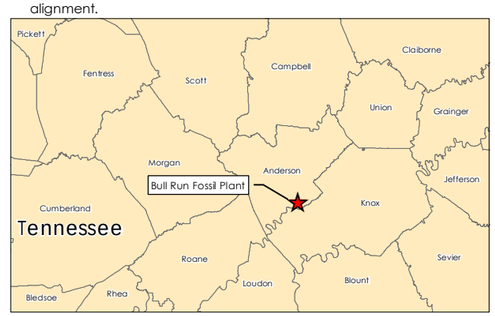
0 150 300 450 600 Feet
1:1,800 (At original document size of 22x34)

Legend

- Proposed Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, and Geotechnical Data) (Screened Interval)
- Proposed Cone Penetration Test
- Existing Boring
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Historical TVA Drawing 10W293-1 R2 (1993) is shown.
4. CPT borings on 5 feet spacing along historical unnamed tributary alignment.



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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
Field pH Test Kits
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
MATERIAL QUANTITY SAP

Material Quantity Sampling and Analysis Plan Bull Run Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Bull Run Fossil Plant
Clinton, Tennessee

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 17, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	October 27, 2017
2	Addresses January 29, 2018 TDEC Review Comments and Issued for TDEC Review	March 30, 2018
3	Addresses May 22, 2018 TDEC Review Comments and Issued for TDEC Review	July 13, 2018
4	Addresses Applicable Programmatic Revisions, and Issued for TDEC Approval	December 17, 2018

MATERIAL QUANTITY
SAMPLING AND ANALYSIS PLAN
BULL RUN FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Material Quantity
Sampling and Analysis Plan
Bull Run Fossil Plant
Tennessee Valley Authority
Clinton, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 17, 2018 Revision 4

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	12/13/18 Date
McClung, Nicholas Anthony — Digitally signed by McClung, Nicholas Anthony Date: 2018.12.07 09:53:28 -05'00'	
TVA Investigation Field Lead	Date
Health, Safety, and Environmental (HSE) Manager	12/13/18 Date
Investigation Project Manager	12/6/2018 Date
Rock J. Vitale — Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envsid.com, c=US Date: 2018.12.11 12:57:54 -05'00'	
QA Oversight Manager	Date
Laboratory Project Manager	12/6/2018 Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

Stantec

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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 Bull Run Fossil Plant (BRF) on July 13-14, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at BRF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference.

On September 13, 2016, TDEC issued 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 January 9, 2017, TVA submitted BRF 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 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 Dry Fly Ash Stack Phase 1 and 2, Dry Fly Ash Stack Lateral Expansion, Railroad Loop Disposal Area, Bottom Ash Disposal Area, Sluice Channel, Former Disposal Area, Chemical Pond, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C.

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 Dry Fly Ash Stack Phases 1 and 2, Dry Fly Ash Stack Lateral Expansion, Railroad Loop Disposal Area, Bottom Ash Disposal Area, Sluice Channel, Former Disposal Area, Chemical Pond, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C. Activities described in this SAP will be completed to:

- Estimate the volume of CCR above and below groundwater
- Estimate the volume of CCR above and below the piezometric level of saturation
- Develop three-dimensional models of the subsurface from ground surface to bedrock and CCR volume estimates for each area
- Model the sluiced fly ash and bottom ash in the Bottom Ash Disposal Area and CCR closure elevations to evaluate whether proposed CCR closure elevations intersect sluiced fly ash

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 APPROACH

4.1 EXPLORATORY BORINGS AND INSTRUMENTATION

4.1.1 Proposed TDEC Order Borings and Instrumentation

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 performing cone penetration tests (CPT) and installing multi-purpose borings and temporary wells at locations shown on Figures 1 through 4 (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 74 CPTs and 18 borings are proposed.

Details regarding proposed drilling, sampling, temporary well and piezometer installation activities are provided in the Exploratory Drilling SAP. Details regarding proposed drilling, sampling, and groundwater well installation activities are provided in the Hydrogeological Investigation SAP. Table 1 provides the number of CPTs, borings, temporary wells, and piezometers proposed in each CCR unit.

Table 1. Exploratory Drilling Proposed in each CCR Unit

CCR Unit	Total No. of Proposed CPT	Total No. of Proposed Borings	No. of Borings with Temporary Wells	No. of Borings with Rock Coring
Main Ash Pond	28	1	1	1
Gypsum Disposal Area 2A	21	6	6	3
Bottom Ash Disposal Area	14	3	3	3
Former Disposal Area	0	2	0	2
Railroad Loop Disposal Area	11	2	2	2
Dry Fly Ash Stack Phases 1 and 2	14	3	3	0
Total	**88**	**17**	**15**	**11**

4.1.2 Data Analysis

Data from the proposed multi-purpose borings will be compared to the existing boring data and pre-construction topographic information available for each 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.

4.1.3 Water Level Monitoring

Monthly water level monitoring will be conducted for 6 months to estimate and monitor piezometric saturation levels in each CCR unit. Manual readings from temporary wells and open standpipe piezometers and readings from automated vibrating wire transducer piezometers will be used 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 elect to remove the temporary wells following the 6 month monitoring period.

4.2 THREE-DIMENSIONAL MODELS

Three-dimensional models of Dry Fly Ash Stack Phases 1 and 2, Dry Fly Ash Stack Lateral Expansion, Railroad Loop Disposal Area, Bottom Ash Disposal Area, Sluice Channel, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C will be developed to depict subsurface conditions from the ground surface to bedrock. The models will be developed using the data summarized below which includes data from the proposed exploratory borings, piezometers, and wells discussed in Section 3.1, as well as other relevant data collected during the Investigation.

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

2. TVA surveyed slopes, embankments, and benches to develop stability cross-sections. TVA will use this topographic data with the most recent aerial survey data to model the geometry of the dikes and benches.

3. Contour data from the most recent aerial and hydrographic surveys, borings shown on Figures 1 through 6, and as-built survey data from the Railroad Loop Disposal Area closure (Attachment B) will be used to model the upper CCR surface.

4. Record drawings documenting the drainage/capillary break layer will be used to model the lower CCR surface of the Dry Fly Ash Stack Lateral Expansion. Pre-construction topographic information from TVA drawings (Attachment C) and data from borings that penetrated the lower boundary of the CCR surface shown on Figures 1 through 6 will be used to model the lower CCR surface at the remaining units.

5. Data from borings shown on Figures 3 and 6 will be used to model sluiced ash and bottom ash in the Bottom Ash Disposal Area.

6. Data from borings that encountered foundation soils shown on Figures 1 through 4, 7, and 8 will be used to model the foundation soils underlying each site.

7. Data from borings that encountered top of bedrock shown on Figures 1-4, 9, and 10 will be used to model the top of bedrock surface.

8. Estimated piezometric levels of saturation discussed in Section 3.1.3 will be incorporated into the models.

9. Groundwater levels estimated as part of the hydrogeological investigation described in the Hydrogeological Investigation SAP will be incorporated into the models.

The three-dimensional models 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 models of the facilities.

4.3 DRAWINGS

After the three-dimensional models are finalized, they will be used to produce drawings of the Dry Fly Ash Stack Phase 1 & 2, Dry Fly Ash Stack Lateral Expansion, Railroad Loop Disposal Area, Bottom Ash Disposal Area, Sluice Channel, Former Disposal Area, Chemical Pond, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C showing the following:

- Subsurface material types, properties, elevations, and thickness from the ground surface to top of bedrock
- 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 Fly Ash Stilling Pond 2C
- Sluiced fly ash and bottom ash in the Bottom Ash Disposal Area
- Proposed Bottom Ash Disposal Area CCR closure elevations

4.4 VOLUMETRIC ESTIMATES

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

5.0 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.

6.0 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.

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 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.

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.

7.0 SCHEDULE

Anticipated schedule activities and durations for the implementation of the Material Quantity SAP are summarized below. This schedule is preliminary and subject to change based on approvals. For the anticipated overall EIP Implementation schedule, see the schedule provided in the BRF 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 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

8.0 ASSUMPTIONS AND LIMITATIONS

In preparing this SAP, the Investigation Project Manager has made the following assumptions:

- 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.

ATTACHMENT A
FIGURES

Figure No.

1

Title

Proposed Geotechnical Borings
Dry Fly Ash Stack

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175568274

Prepared by MB on 2018-12-13
Technical Review by TG on 2018-12-13

0 150 300 450 600 Feet

1:1,800 (At original document size of 22x34)

Legend

- Proposed Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, and Geotechnical Data) (Screened Interval)
- Proposed Cone Penetration Test
- Existing Boring
- CCR Unit Area (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Historical TVA Drawing 10W293-1 R2 (1993) is shown.
4. CPT borings on 5 feet spacing along historical unnamed tributary alignment.

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U:\TVA-EPV\175568274_BRF_Phase2\gis\mxd\BRF_Proposed_GeoTech_Borings_DryFly.mxd Revised: 2018-12-13 By: mbough

Figure No.

2

Title

Existing Monitoring Well and Proposed Monitoring Well, Piezometer and Pilot Hole Locations

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346
Prepared by LMB on 2018-03-06
Technical Review by TG on 2018-03-06

0 700 1,400 2,100 2,800 Feet

1:8,400 (At original document size of 22x34)

Legend

- Proposed Pilot Hole to be Converted to Piezometer
- Proposed Pilot Hole to be Converted to Monitoring Well
- Proposed Monitoring Well

Existing Well

- Existing Monitoring Well (State Compliance)
- Observation Well (State Compliance)
- Existing Monitoring Well (State and CCR Rule Compliance)
- Existing Monitoring Well (Other)
- Surface Water Gauging Station
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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U:\TVA-EIP\175566346\gis\mxds\Exhibit\Updates_2018\022A\BRF_Existing_Wells_Proposed_Wells.mxd Revised: 2018-03-06 By: lbackman

Figure No.

3

Title

Proposed Geotechnical Borings
Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Fly Ash Stilling Pond 2C & Main Ash Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175568274

Prepared by MB on 2018-12-13
Technical Review by TG on 2018-12-13

0 300 600 900 1,200 Feet

1:3,600 (At original document size of 22x34)

Legend

- Proposed Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, and Geotechnical Data) (Screened Interval)
- Proposed Geotechnical Boring
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

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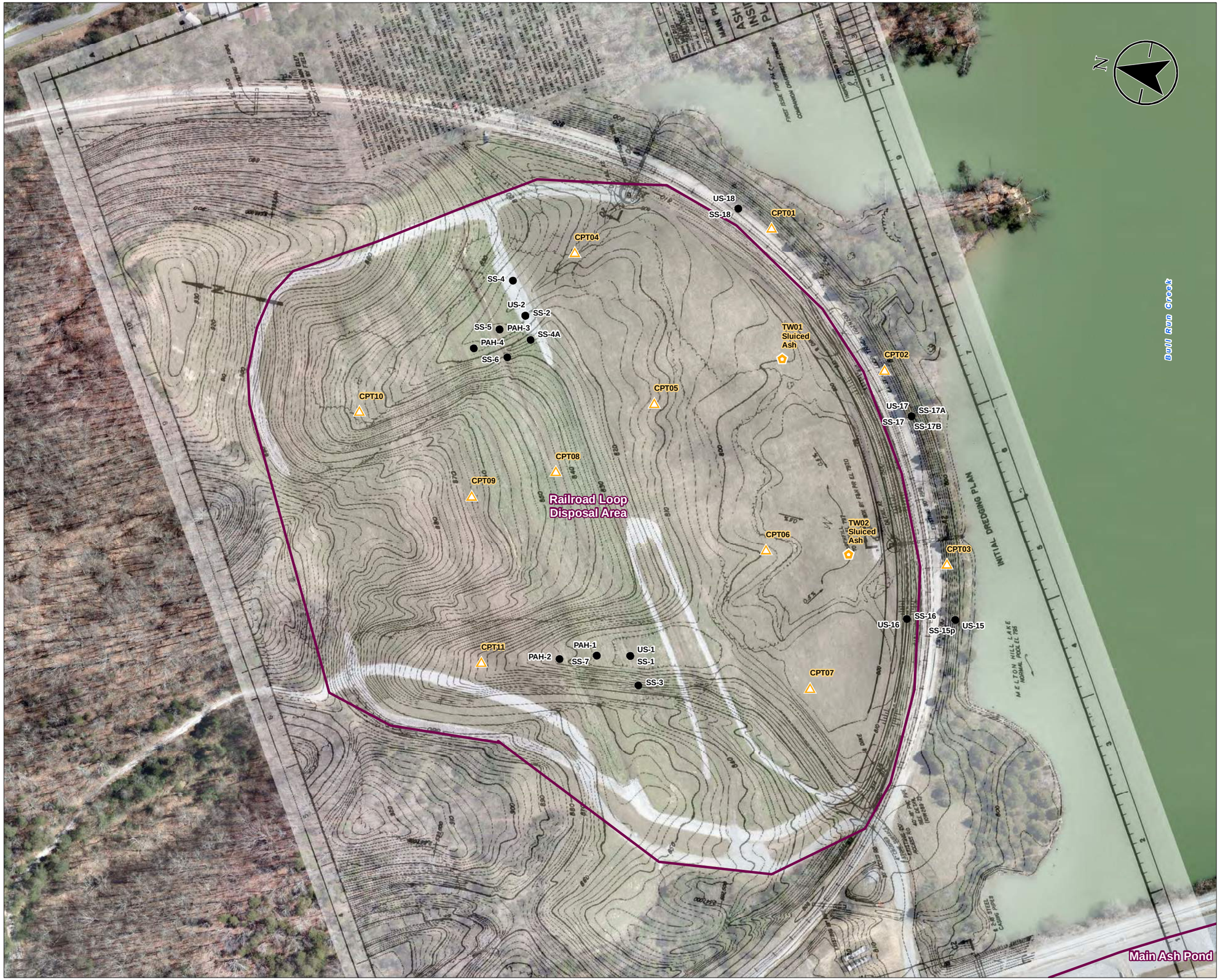

Figure No.
4

Title
Proposed Geotechnical Borings
Railroad Loop Disposal Area

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-06-14
Technical Review by TG on 2018-06-14

0 80 160 240 320 Feet
1:960 (At original document size of 22x34)

Legend

- Proposed Cone Penetration Test
- Proposed Boring with Temporary Well (Saturation Level in CCR, Pore Water Sampling, and Geotechnical Data) (Screened Interval)
- Existing Boring
- CCR Unit Area (Approximate)

Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Historical TVA Drawing 10W289-1 R0 (1981) is shown.

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Figure No.

5

Title

Existing CCR Thickness Boring Data
Dry Fly Ash Stack

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

0 150 300 450 600 Feet

1:1,800 (At original document size of 22x34)

Legend

- Boring with CCR Thickness Data
- CCR Unit Area (Approximate)
- Constructed Geologic Buffer (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Borings within Lateral Expansion Area pre-date the construction of the geologic buffer. CCR material was removed during construction.

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Figure No.

6

Title

Existing CCR Thickness Boring Data
Bottom Ash Disposal Area, Gypsum Disposal Area 2A,
Fly Ash Stilling Pond 2C, Railroad Loop & Main Ash Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-23
Technical Review by TG on 2017-10-23

0 250 500 750 1,000 Feet

1:3,600 (At original document size of 22x34)

Legend

- Boring with CCR Thickness Data
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

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Figure No.
7

Title
Uppermost Foundation Soil Data
Dry Fly Ash Stack

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-03-28
Technical Review by TG on 2018-03-28

0 150 300 450 600 Feet
1:1,800 (At original document size of 22x34)

Legend

Bedrock	▣	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Clay	●	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Clayey Fill	▲	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Silt	⬢	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*

CCR Unit Area (Approximate)

Constructed Geologic Buffer (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. Borings within Lateral Expansion Area pre-date the construction of the geologic buffer.
4. Borings prior to 1994 pre-date the geologic buffer in the Phase 2 footprint.
5. The Phase 2 footprint includes a constructed geologic buffer, with a specified hydraulic conductivity of less than or equal to 1.0E-06 cm/s, confirmed by construction quality assurance testing.
6. The Lateral Expansion footprint includes a constructed geologic buffer, with a specified hydraulic conductivity of less than or equal to 1.0E-06 cm/s. A compacted clay liner, with a specified hydraulic conductivity of less than or equal to 1.0E-07 cm/s, and a geomembrane overlie the geologic buffer. Hydraulic conductivity requirements were confirmed by construction quality assurance testing.

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I:\TVA-EP\175566346\gis\mxds\BRF Foundation_Soils_DryFly.mxd Revised: 2018-03-28 By: TRink

Figure No.

8

Title

Uppermost Foundation Soil Data
Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Fly Ash Stilling Pond 2C, Railroad Loop & Main Ash Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by TKR on 2018-03-28
Technical Review by TG on 2018-03-28

0 250 500 750 1,000 Feet

1:3,600 (At original document size of 22x34)

Legend

Bedrock	▣	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Clay	Ⓒ	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Clayey Sand	◉	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Clayey Fill	▲	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Sand	●	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*
Silt	⬟	*Boring ID, Test Type, Hydraulic Conductivity (cm/s) [if completed]*

CCR Unit Area (Approximate)

Former Disposal Area (Approximate)

Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)

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Figure No.

9

Title

Existing Top of Rock Boring Data
Dry Fly Ash Stack

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by TKR on 2017-09-27
Technical Review by TG on 2017-09-27

0 150 300 450 600 Feet

1:1,800 (At original document size of 22x34)

Legend

- Boring without Rock Core Data [ID, TOR Elevation]
- Boring with Rock Core Data [ID, TOR Elevation, RQD]
- Fault Line
- CCR Unit Area (Approximate)
- Cr - Rome Formation
- Och - Chickamauga Group, includes Upper part of Chickamauga Group (Reedsville Shale, and Unnamed limestone unit) and Middle and Lower part of Chickamauga Group
- Onc - Unnamed (upper part of Knox Group), including Newala Formation, Mascot Dolomite, Kingsport Formation, Longview Dolomite, and Chepultepec Dolomite

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. RQD value corresponds to upper 20 feet of rock core.

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Figure No.

10

Title

Existing Top of Rock Elevation Boring Data
Bottom Ash Disposal Area, Gypsum Disposal Area 2A,
Fly Ash Stilling Pond 2C, Railroad Loop & Stilling Pond

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

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 [ID, TOR Elevation, RQD]
- Fault Line
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)
- Ccl - Nolichucky Shale, and Maryville, Rogersville, and Rutledge Formations, and Pumpkin Valley Shale
- Ccr - Copper Ridge Dolomite
- Cmn - Maynardville Limestone
- Cr - Rome Formation
- Och - Chickamauga Group, includes Upper part of Chickamauga Group (Reedsville Shale, and Unnamed limestone unit) and Middle and Lower part of Chickamauga Group

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Tuck Mapping (2017-03-16)
3. RQD value corresponds to upper 20 feet of rock core.

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ATTACHMENT B
RAILROAD LOOP DISPOSAL AREA
CLOSURE AS-BUILT SURVEY DATA

Singleton Laboratories

PREPARED FOR:
TVA BULL RUN FOSSIL PLANT
1254 Edgemoor Rd
Clinton, TN 37716
As Requested By: G.L. Corder

1413 Topside Road • Louisville, Tennessee 37777
(423) 970-2299 •1-800-735-2299 • Fax (423) 970-2312

Singleton Laboratories

The Critical Link.®

January 4, 1996

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING FOR
CLAY CAPPING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

SL Report 209-078-001B

PREPARED FOR:
TVA BULL RUN FOSSIL PLANT
1254 Edgemoor Rd
Clinton, TN 37716
As Requested By: G.L. Corder

SINGLETON LABORATORIES
1413 Topside Road
Louisville, TN 37777
615-970-2299

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Post-Construction Survey	3
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Summary	6

Tables:
1 Summary of Survey Data for Upper Ash Disposal Area Inside Loop Track
2 Summary of Survey Data for East and West Pond Ash Disposal Areas Inside Loop Track
3 Summary of Field Moisture-Density Test Results of Compacted Clay Cap
4 Summary of Permeability Verification for Compacted Clay Cap

Figures:
1 General Location of Ash Disposal Area Inside Loop Track
2 Ash Elevation Survey for Upper Ash Disposal Area
3 Ash Elevation Survey for East and West Ponds Ash Disposal Area
4 Acceptable Zone of Moisture-Density Points for Permeability
5 Clay Cap Elevation survey for Upper Ash disposal Area
6 Top Soil Elevation survey for Upper Ash disposal Area
7 Clay Cap Elevation Survey for East and West Ponds Ash Disposal Area
8 Top Soil Elevation Survey for East and West Ponds Ash Disposal Area

Attachments:
A Daily Report and Test Data of QA/QC Inspection and Testing
B Laboratory Test Data for Permeability Verification
C Purchase Receipts

Appendix:
A Compaction Curves and Laboratory Test Data

INTRODUCTION

Singleton Laboratories has completed QA/QC inspection and testing for clay capping of ash disposal at TVA Bull Run Fossil Plant as requested in TVA PO NO. P-95P3G-147727-000 RLSE 0000000, dated August 2, 1995. This investigation was conducted in general accordance with Singleton Laboratories Proposal 95-160R1, dated July 28, 1995. The purpose of the investigation was to ensure the closure and clay capping of ash disposal area inside loop track at Bull Run Fossil Plant meet the requirement of one foot of compacted clay with a maximum hydraulic conductivity of $1x10^{-7}$ cm/sec and one foot of specified vegetative cover. The ash disposal area inside loop track consists of upper ash disposal area, east pond ash disposal area, and west pond ash disposal area. A total area of the ash disposal inside loop track is approximately 25 acres. A general location of the ash disposal area inside loop track is shown in Figure 1. The investigation consisted of: (1) a pre-construction survey to determine initial elevations prior to clay capping and top soil placement; (2) verification of clay source at the designated borrow area; (3) QA/QC inspection and testing during construction for clay capping; (4) a post-construction survey to determine final elevations of clay cap and top soil; (5) permeability verification of the compacted clay cap; and (6) preparation of final report. The investigation included both field inspection and testing and laboratory analysis of soil. The following report presents the activities and results of the investigation.

PRE-CONSTRUCTION SURVEY

After completion of fly ash stacking in accordance with the stacking plan, initial survey was performed to determine the final ash elevations across the site on August 2, 1995 for the upper ash disposal area inside loop track and October 4, 1995 for the east and west pond ash disposal areas inside loop track. Survey data is summarized in Tables 1 and 2 for the upper area and the east and west pond areas, respectively. Survey locations are shown in Figures 2 and 3.

PRE-CONSTRUCTION TESTING

Clay Source Verification

The clay source of Rogers Group which has been approved for the previous projects for clay capping and geologic buffer construction

at Bull Run Fossil Plant site was used for this project. As reported in Singleton Laboratories Report 015-672-039A dated November 28, 1994, bag soil samples were obtained from the designated borrow area for laboratory compaction. All bag samples were dried in air until they were friable. After drying, the soils were thoroughly broken up and passed through a No. 4 sieve. Based on visual classification, a number of soil types was identified for compaction. The processed materials of each soil group were mixed. Classification tests including grain-size analysis (ASTM D 422) and Atterberg Limits determination (ASTM D 4318) were performed on the mixed material of each soil group. Grain-size distribution curves and index properties including liquid limit, plastic limit, and plasticity index were performed. To assure a higher degree of accuracy, duplicate samples were prepared and tested for liquid limit for each soil sample. Therefore, there were two classification test results for each soil sample tested.

In this borrow area, two soil types were identified as Soil Classes I and II. Generally, the soil of Class I was classified as a silt with high plasticity, containing 12 percent gravel, 10 percent sand, 12 percent silt, and 66 percent clay. The soil has a specific gravity of 2.71, a liquid limit of 72 percent, and a plasticity index of 39 percent. The soil of Class II was classified as a fat silty clay (MH) with high plasticity, containing 4 percent gravel, 15 percent sand, 16 percent silt, and 65 percent clay. The soil has a specific gravity of 2.74, a liquid limit of 64 percent, and a plasticity index of 33 percent.

Standard compaction tests were performed in accordance with ASTM D 698 Methods A and C based on grain-size criteria. Optimum moisture contents and maximum dry densities were determined to be 28.1 percent and 91.2 pcf, respectively, for Soil Class I and 29.6 percent and 90.7 pcf, respectively, for Soil Class II. Compaction curves and test data reported in Singleton Laboratories Report 015-672-039A are enclosed in Appendix A.

Permeability Tests

Permeability tests were performed in accordance with ASTM D 5084 (Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter) on soil specimens, using a falling head method. The test specimens were remolded to varying moisture contents and dry densities based on the optimum moisture content and maximum dry density of each Soil Class. The specimens were consolidated after completion of back pressure saturation. For each specimen, several runs of permeability testing were conducted. The permeability was calculated based on the following equation.

$$K = \frac{a_{in}\, a_{out}\, L}{At\ (a_{in} + a_{out})} \ln \frac{h_1}{h_2}$$

where:

a_{in}	=	cross-sectional area of the reservoir containing the influent liquid, cm^2
a_{out}	=	cross-sectional area of the reservoir containing the effluent liquid, cm^2
L	=	length of the specimen, cm
A	=	cross-sectional area of the specimen, cm^2
t	=	elapsed time between determination of h_1 and h_2, sec
h_1	=	head loss across the specimen at time t, cm
h_2	=	head loss across the specimen at time t, cm

Permeability tests were performed on the two soil classes determined. Based on permeability test results and molding conditions of the test specimen, an acceptable zone of permeability was established in the compaction curves and is shown in Figure 5. Individual permeability test data for each specimen tested are enclosed in Appendix A and were also reported in Singleton Laboratories Report 015-672-039A.

QA/QC INSPECTION AND TESTING DURING CONSTRUCTION

Construction of Clay Cap

Closure and clay capping for the ash disposal area inside loop track was constructed between August 10 and October 19, 1995. During this period, a qualified inspector from Singleton Laboratories was on-site to inspect the construction work. Inspection of the construction work included the following:

1. Inspection of the water content, density, and other physical properties of the soil during processing, placement, and compaction.

2. Inspection of the thickness of lifts as loosely placed and as compacted.

3. Inspection of the action of the compaction and heavy hauling equipment on the construction surface (sheepsfoot penetration, pumping, cracking, etc.).

4. Inspection of the number of passes used to compact each lift.

Nuclear density method were used for all density testing due to the relatively large number of tests which could be run in a specified time. At locations where the field testing indicated densities below the requirements of the specifications, the failing area was scarified and recompacted. An additional test was performed in the corrected area to verify the test results meet the specifications. The process of recompaction and retesting continued to the satisfactory test results. All deficiencies including test number and retest number are shown in the remarks column of the daily test data sheets and the summary of test results. All test results are summarized in Table 2. Daily inspection reports and individual test data sheets in Attachment A. For each daily inspection, the following documents are included:

1. Daily Field Report
2. Field Moisture-Density Test Sheet
3. Test Location Plan
4. Test Data Points located relatively in the acceptable zone of permeability plot.

Vegetative Cover

Vegetative cover construction and seeding were completed in accordance with the specification of closure plan and TVA Specification T-1, Section 580, respectively. A minimum of 12-in. thickness of vegetative cover was placed and verified by survey data. Specified seeds and fertilizer were applied to establish a good vegetative cover over the entire clay capping area. The amount of seeds and fertilizer applied are listed below. All materials were purchased at Tennessee Farmers Cooperative in Anderson County, Tennessee. All receipts of seed are enclosed in Attachment C.

Items	Total Weight, lbs	lbs per acre
Grass seed, Kentucky 31	2,000	60.0
Grass seed, White clover	500	15.2
Grass seed, Perennial rye	650	19.7
Grass seed, Wheat	17 bushels	0.5 b
Fertilizer, 34-0-0	6,600	200.0
Fertilizer, 15-15-15	13,200	400.0
Lime	16,000	484.8
Straw	1,890 bales	57 b

Calculations of pounds per acre were based on 33 acres including 25 acres of this project (ash disposal area inside loop track) and 8 acres of other project (the remaining geologic buffer of Stage II Dry Ash Stacking Facility), and the total weights of seeds and fertilizer shown on the purchased receipts provided.

POST-CONSTRUCTION SURVEY

After completion of each stage of the closure and clay capping, a final survey was conducted to obtain the elevation of each location in the established grid system. The final elevations were compared with the initial elevation at each corresponding location to determine the thickness of compacted clay cap and vegetative cover. All elevations of the post-construction survey are also summarized in Table 1 for the upper ash disposal area and Table 2 for the east and west ponds area. Results indicate the individual thickness of clay cap and vegetative cover of ash disposal area inside loop track meets a minimum of one foot requirement.

PERMEABILITY VERIFICATION OF COMPACTED CLAY CAP

Upon completion of the clay cap construction, undisturbed tube samples were taken to verify the permeability requirement of compacted clay. A total of six (6) 3-in. tube samples were obtained to meet a minimum of one (1) tube per five (5) acres per 1-ft of clay cap in accordance with the specifications. The holes left by the Shelby Tube were carefully backfilled with soil mixed with bentonite, hand tamped, and compacted into place.

The hydraulic conductivity tests were performed on undisturbed soil samples in accordance with ASTM D 5084 and test results indicate the hydraulic conductivities of all 6 samples tested are less than $1x1.0^{-7}$ cm/sec required in the specifications. A summary of test results of soil classification, moisture content, dry density, and permeability is enclosed in Table 4. Individual test data sheets, and tube sample locations are enclosed in Appendix C.

SUMMARY

This report summarized the activities and results of QA/QC inspection and testing for closure and clay capping of the ash disposal area inside loop track including the upper ash disposal and the east and west pond ash disposal areas at TVA Bull Run Fossil Plant. The report also certifies the construction work of closure and clay capping was performed in compliance with the plans and specifications. The individual thickness of clay cap and vegetative cover meets a minimum one foot requirement in accordance with the closure plan. The thickness was verified by (1) inspection during construction, and (2) final survey elevations in comparison with initial survey elevations at the corresponding location after completion of each stage of construction for the clay cap and the vegetative cover. Permeabilities of all six (6) tube samples taken from the compacted clay cap after construction are less than the maximum permeability of $1x10^{-7}$ cm/sec in accordance with the specifications. All documents including Daily Inspection Reports and laboratory test data are enclosed in this report.

TABLE 1

SUMMARY OF SURVEY DATA

Upper Ash Disposal Area

Station	Range	ELEVATIONS			THICKNESS, FT	
		Ash	Clay	Topsoil	Clay	Topsoil
A	0+00	872.44	874.04	875.60	1.60	1.56
B	0+00	876.34	877.54	879.09	1.20	1.55
C	0+00	878.87	880.47	882.33	1.60	1.86
D	0+00	n/a	n/a	n/a	n/a	n/a
A	1+00	874.72	876.39	877.80	1.67	1.41
B	1+00	874.82	877.21	878.25	2.39	1.04
C	1+00	879.13	880.83	883.47	1.70	2.64
D	1+00	883.00	884.02	n/a	1.02	n/a
A	2+00	875.10	877.13	879.31	2.03	2.18
B	2+00	874.30	877.50	878.62	3.20	1.12
C	2+00	879.98	882.08	883.33	2.10	1.25
D	2+00	886.81	887.91	888.98	1.10	1.07
A	3+00	877.61	879.85	881.60	2.24	1.75
B	3+00	878.05	879.06	880.11	1.01	1.05
C	3+00	883.38	884.54	886.33	1.16	1.79
D	3+00	888.79	889.93	891.05	1.14	1.12
A	4+00	878.41	881.30	882.37	2.89	1.07
B	4+00	878.81	879.85	881.06	1.04	1.21
C	4+00	883.63	884.76	885.87	1.13	1.11
D	4+00	888.65	889.73	890.91	1.08	1.18
A	5+00	877.91	880.64	881.71	2.73	1.07
B	5+00	877.94	879.15	880.36	1.21	1.21
C	5+00	881.32	883.16	884.19	1.84	1.03
D	5+00	886.16	887.89	889.15	1.73	1.26

TABLE 1

SUMMARY OF SURVEY DATA

Upper Ash Disposal Area

Station	Range	ELEVATIONS			THICKNESS, FT	
		Ash	Clay	Topsoil	Clay	Topsoil
A	6+00	877.88	879.63	880.68	1.75	1.05
B	6+00	876.20	877.25	878.71	1.05	1.46
C	6+00	880.11	881.20	882.22	1.09	1.02
D	6+00	885.33	887.26	888.38	1.93	1.12
A	7+00	876.72	877.84	879.20	1.12	1.36
B	7+00	874.12	876.28	877.31	2.16	1.03
C	7+00	879.68	880.88	881.97	1.20	1.09
D	7+00	884.73	885.84	886.94	1.11	1.10
A	8+00	875.23	876.63	878.16	1.40	1.53
B	8+00	873.94	875.19	876.25	1.25	1.06
C	8+00	876.72	877.75	878.97	1.03	1.22
D	8+00	881.87	882.90	883.96	1.03	1.06

TABLE 2

SUMMARY OF SURVEY DATA

East and West Ponds

Station	Range	ELEVATIONS			THICKNESS, FT	
		Ash	Clay	Topsoil	Clay	Topsoil
A	0+00	818.22	819.42	820.52	1.20	1.10
B	0+00	816.22	817.35	818.50	1.13	1.15
C	0+00	815.60	817.04	818.14	1.44	1.10
D	0+00	815.26	817.03	818.05	1.77	1.02
E	0+00	814.71	815.72	817.02	1.01	1.30
F	0+00	-	-	-	-	-
G	0+00	-	-	-	-	-
A	1+00	817.89	818.95	819.98	1.06	1.03
B	1+00	816.01	817.45	818.60	1.44	1.15
C	1+00	815.04	816.53	817.62	1.49	1.09
D	1+00	814.69	815.88	816.92	1.19	1.04
E	1+00	813.60	815.10	816.17	1.50	1.07
F	1+00	-	-	-	-	-
G	1+00	-	-	-	-	-
A	2+00	817.81	818.94	819.99	1.13	1.05
B	2+00	815.63	816.64	817.88	1.03	1.24
C	2+00	815.29	816.39	817.41	1.10	1.02
D	2+00	814.61	815.62	816.78	1.01	1.16
E	2+00	814.37	815.40	816.49	1.03	1.09
F	2+00	813.07	814.13	815.45	1.06	1.32
G	2+00	-	-	-	-	-
A	3+00	817.50	818.63	819.64	1.13	1.01
B	3+00	815.63	817.10	818.15	1.47	1.05
C	3+00	814.84	816.00	817.11	1.16	1.11
D	3+00	814.46	815.55	816.67	1.09	1.12
E	3+00	814.18	815.33	816.41	1.15	1.08
F	3+00	812.85	813.95	815.23	1.10	1.28

TABLE 2

SUMMARY OF SURVEY DATA

East and West Ponds

Station	Range	ELEVATIONS			THICKNESS, FT	
		Ash	Clay	Topsoil	Clay	Topsoil
G	3+00	-	-	-	-	-
A	4+00	817.72	818.74	820.34	1.02	1.60
B	4+00	816.41	817.99	818.99	1.58	1.00
C	4+00	815.67	817.07	818.11	1.40	1.04
D	4+00	815.19	816.50	817.62	1.31	1.12
E	4+00	815.10	816.11	817.20	1.01	1.09
F	4+00	814.16	815.32	816.35	1.16	1.03
G	4+00	813.83	815.15	816.20	1.32	1.05
A	5+00	819.11	820.12	821.50	1.01	1.38
B	5+00	817.17	818.47	819.52	1.30	1.05
C	5+00	816.14	817.26	818.30	1.12	1.04
D	5+00	815.75	816.89	817.95	1.14	1.06
E	5+00	815.46	816.62	817.72	1.16	1.10
F	5+00	814.56	815.82	817.04	1.26	1.22
G	5+00	814.50	815.50	816.54	1.00	1.04
H	5+00	814.02	815.02	816.12	1.00	1.10
A	6+00	818.23	819.33	820.45	1.10	1.12
B	6+00	816.91	818.03	819.03	1.12	1.00
C	6+00	815.66	816.68	817.82	1.02	1.14
D	6+00	814.62	816.10	817.44	1.48	1.34
E	6+00	814.91	816.07	817.13	1.16	1.06
F	6+00	814.81	815.94	817.02	1.13	1.08
G	6+00	814.52	815.61	816.76	1.09	1.15
H	6+00	813.92	815.09	816.12	1.17	1.03
A	7+00	817.34	818.64	819.78	1.30	1.14
B	7+00	816.45	817.46	818.61	1.01	1.15

TABLE 2

SUMMARY OF SURVEY DATA

East and West Ponds

Station	Range	ELEVATIONS			THICKNESS, FT	
		Ash	Clay	Topsoil	Clay	Topsoil
C	7+00	815.29	816.74	817.82	1.45	1.08
D	7+00	815.32	816.40	817.45	1.08	1.05
E	7+00	815.16	816.17	817.31	1.01	1.14
F	7+00	815.00	816.11	817.22	1.11	1.11
G	7+00	814.74	815.84	816.86	1.10	1.02
H	7+00	813.11	814.17	815.29	1.06	1.12
A	8+00	816.93	818.19	819.20	1.26	1.01
B	8+00	816.24	817.37	818.47	1.13	1.10
C	8+00	815.22	816.43	817.72	1.21	1.29
D	8+00	815.28	816.46	817.52	1.18	1.06
E	8+00	815.01	816.11	817.17	1.10	1.06
F	8+00	814.12	815.25	816.86	1.13	1.61
G	8+00	812.83	813.97	815.76	1.14	1.79
A	9+00	816.61	817.74	818.86	1.13	1.12
B	9+00	815.95	817.01	818.03	1.06	1.02
C	9+00	815.36	816.46	817.56	1.10	1.10
D	9+00	815.30	816.35	817.40	1.05	1.05
E	9+00	814.66	815.78	816.82	1.12	1.04
F	9+00	813.89	814.98	815.98	1.09	1.00
G	9+00	-	-	-	-	-
A	10+00	816.65	818.40	819.51	1.75	1.11
B	10+00	816.19	817.38	818.43	1.19	1.05
C	10+00	815.42	816.67	817.75	1.25	1.08
D	10+00	815.37	816.43	817.51	1.06	1.08
E	10+00	813.76	814.83	815.96	1.07	1.13
F	10+00	-	-	-	-	-
G	10+00	-	-	-	-	-

TABLE 2

SUMMARY OF SURVEY DATA

East and West Ponds

Station	Range	ELEVATIONS			THICKNESS, FT	
		Ash	Clay	Topsoil	Clay	Topsoil
A	11+00	816.16	818.20	819.50	2.04	1.30
B	11+00	816.44	817.54	818.68	1.10	1.14
C	11+00	815.88	816.89	817.93	1.01	1.04
D	11+00	815.52	816.56	817.60	1.04	1.04
E	11+00	-	-	-	-	-
F	11+00	-	-	-	-	-
G	11+00	-	-	-	-	-
A	12+00	818.01	819.18	821.30	1.17	2.12
B	12+00	817.13	818.27	819.52	1.04	1.25
C	12+00	-	-	-	-	-
D	12+00	-	-	-	-	-
E	12+00	-	-	-	-	-
F	12+00	-	-	-	-	-
G	12+00	-	-	-	-	-

TABLE 3

BULL RUN STEAM PLANT- ASH DISPOSAL AREA (INSIDE LOOP TRACK)
SUMMARY OF FIELD MOISTURE-DENSITY TEST RESULTS

Test	Date Tested	Moisture Content (%)	Dry Density (pcf)	Compaction (%)	Remarks
1	8/10/95	28.3	94.3	103.4	95% required
2	8/10/95	30.1	90.8	99.5	95% required
3	8/10/95	28.8	95.1	104.3	95% required
4	8/10/95	29.6	92.9	101.9	95% required
5	8/11/95	29.0	89.8	98.5	95% required
6	8/11/95	29.6	90.8	99.6	95% required
7	8/11/95	31.5	89.5	98.1	95% required
8	8/11/95	31.1	89.5	98.1	95% required
9	8/11/95	35.6	86.9	95.8	95% required
10	8/14/95	31.1	88.7	97.2	95% required
11	8/14/95	30.4	88.9	97.5	95% required
12	8/14/95	31.6	90.0	98.7	95% required
13	8/14/95	30.9	89.8	98.5	95% required
14	8/14/95	34.6	86.5	95.4	95% required
15	8/14/95	30.5	91.9	100.8	95% required
16	8/14/95	30.5	90.8	99.6	95% required
17	8/14/95	30.8	88.7	97.3	95% required
18	8/15/95	29.1	89.6	98.2	95% required
19	8/15/95	29.0	94.9	104.1	95% required
SC-19	8/15/95	28.7	94.1	103.2	95% required
20	8/15/95	35.1	82.6	91.1	*Failed
21	8/15/95	35.7	81.6	89.9	*Retest #20
22	8/15/95	29.4	96.7	106.0	*Retest #20 & 21
23	8/15/95	32.2	91.1	99.9	95% required
24	8/15/95	31.2	89.9	98.6	95% required
25	8/16/95	36.2	86.4	95.3	95% required
26	8/16/95	32.9	86.9	95.8	95% required
27	8/16/95	35.4	84.8	93.5	*Failed

TABLE 3

BULL RUN STEAM PLANT- ASH DISPOSAL AREA (INSIDE LOOP TRACK)

SUMMARY OF FIELD MOISTURE-DENSITY TEST RESULTS

Test	Date Tested	Moisture Content (%)	Dry Density (pcf)	Compaction (%)	Remarks
28	8/16/95	32.7	88.7	97.8	* Retest #27
29	8/16/95	30.9	87.5	96.4	95% required
30	8/16/95	29.4	91.7	100.5	95% required
31	8/16/95	29.8	91.7	100.5	95% required
32	8/16/95	30.9	90.9	99.7	95% required
33	8/17/95	30.0	93.2	102.2	95% required
34	8/17/95	30.0	92.6	101.6	95% required
35	8/17/95	32.0	92.3	101.3	95% required
36	8/17/95	32.5	87.8	96.8	95% required
37	8/17/95	29.7	91.0	99.8	95% required
38	8/18/95	30.7	93.2	102.1	95% required
39	8/18/95	31.4	89.8	98.5	95% required
40	8/18/95	28.9	93.8	102.9	95% required
41	8/18/95	30.5	85.0	93.7	*Failed
42	8/18/95	31.0	89.2	98.3	*Retest #41
43	8/18/95	29.6	90.3	99.0	95% Required
44	8/18/95	29.4	89.8	98.5	95% Required
45	8/18/95	29.8	91.2	100.0	95% Required
46	8/18/95	29.2	94.8	103.9	95% Required
47	8/18/95	28.7	90.6	99.3	95% Required
48	8/18/95	29.5	90.6	99.3	95% Required
49	8/18/95	29.0	91.8	100.7	95% Required
50	8/18/95	27.1	93.0	101.9	95% Required
51	8/18/95	27.9	92.8	101.2	95% Required
52	8/18/95	30.5	89.6	98.2	95% Required
53	8/18/95	31.8	87.9	96.9	95% Required
54	8/18/95	30.8	88.7	97.3	95% Required
55	8/21/95	33.6	88.2	97.2	95% Required

TABLE 3

BULL RUN STEAM PLANT- ASH DISPOSAL AREA (INSIDE LOOP TRACK)
SUMMARY OF FIELD MOISTURE-DENSITY TEST RESULTS

Test	Date Tested	Moisture Content (%)	Dry Density (pcf)	Compaction (%)	Remarks
SC-55	8/21/95	29.0	91.2	100.0	95% Required
56	8/21/95	30.9	90.9	99.7	95% Required
57	8/21/95	28.9	91.3	100.1	95% Required
58	9/1195	30.7	91.8	100.6	95% Required
59	9/1195	30.1	87.8	96.8	95% Required
60	9/1195	28.5	92.1	101.5	95% Required
SC-58	9/12/95	29.0	95.9	105.1	95% Required
61	9/12/95	30.7	91.2	100.0	95% Required
62	9/12/95	28.6	88.3	97.4	95% Required
63	9/12/95	31.1	90.9	100.2	95% Required
64	9/13/95	27.9	97.5	106.9	95% Required
65	9/13/95	27.0	94.0	103.0	95% Required
66	9/13/95	32.1	89.0	97.6	95% Required
67	9/13/95	29.8	93.0	101.9	95% Required
68	9/13/95	28.4	91.3	100.1	95% Required
69	9/13/95	26.5	94.9	104.0	95% Required
70	9/13/95	26.3	92.2	101.1	95% Required
71	9/15/95	28.1	95.1	104.2	95% Required
72	9/15/95	29.5	90.9	99.7	95% Required
73	9/15/95	29.6	88.8	97.5	95% Required
74	9/15/95	29.4	90.6	99.4	95% Required
75	9/15/95	28.8	92.5	101.4	95% Required
76	9/15/95	29.5	92.0	100.9	95% Required
77	9/18/95	30.5	91.7	100.5	95% Required
78	9/18/95	28.9	93.4	102.4	95% Required
79	9/18/95	30.5	91.8	100.7	95% Required
80	9/18/95	32.3	91.6	100.4	95% Required
81	9/18/95	29.9	90.4	99.1	95% Required

TABLE 3

BULL RUN STEAM PLANT- ASH DISPOSAL AREA (INSIDE LOOP TRACK)
SUMMARY OF FIELD MOISTURE-DENSITY TEST RESULTS

Test	Date Tested	Moisture Content (%)	Dry Density (pcf)	Compaction (%)	Remarks
SC-81	9/19/95	27.8	89.5	98.1	95% Required
82	9/20/95	29.4	90.8	99.6	95% Required
83	9/20/95	30.0	88.3	96.8	95% Required
84	9/20/95	28.8	93.8	102.8	95% Required
85	9/20/95	31.0	90.5	99.2	95% Required
86	9/20/95	30.3	91.7	100.5	95% Required
87	9/20/95	31.6	88.7	97.3	95% Required
88	9/20/95	32.4	87.6	96.1	95% Required
89	9/27/95	27.3	90.7	99.5	95% Required
90	9/27/95	27.8	94.3	103.3	95% Required
91	9/27/95	29.0	93.6	102.6	95% Required
92	9/28/95	30.3	92.8	101.8	95% Required
93	9/28/95	31.1	91.7	100.5	95% Required
94	9/28/95	32.4	90.0	98.7	95% Required
95	9/28/95	28.7	92.0	100.9	95% Required
96	9/28/95	28.5	91.2	100.0	95% Required
97	9/28/95	29.2	92.0	100.9	95% Required
98	9/28/95	27.8	93.5	102.5	95% Required
SC-98	9/28/95	27.4	94.0	103.0	95% Required
99	9/29/95	28.2	88.8	97.4	95% Required
100	9/29/95	28.9	90.1	99.3	95% Required
101	9/29/95	28.8	93.7	102.7	95% Required
102	9/29/95	30.7	91.3	100.1	95% Required
103	9/29/95	30.5	92.1	100.9	95% Required
104	9/30/95	32.9	90.1	98.7	95% Required
105	9/30/95	28.5	90.9	99.6	95% Required
106	9/30/95	28.2	92.1	101.0	95% Required
107	9/30/95	30.2	89.4	98.0	95% Required

TABLE 3

BULL RUN STEAM PLANT- ASH DISPOSAL AREA (INSIDE LOOP TRACK)
SUMMARY OF FIELD MOISTURE-DENSITY TEST RESULTS

Test	Date Tested	Moisture Content (%)	Dry Density (pcf)	Compaction (%)	Remarks
108	9/30/95	28.4	94.0	103.0	95% Required
109	9/30/95	29.4	90.0	98.7	95% Required
110	10/2/95	27.2	91.4	100.1	95% Required
111	10/2/95	28.4	90.7	99.4	95% Required
112	10/2/95	27.1	93.0	101.9	95% Required
113	10/2/95	27.0	93.4	102.4	95% Required
114	10/2/95	33.0	90.5	99.2	95% Required
115	10/2/95	33.3	90.2	98.9	95% Required
116	10/2/95	30.2	92.6	101.5	95% Required
117	10/2/95	27.8	94.5	103.6	95% Required
118	10/2/95	28.0	93.9	102.9	95% Required
119	10/17/95	29.2	90.1	98.8	95% Required
120	10/17/95	31.1	86.1	95.0	95% Required
121	10/17/95	29.4	89.0	97.5	95% Required
122	10/17/95	29.0	89.8	98.5	95% Required
123	10/17/95	30.2	92.5	101.3	95% Required
124	10/17/95	30.3	92.3	101.2	95% Required
125	10/17/95	28.6	93.4	102.4	95% Required
126	10/17/95	29.6	91.0	99.7	95% Required
127	10/17/95	34.0	86.6	95.0	95% Required
128	10/17/95	32.8	87.1	95.5	95% Required
129	10/17/95	32.8	87.2	95.5	95% Required
130	10/17/95	32.3	88.4	96.9	95% Required
131	10/17/95	30.1	91.6	100.4	95% Required
132	10/17/95	31.9	88.8	97.3	95% Required
133	10/17/95	30.3	90.1	98.7	95% Required
SC-119	10/19/95	29.5	89.1	98.2	95% Required
SC-133	10/19/95	30.0	88.8	97.9	95% Required

TABLE
BULL RUN STEAM PLANT
ASH DISPOSAL AREA

SUMMARY OF LABORATORY TEST DATA

Sample No.	Station	Range	Soil Symbol	Natural Moisture		Grain-Size Analysis					Atterberg Limits		Dry Density pcf	% Compaction	Coefficient of Permeability	
				%	% Sat.	Gravel %	Sand %	Silt %	Clay %	D_{10} mm	Liquid Limit (%)	Plastic Index (%)			K_h cm/sec	K_v cm/sec
1	1+00	D-Line	CH			9	13	13	65	-	68	42				
2	3+00	B-Line	CH/MH			3	12	16	69	-	70	37				
3	1+00	B-Line	CH/MH			0	12	14	74	-	71	38				
4	4+00	C-Line	CH			0	3	23	74	-	78	45				
5	6+00	A-Line	CH			6	13	16	65	-	67	37				
ST-1	6+00	B-Line	CH	30.0		9	13	16	62	-	68	42	93.2	102.2		$4.5x10^{-8}$
ST-2	2+00	C-Line	CH	30.0		12	10	14	64	-	72	44	92.2	101		$1.9x10^{-8}$
ST-3	2+00	D-Line	MH	33.0		3	9	8	80	-	72	37	85.7	94.5		$3.1x10^{-8}$
ST-4	4+00	D-Line	MH	32.0		3	9	14	74	-	58	23	85.7	94.5		$2.9x10^{-8}$
ST-5	7+00	E-Line	CH	32.0		12	10	13	65	-	68	39	89.2	98.3		$3.0x10^{-8}$
ST-6	11+00	B-Line	MH/CH	30.0		12	4	6	78	-	64	31	92.9	101.9		$3.0x10^{-8}$

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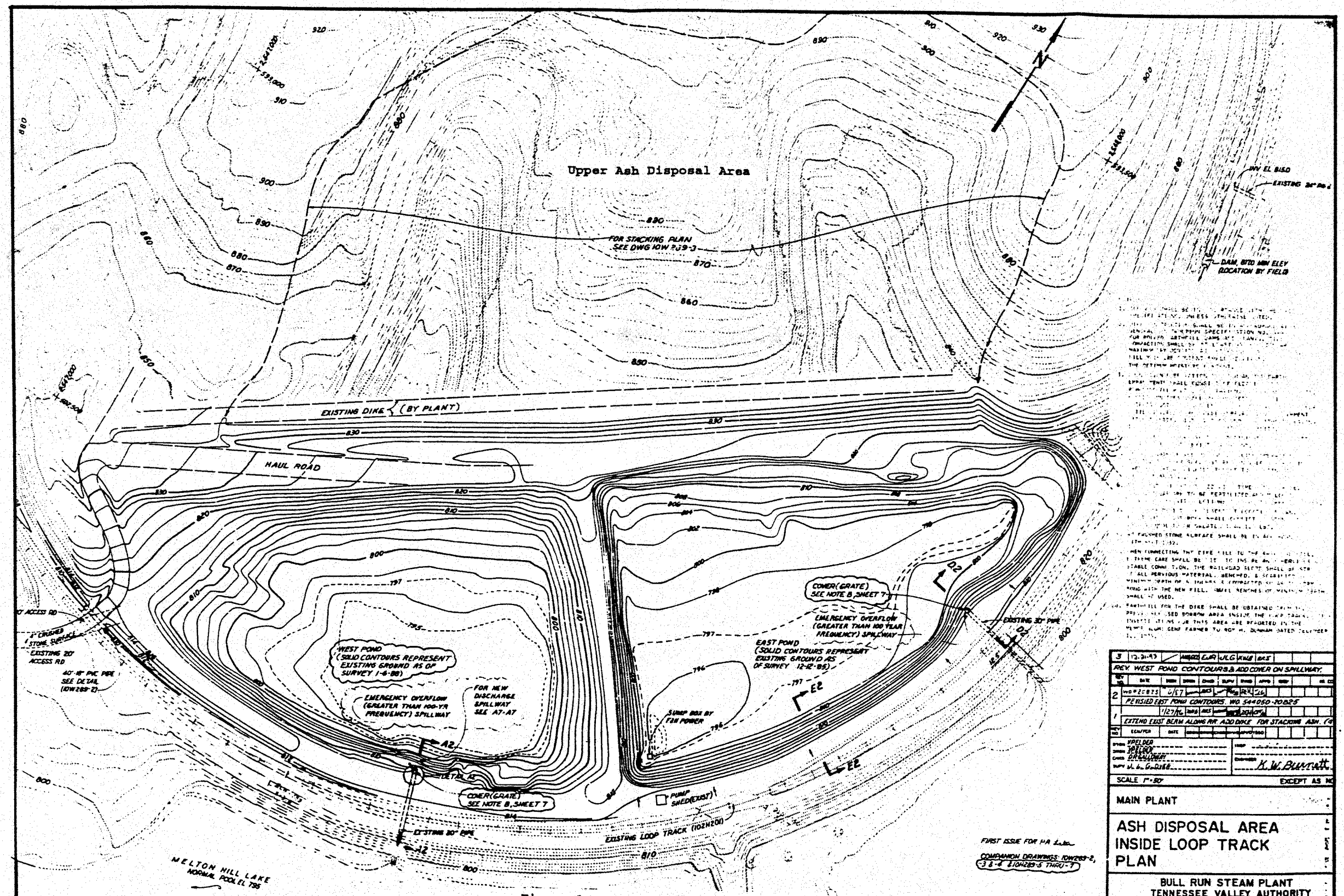

Figure 1
General Location of Ash Disposal Area Inside Loop Track

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The Critical Link.

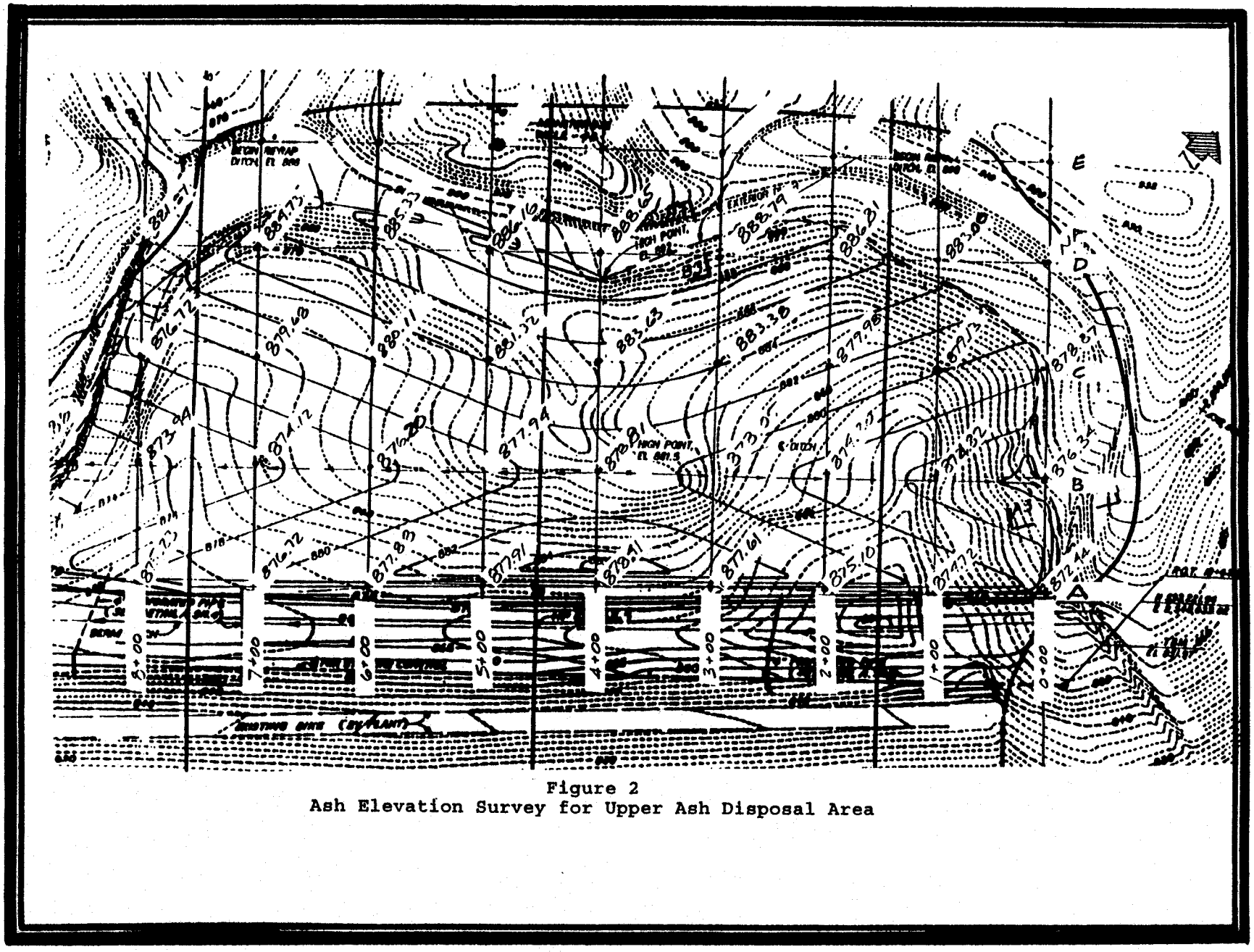

Figure 2
Ash Elevation Survey for Upper Ash Disposal Area

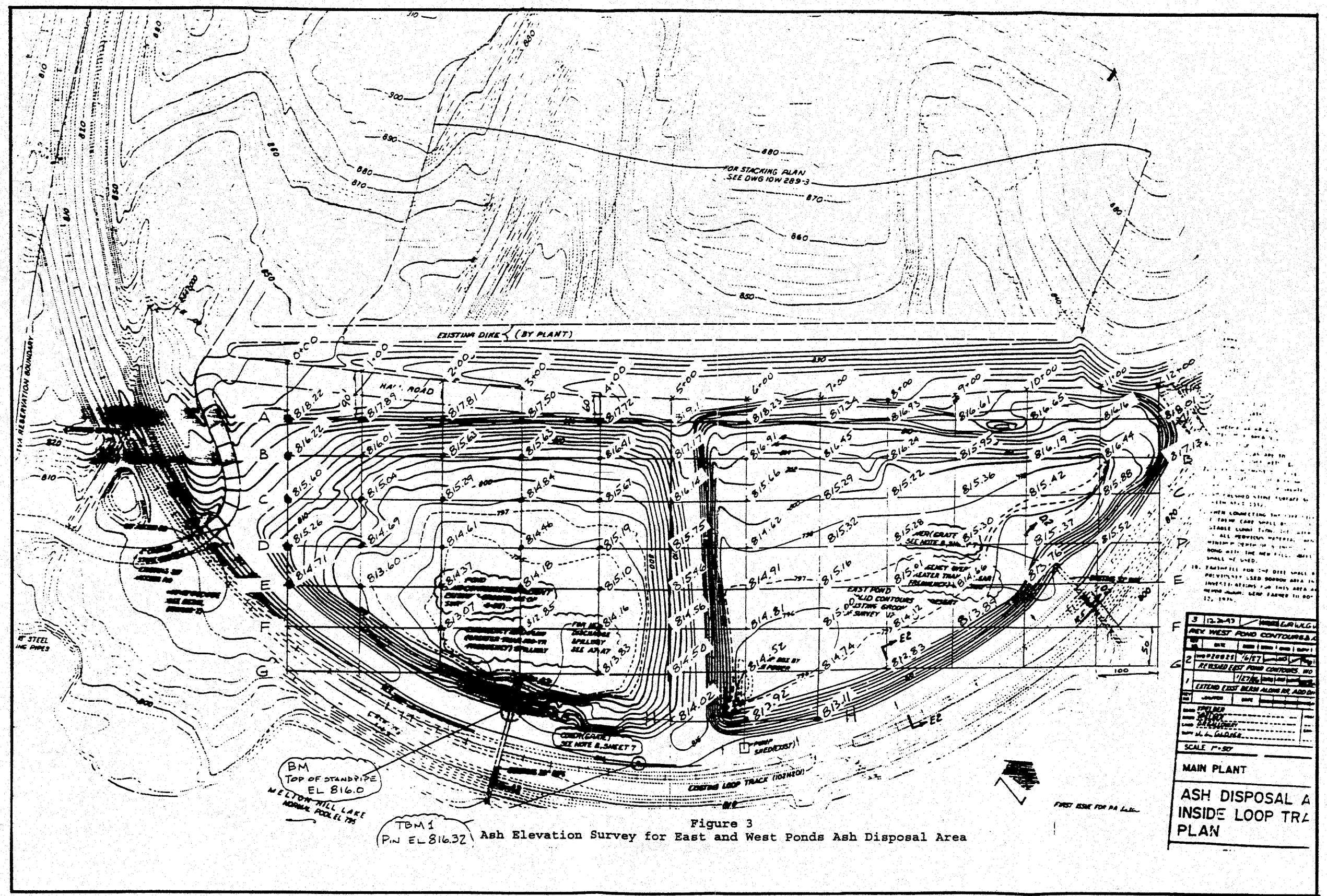

Figure 3
Ash Elevation Survey for East and West Ponds Ash Disposal Area

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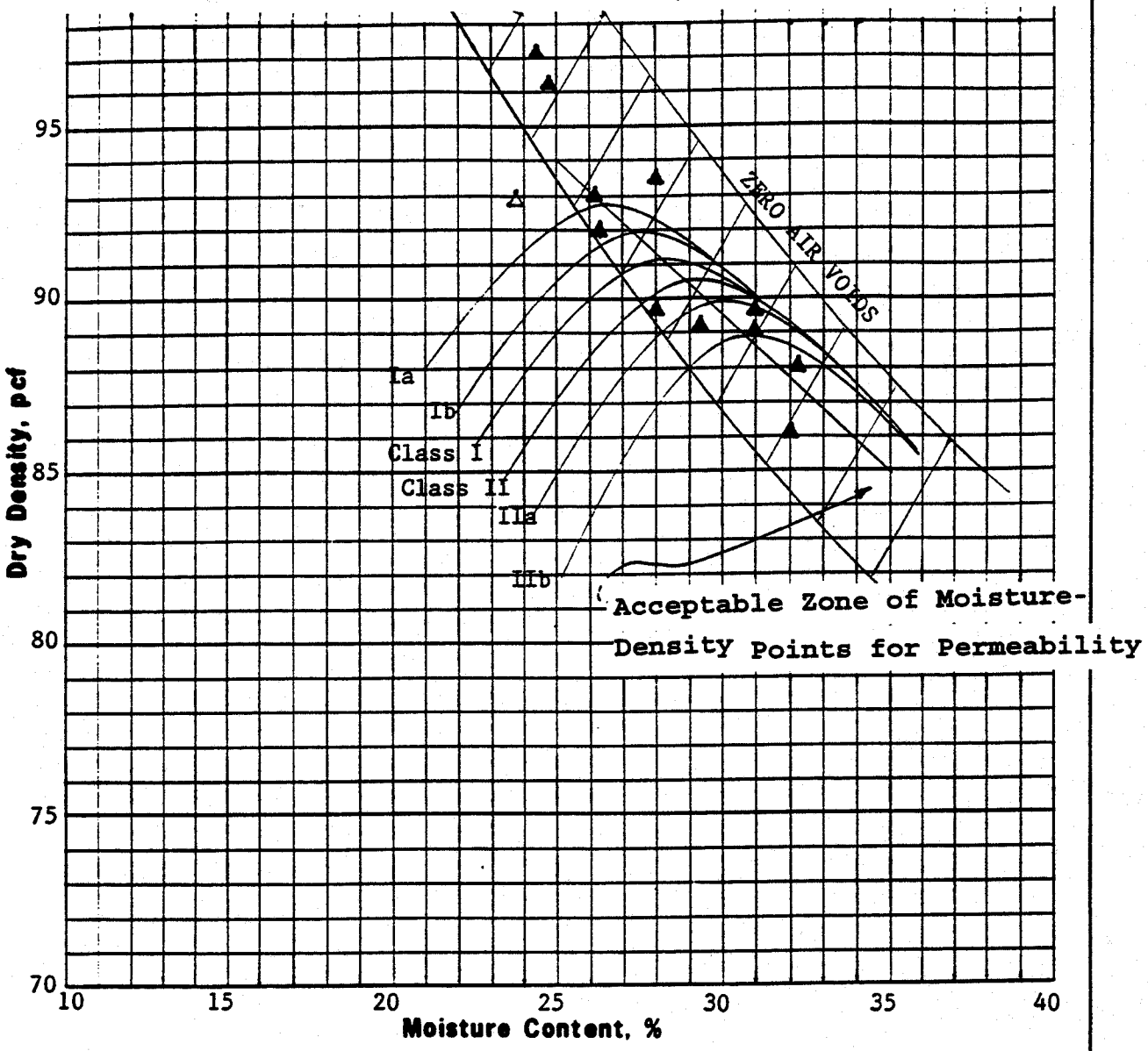
Figure 4
Acceptable Zone of Moisture-Density Points for Permeability



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95
COMPACTION TEST (FAMILY OF CURVES)	

Tested by: TAL Reviewed by: [signature]

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The Critical Link.™

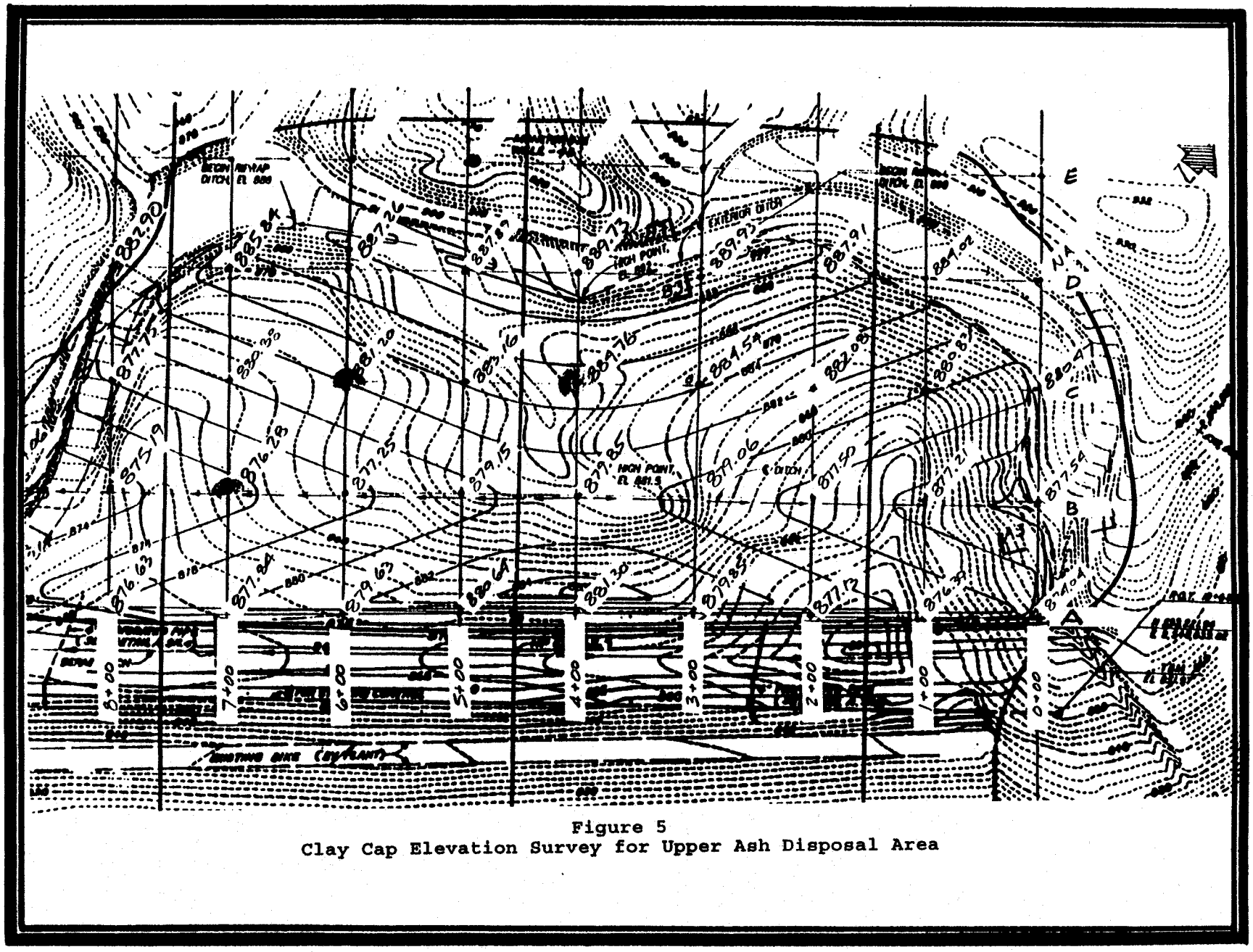

Figure 5
Clay Cap Elevation Survey for Upper Ash Disposal Area

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The Critical Link.

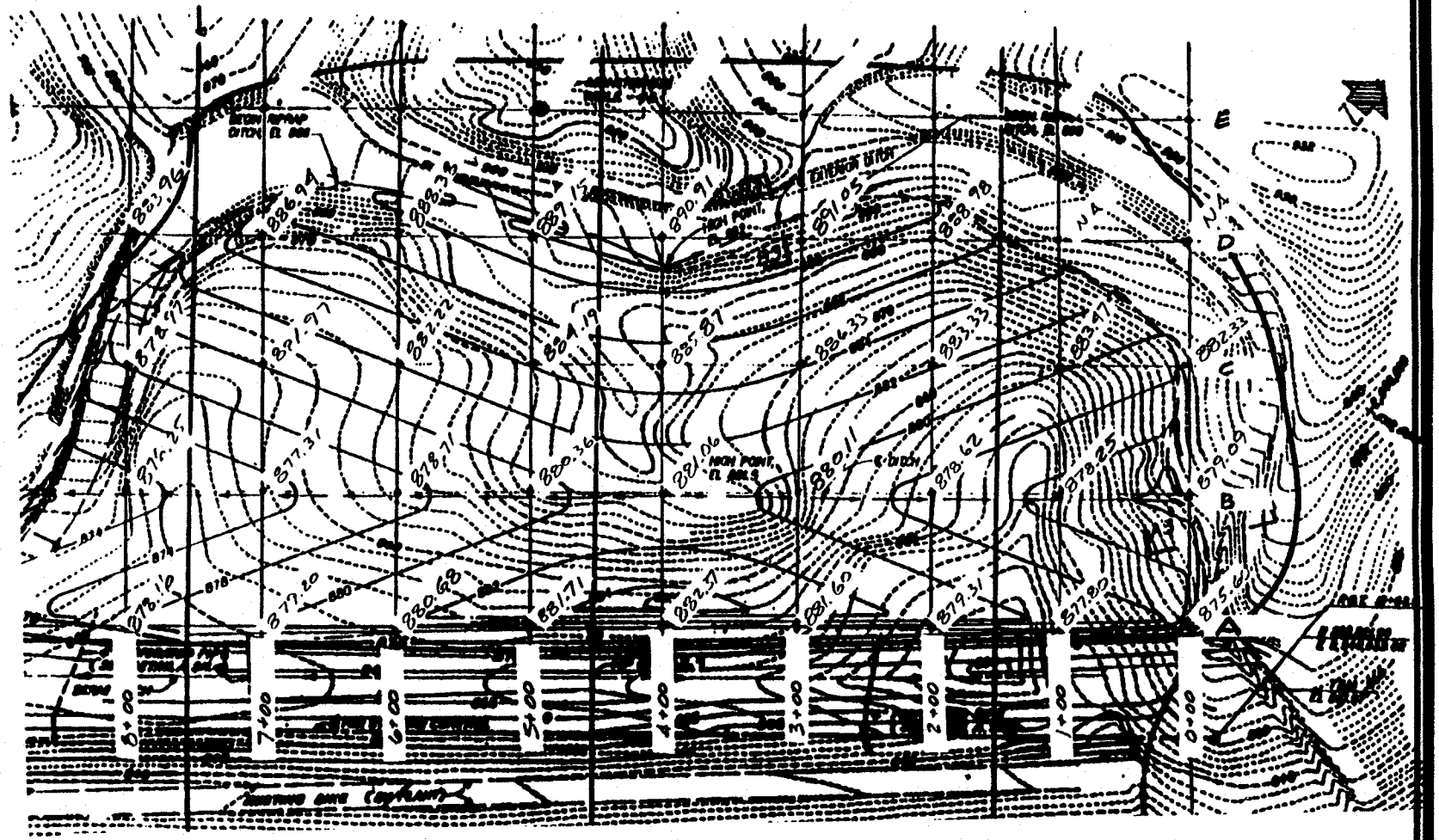


Figure 6
Topsoil Elevation Survey for Upper Ash Disposal Area

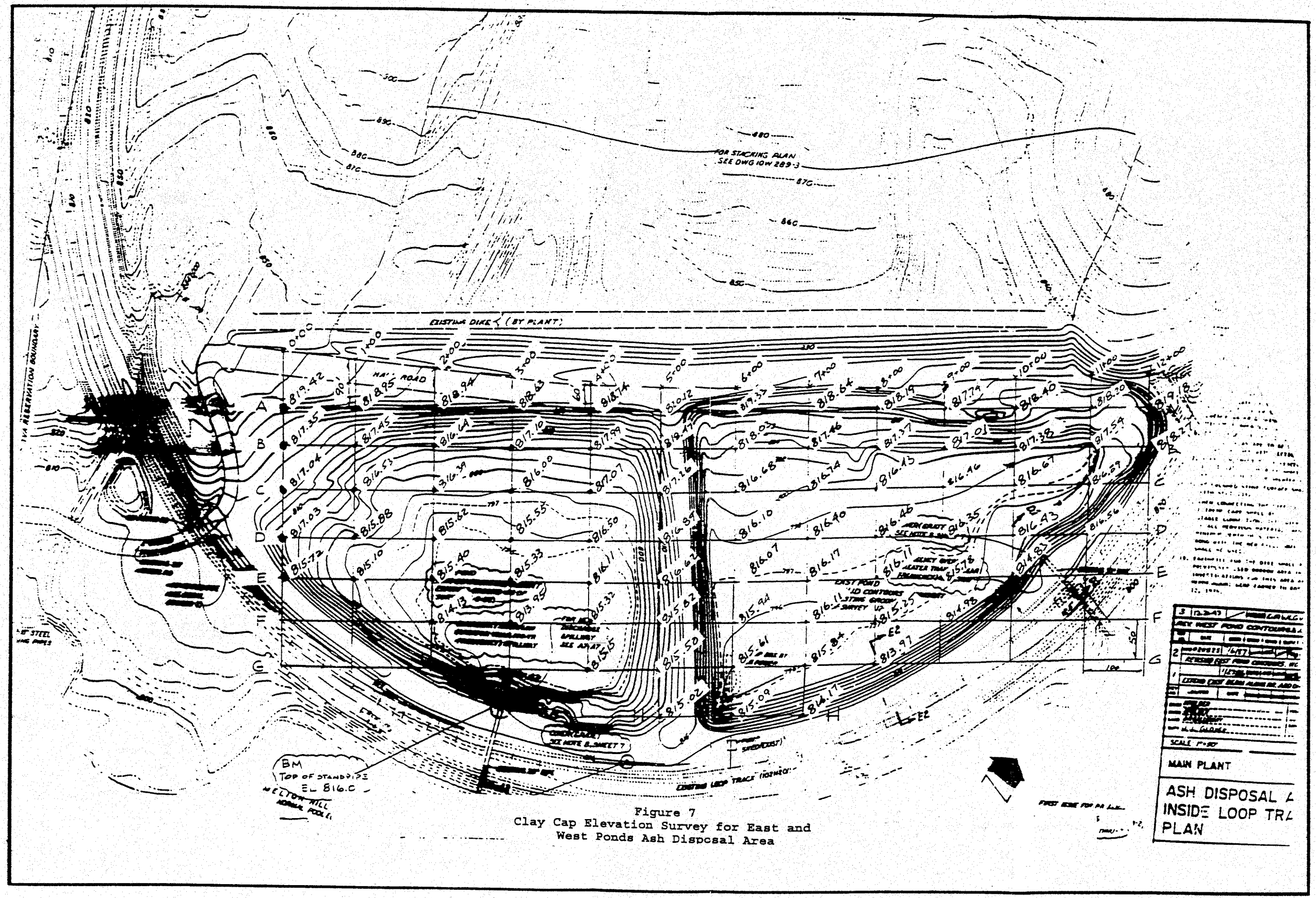


Figure 7
Clay Cap Elevation Survey for East and
West Ponds Ash Disposal Area

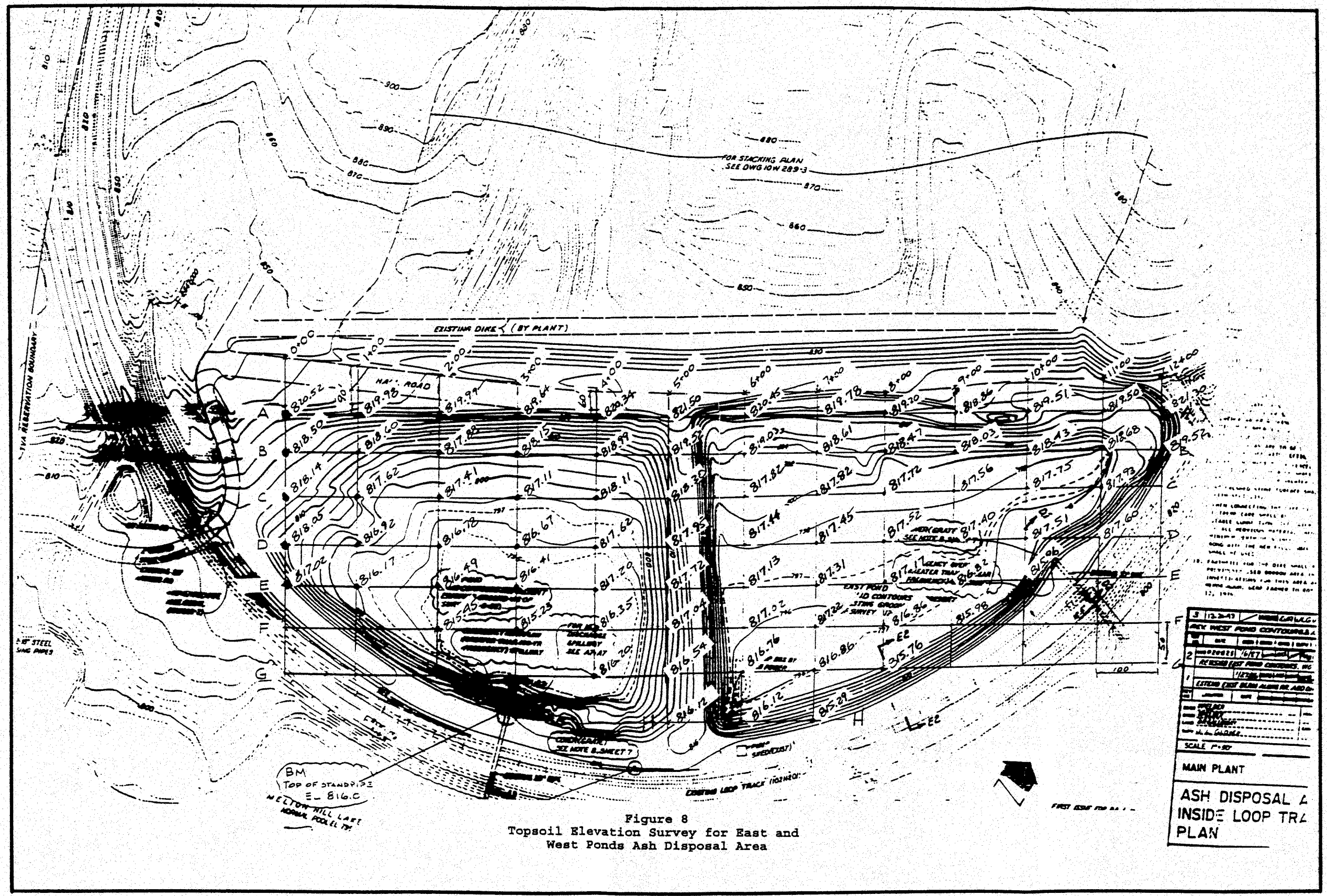


Figure 8
Topsoil Elevation Survey for East and
West Ponds Ash Disposal Area

ATTACHMENT A

Daily Report and Test Data of
QA/QC Inspection and Testing

TABLE 3

BULL RUN STEAM PLANT- ASH DISPOSAL AREA (INSIDE LOOP TRACK)
SUMMARY OF FIELD MOISTURE-DENSITY TEST RESULTS

Test	Date Tested	Moisture Content (%)	Dry Density (pcf)	Compaction (%)	Remarks
1	8/10/95	28.3	94.3	103.4	95% required
2	8/10/95	30.1	90.8	99.5	95% required
3	8/10/95	28.8	95.1	104.3	95% required
4	8/10/95	29.6	92.9	101.9	95% required
5	8/11/95	29.0	89.8	98.5	95% required
6	8/11/95	29.6	90.8	99.6	95% required
7	8/11/95	31.5	89.5	98.1	95% required
8	8/11/95	31.1	89.5	98.1	95% required
9	8/11/95	35.6	86.9	95.8	95% required
10	8/14/95	31.1	88.7	97.2	95% required
11	8/14/95	30.4	88.9	97.5	95% required
12	8/14/95	31.6	90.0	98.7	95% required
13	8/14/95	30.9	89.8	98.5	95% required
14	8/14/95	34.6	86.5	95.4	95% required
15	8/14/95	30.5	91.9	100.8	95% required
16	8/14/95	30.5	90.8	99.6	95% required
17	8/14/95	30.8	88.7	97.3	95% required
18	8/15/95	29.1	89.6	98.2	95% required
19	8/15/95	29.0	94.9	104.1	95% required
SC-19	8/15/95	28.7	94.1	103.2	95% required
20	8/15/95	35.1	82.6	91.1	*Failed
21	8/15/95	35.7	81.6	89.9	*Retest #20
22	8/15/95	29.4	96.7	106.0	*Retest #20 & 21
23	8/15/95	32.2	91.1	99.9	95% required
24	8/15/95	31.2	89.9	98.6	95% required
25	8/16/95	36.2	86.4	95.3	95% required
26	8/16/95	32.9	86.9	95.8	95% required
27	8/16/95	35.4	84.8	93.5	*Failed

TABLE 3

BULL RUN STEAM PLANT- ASH DISPOSAL AREA (INSIDE LOOP TRACK)
SUMMARY OF FIELD MOISTURE-DENSITY TEST RESULTS

Test	Date Tested	Moisture Content (%)	Dry Density (pcf)	Compaction (%)	Remarks
28	8/16/95	32.7	88.7	97.8	* Retest #27
29	8/16/95	30.9	87.5	96.4	95% required
30	8/16/95	29.4	91.7	100.5	95% required
31	8/16/95	29.8	91.7	100.5	95% required
32	8/16/95	30.9	90.9	99.7	95% required
33	8/17/95	30.0	93.2	102.2	95% required
34	8/17/95	30.0	92.6	101.6	95% required
35	8/17/95	32.0	92.3	101.3	95% required
36	8/17/95	32.5	87.8	96.8	95% required
37	8/17/95	29.7	91.0	99.8	95% required
38	8/18/95	30.7	93.2	102.1	95% required
39	8/18/95	31.4	89.8	98.5	95% required
40	8/18/95	28.9	93.8	102.9	95% required
41	8/18/95	30.5	85.0	93.7	*Failed
42	8/18/95	31.0	89.2	98.3	*Retest #41
43	8/18/95	29.6	90.3	99.0	95% Required
44	8/18/95	29.4	89.8	98.5	95% Required
45	8/18/95	29.8	91.2	100.0	95% Required
46	8/18/95	29.2	94.8	103.9	95% Required
47	8/18/95	28.7	90.6	99.3	95% Required
48	8/18/95	29.5	90.6	99.3	95% Required
49	8/18/95	29.0	91.8	100.7	95% Required
50	8/18/95	27.1	93.0	101.9	95% Required
51	8/18/95	27.9	92.8	101.2	95% Required
52	8/18/95	30.5	89.6	98.2	95% Required
53	8/18/95	31.8	87.9	96.9	95% Required
54	8/18/95	30.8	88.7	97.3	95% Required
55	8/21/95	33.6	88.2	97.2	95% Required

TABLE 3

BULL RUN STEAM PLANT- ASH DISPOSAL AREA (INSIDE LOOP TRACK)
SUMMARY OF FIELD MOISTURE-DENSITY TEST RESULTS

Test	Date Tested	Moisture Content (%)	Dry Density (pcf)	Compaction (%)	Remarks
SC-55	8/21/95	29.0	91.2	100.0	95% Required
56	8/21/95	30.9	90.9	99.7	95% Required
57	8/21/95	28.9	91.3	100.1	95% Required
58	9/1195	30.7	91.8	100.6	95% Required
59	9/1195	30.1	87.8	96.8	95% Required
60	9/1195	28.5	92.1	101.5	95% Required
SC-58	9/12/95	29.0	95.9	105.1	95% Required
61	9/12/95	30.7	91.2	100.0	95% Required
62	9/12/95	28.6	88.3	97.4	95% Required
63	9/12/95	31.1	90.9	100.2	95% Required
64	9/13/95	27.9	97.5	106.9	95% Required
65	9/13/95	27.0	94.0	103.0	95% Required
66	9/13/95	32.1	89.0	97.6	95% Required
67	9/13/95	29.8	93.0	101.9	95% Required
68	9/13/95	28.4	91.3	100.1	95% Required
69	9/13/95	26.5	94.9	104.0	95% Required
70	9/13/95	26.3	92.2	101.1	95% Required
71	9/15/95	28.1	95.1	104.2	95% Required
72	9/15/95	29.5	90.9	99.7	95% Required
73	9/15/95	29.6	88.8	97.5	95% Required
74	9/15/95	29.4	90.6	99.4	95% Required
75	9/15/95	28.8	92.5	101.4	95% Required
76	9/15/95	29.5	92.0	100.9	95% Required
77	9/18/95	30.5	91.7	100.5	95% Required
78	9/18/95	28.9	93.4	102.4	95% Required
79	9/18/95	30.5	91.8	100.7	95% Required
80	9/18/95	32.3	91.6	100.4	95% Required
81	9/18/95	29.9	90.4	99.1	95% Required

TABLE 3

BULL RUN STEAM PLANT- ASH DISPOSAL AREA (INSIDE LOOP TRACK)
SUMMARY OF FIELD MOISTURE-DENSITY TEST RESULTS

Test	Date Tested	Moisture Content (%)	Dry Density (pcf)	Compaction (%)	Remarks
SC-81	9/19/95	27.8	89.5	98.1	95% Required
82	9/20/95	29.4	90.8	99.6	95% Required
83	9/20/95	30.0	88.3	96.8	95% Required
84	9/20/95	28.8	93.8	102.8	95% Required
85	9/20/95	31.0	90.5	99.2	95% Required
86	9/20/95	30.3	91.7	100.5	95% Required
87	9/20/95	31.6	88.7	97.3	95% Required
88	9/20/95	32.4	87.6	96.1	95% Required
89	9/27/95	27.3	90.7	99.5	95% Required
90	9/27/95	27.8	94.3	103.3	95% Required
91	9/27/95	29.0	93.6	102.6	95% Required
92	9/28/95	30.3	92.8	101.8	95% Required
93	9/28/95	31.1	91.7	100.5	95% Required
94	9/28/95	32.4	90.0	98.7	95% Required
95	9/28/95	28.7	92.0	100.9	95% Required
96	9/28/95	28.5	91.2	100.0	95% Required
97	9/28/95	29.2	92.0	100.9	95% Required
98	9/28/95	27.8	93.5	102.5	95% Required
SC-98	9/28/95	27.4	94.0	103.0	95% Required
99	9/29/95	28.2	88.8	97.4	95% Required
100	9/29/95	28.9	90.1	99.3	95% Required
101	9/29/95	28.8	93.7	102.7	95% Required
102	9/29/95	30.7	91.3	100.1	95% Required
103	9/29/95	30.5	92.1	100.9	95% Required
104	9/30/95	32.9	90.1	98.7	95% Required
105	9/30/95	28.5	90.9	99.6	95% Required
106	9/30/95	28.2	92.1	101.0	95% Required
107	9/30/95	30.2	89.4	98.0	95% Required

TABLE 3

BULL RUN STEAM PLANT- ASH DISPOSAL AREA (INSIDE LOOP TRACK)
SUMMARY OF FIELD MOISTURE-DENSITY TEST RESULTS

Test	Date Tested	Moisture Content (%)	Dry Density (pcf)	Compaction (%)	Remarks
108	9/30/95	28.4	94.0	103.0	95% Required
109	9/30/95	29.4	90.0	98.7	95% Required
110	10/2/95	27.2	91.4	100.1	95% Required
111	10/2/95	28.4	90.7	99.4	95% Required
112	10/2/95	27.1	93.0	101.9	95% Required
113	10/2/95	27.0	93.4	102.4	95% Required
114	10/2/95	33.0	90.5	99.2	95% Required
115	10/2/95	33.3	90.2	98.9	95% Required
116	10/2/95	30.2	92.6	101.5	95% Required
117	10/2/95	27.8	94.5	103.6	95% Required
118	10/2/95	28.0	93.9	102.9	95% Required
119	10/17/95	29.2	90.1	98.8	95% Required
120	10/17/95	31.1	86.1	95.0	95% Required
121	10/17/95	29.4	89.0	97.5	95% Required
122	10/17/95	29.0	89.8	98.5	95% Required
123	10/17/95	30.2	92.5	101.3	95% Required
124	10/17/95	30.3	92.3	101.2	95% Required
125	10/17/95	28.6	93.4	102.4	95% Required
126	10/17/95	29.6	91.0	99.7	95% Required
127	10/17/95	34.0	86.6	95.0	95% Required
128	10/17/95	32.8	87.1	95.5	95% Required
129	10/17/95	32.8	87.2	95.5	95% Required
130	10/17/95	32.3	88.4	96.9	95% Required
131	10/17/95	30.1	91.6	100.4	95% Required
132	10/17/95	31.9	88.8	97.3	95% Required
133	10/17/95	30.3	90.1	98.7	95% Required
SC-119	10/19/95	29.5	89.1	98.2	95% Required
SC-133	10/19/95	30.0	88.8	97.9	95% Required

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 8/9/95 Weather: Overcast-80F

Location: Ash Disposal Area (Inside Loop Track)

==========

Observations: Andy Luttrell & I left Singleton Labs at 10:45 A.M.- arrived at Bull Run S.P. 11:20 A.M. Contacted Bill Leach of G UB MK who in turn directed us to Garland Corder, TVA & Alan Myers of G UB MK. We discussed the possibility of using material from 2 proposed borrow areas, Rogers Quarry & the borrow area off highway 25W. He suggested using a family of curves to cover all the materials used. The idea of using both areas is to insure sufficient quantities on a day to day basis. While visiting the job site we noted the east & west ponds were being dewatered & filled. Left job site at 2 P.M. arrived at S. Labs. 2:40 P.M.

Inspector: Charles B. Essex

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 8/10/95 Weather: Sunny-Hot

Location: Upper Ash Pond within the Railroad Loop

==========

Observations: Left Singleton Labs at 9:40 a.m. arrived Bull Run S.P. 10:15 a.m. Met with Garland Corder, TVA. He pointed out the limit on the gravel size, on all the ash pond caps, is 3 inches. The information has been passed on to both quarries for approval. Some of the soil placed early had larger than 3 inch gravel. The Rex Pactor was used to crush this rock. The fill was placed in the ditch along line "D". We stressed the importance of keeping the placed fill well watered. Performed 4 density tests in the ditch. Left the job site 3:20 p.m. arrived S. Labs. 4:00 p.m.

Inspector: Charles B. Essex

SINGLETON LABORATORIES

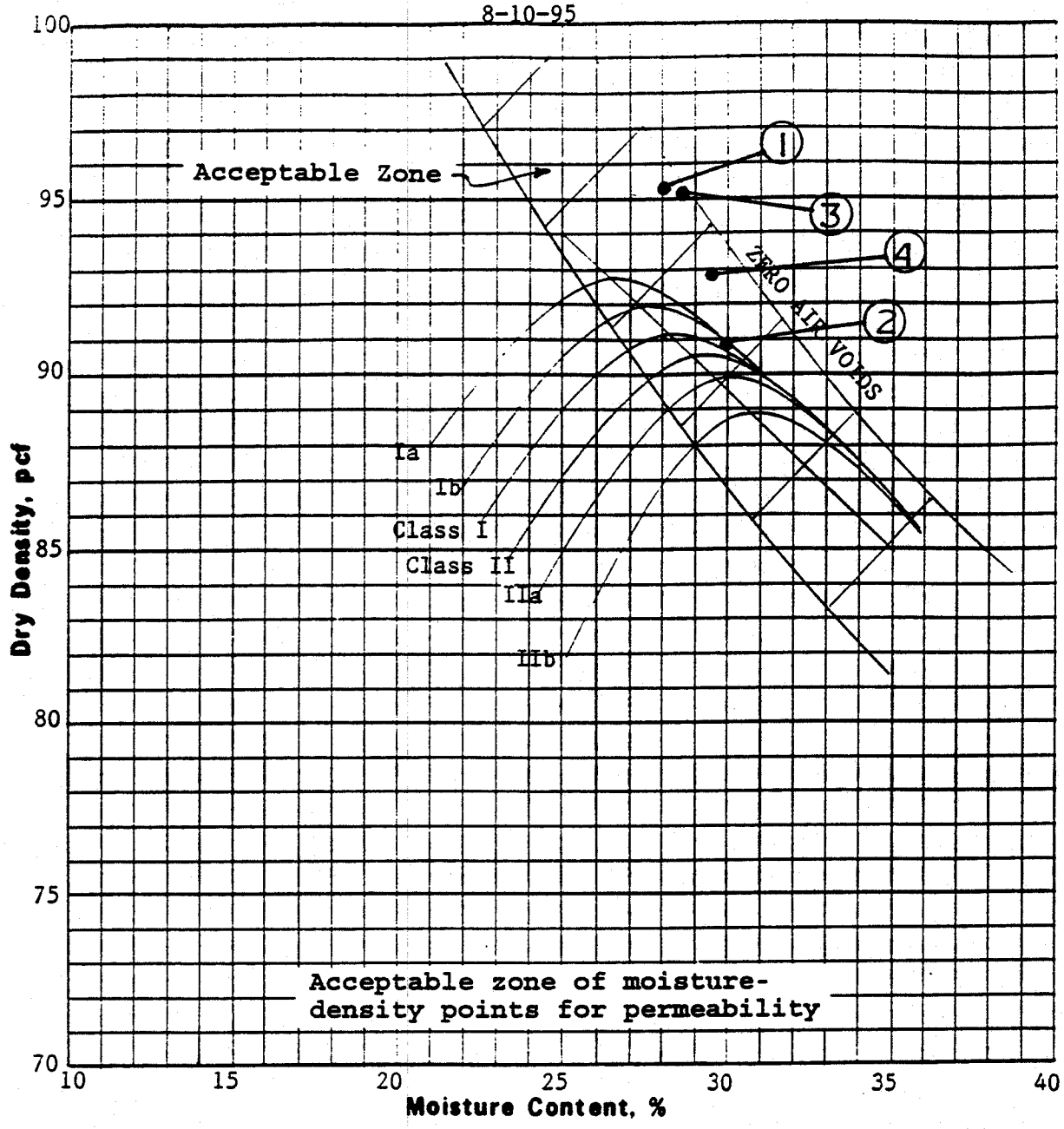
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Disposal Area (Inside Loop Track)
Tested By C. Essex
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.6
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
1	8/10/95	Station 4+60 D-Line	-0.0'	0.9410.91	8"	121.0	26.7	28.3	94.3	103.4	95% required
2	8/10/95	Station 5+70 O-Line	-0.0'	0.9410.91	8"	118.1	27.3	30.1	90.8	99.5	95% required
3	8/10/95	Station 7+00 D-Line	-0.0'	0.9410.91	8"	122.6	27.5	28.8	95.1	104.3	95% required
4	8/10/95	Station 8+00 D-Line	-0.0'	0.9410.91	8"	120.4	27.5	29.6	92.9	101.9	95% required

8-10-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95
COMPACTION TEST (FAMILY OF CURVES)	

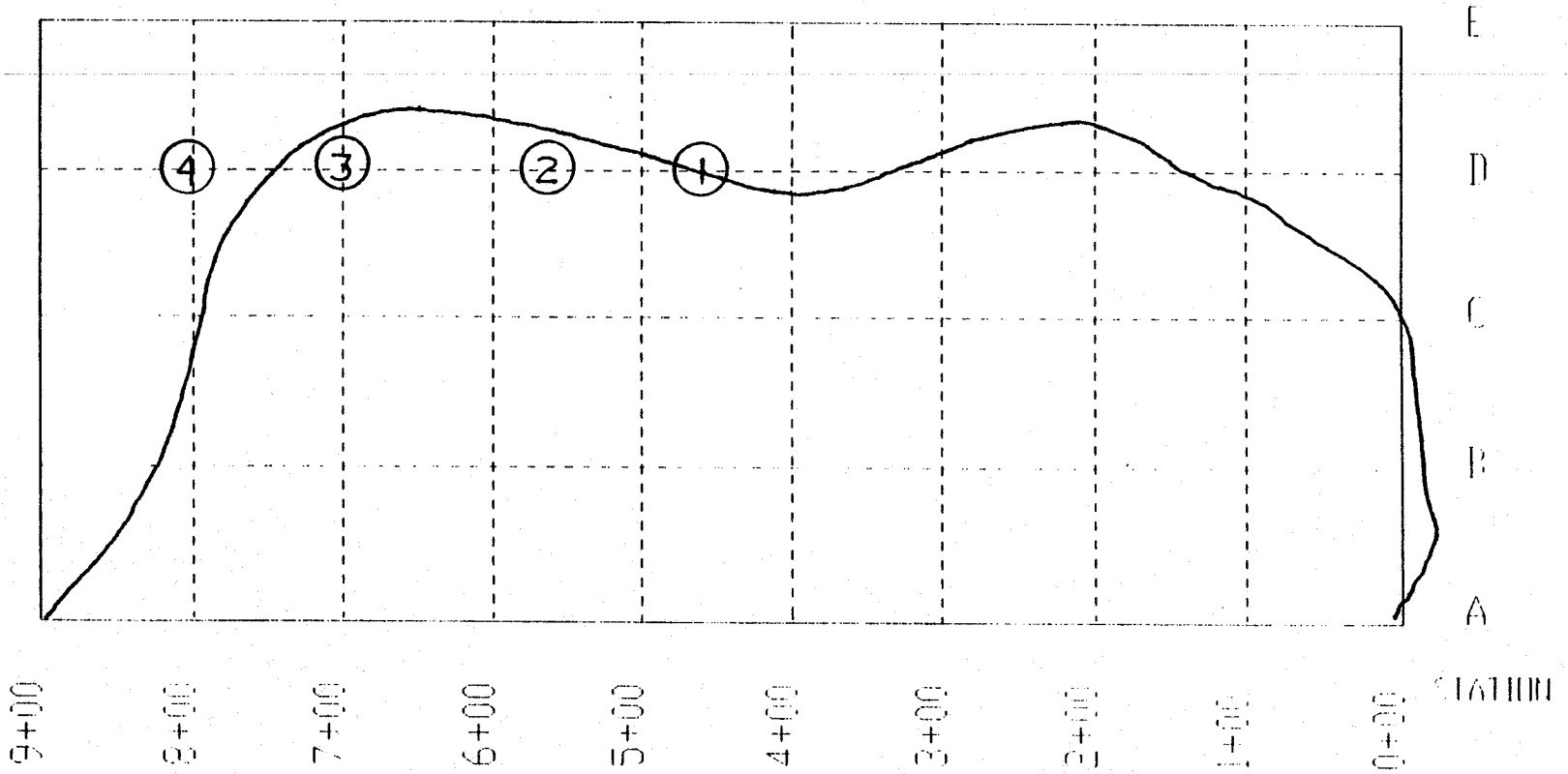
Tested by: TAL Reviewed by: [illegible]

Singleton Laboratories

The Critical Link.

TVA BULL RUN FOSSIL PLANT
5.5-ACRE ASH DISPOSAL AREA CLOSURE
TEST LOCATION PLAN

DATE: 8-10-95



TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 8/11/95 Weather: Sunny Hot 93F

Location: Upper Ash Pond (Inside Loop Track)

==========

Observations: Left Singleton Labs 9:30 a.m. - Arrived at job site 10:10 a.m. Andy Luttrell was already on the job. He had taken densities at three locations. Talked with water truck driver about when to add more water to bring the fill up to the necessary moisture. Any large individual rocks were buried in the ash pond. A total of 5 densities were performed in the trench. Left job site at 3:30 p.m. arrived at Singleton Labs 4:10 p.m.

Inspector: CB Essex

SINGLETON LABORATORIES

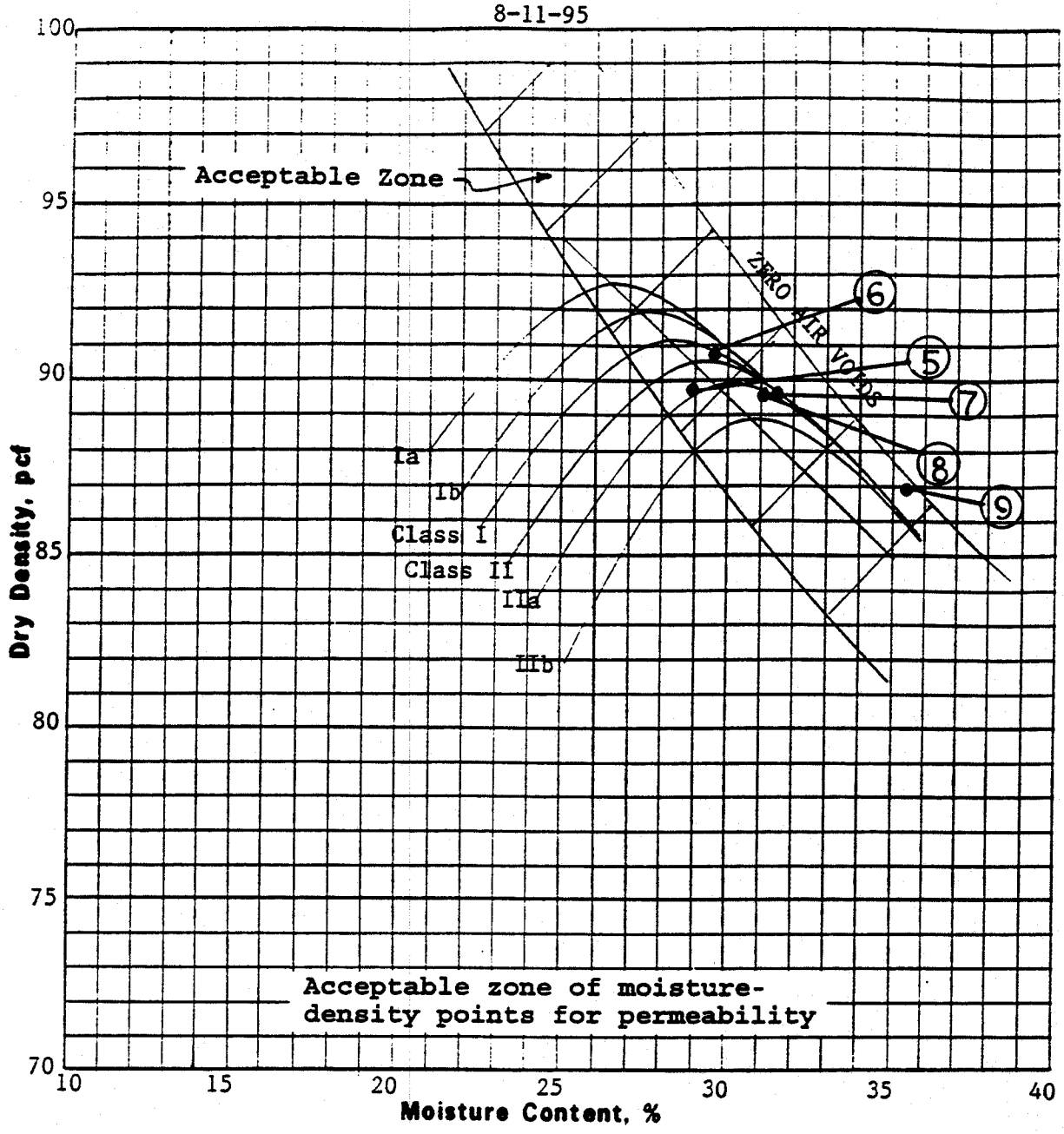
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. ASH DISPOSAL AREA (INSIDE LOOP TRACK)
Tested By CB Essex
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
5	8/11/95	Station 1 + 90 D-Line	-0.0'	0.86/1.00	8"	115.9	26.1	29.0	89.8	98.5	95% required
6	8/11/95	Station 2+80 D-Line	-0.0'	0.86/1.00	8"	117.8	27.0	29.6	90.8	99.6	95% required
7	8/11/95	Station 3+00 D-Line	-0.0'	0.86/1.00	8"	117.7	28.2	31.5	89.5	98.1	95% required
8	8/11/95	Station 0+80 D-Line	-0.0'	0.86/1.00	8"	117.3	27.8	31.1	89.5	98.1	95% required
9	8/11/95	Station 1+00 D-Line	-0.0'	0.86/1.00	8"	117.8	30.9	35.6	86.9	95.8	95% required

8-11-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95

COMPACTION TEST (FAMILY OF CURVES)

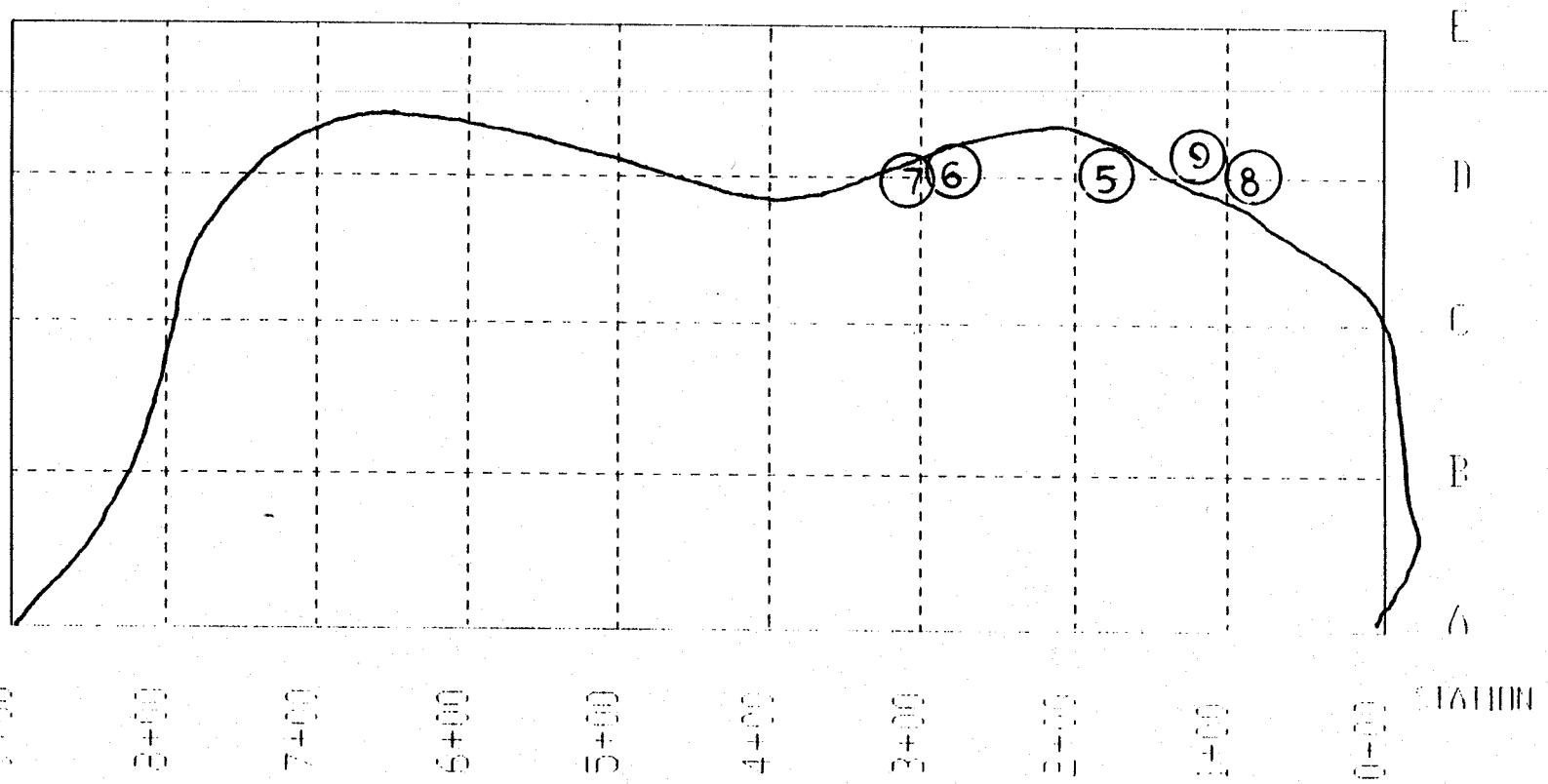
Tested by: TAL Reviewed by:

Singleton Laboratories

The Critical Link.

TVA BULL RUN FOSSIL PLANT
5.5-ACRE ASH DISPOSAL AREA CLOSURE
TEST LOCATION PLAN

DATE: 8-11-95



TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 8/14/95 Weather: Hot 97F

Location: Upper Ash Pond within the Railroad Loop

==========

Observations: Left Singleton Labs 9:50 a.m. - arrived Bull Run S.P. 10:30 a.m. Andy Luttrell was already on the job. The trucks, from the borrow area on 25W were bringing material mixed with large roots & topsoil. I sent two trucks back that were unacceptable. Bob Akins, of Akins Trucking wanted a discussion with parties involved. Garland Corder, TVA, Terry Hannigan, Tony Luttrell, & I met at the 25W borrow area. Most of the material remaining was not that which had been approved for fill in the ash dike. A verbal stop, was put on that borrow to Bob Akins. TVA would follow with the necessary paper work to make it legal & Mr. Corder of TVA would start the proceedings by notifying the TVA purchasing agent. Rogers borrow will try to bring backfill after normal TVA-GUBMK working. This material will be stockpiled until a visual inspection is made the next morning by a representative of Singleton Lab. Performed 7 nuclear densities. Left job site 3:30 p.m. - Arrived at Singleton 4:05 p.m.

Inspector: CB Essex

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 8/14/95 Weather: Hot & Dry

Location: Upper Ash Pond within the Railroad Loop

==========

Observations: Left Singleton Laboratories at 12:00 p.m. Arrived borrow area site on Highway 25W at 12:30 p.m. Met with Garland Corder (TVA), Terry Hannigan, Bob Akins, and Charles Essex also of Singleton Laboratories. Visually inspected remaining soils in borrow area, found materials were unsuitable for Ash pond capping. The materials remaining at borrow area were mixed with top-soil and roots and other debris. Asked Bob Akins if he could move 150' north into embankment of suitable soils, and was told that this area was owned by another party. A verbal stoppage was placed on materials from the 25W borrow, by Mr. Garland Corder of TVA. Left job-site at 3:00 p.m. Arrived Singleton at 3:30.

Inspector: Tony Luttrell

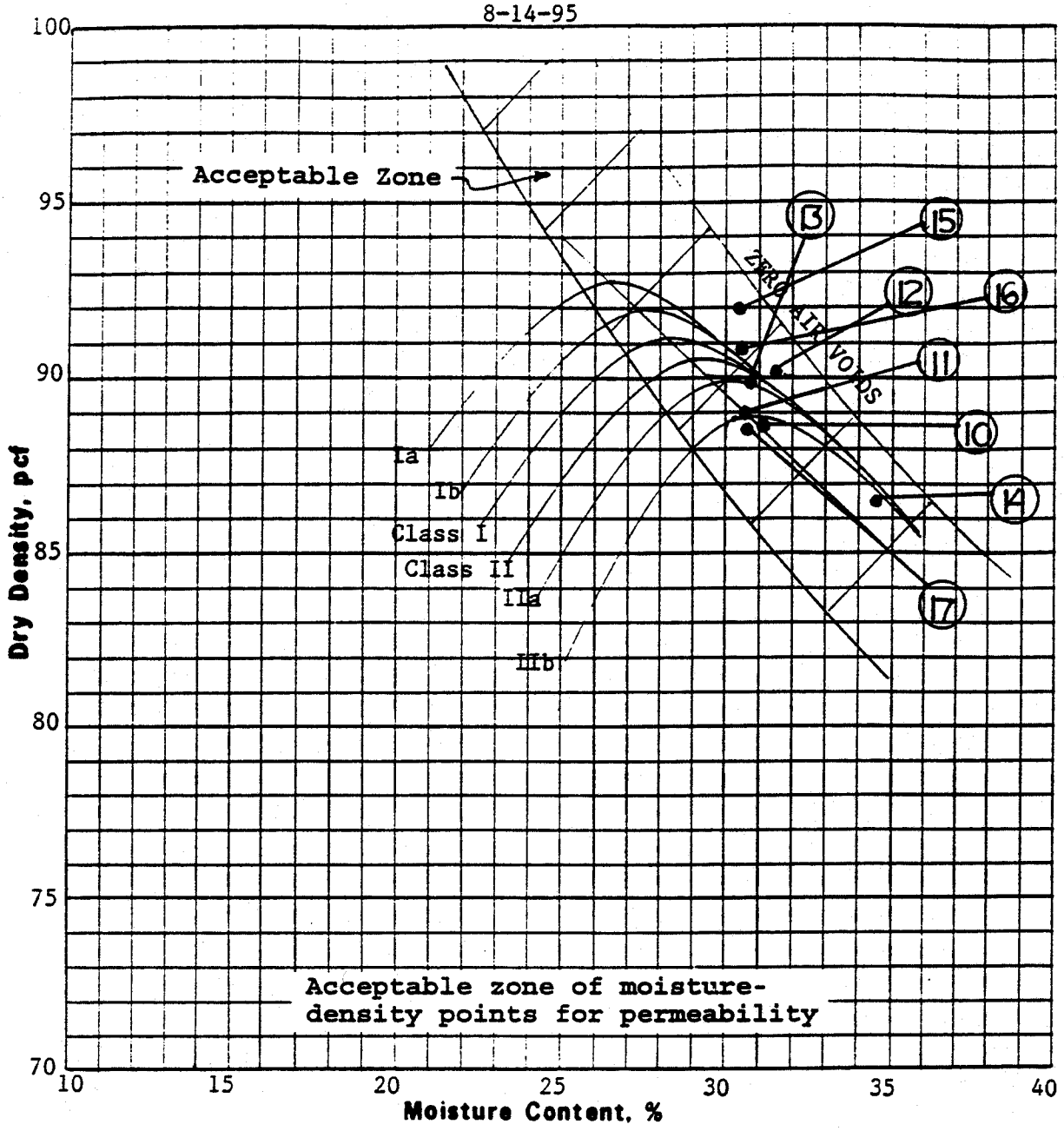
SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Disposal Area (Inside Loop Track)
Tested By CB Essex
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
10	8/14/95	Station 2+15 C-Line	-0.0'	0.98/0.95	8"	116.3	27.6	31.1	88.7	97.2	95% required
11	8/14/95	Station 2+60 C-Line	-0.0'	0.98/0.95	8"	115.9	27.1	30.4	88.9	97.5	95% required
12	8/14/95	Station 2+15 C-Line	-0.0'	0.98/0.95	8"	118.4	28.4	31.6	90.0	98.7	95% required
13	8/14/95	Station 1+50 C-Line	-0.0'	0.98/0.95	8"	117.6	27.8	30.9	89.8	98.5	95% required
14	8/14/95	Station 1+00 C-Line	-0.0'	0.98/0.95	8"	116.4	29.9	34.6	86.5	95.4	95% required
15	8/14/95	Station 1+70 B-Line	-0.0'	0.98/0.95	8"	119.9	28.0	30.5	91.9	100.8	95% required
16	8/14/95	Station 2+50 B-Line	-0.0'	0.98/0.95	8"	118.5	27.7	30.5	90.8	99.6	95% required
17	8/14/95	Station 1+30 B-Line	-0.0'	0.98/0.95	8"	116.0	27.3	30.8	88.7	97.3	95% required

8-14-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95
COMPACTION TEST (FAMILY OF CURVES)	

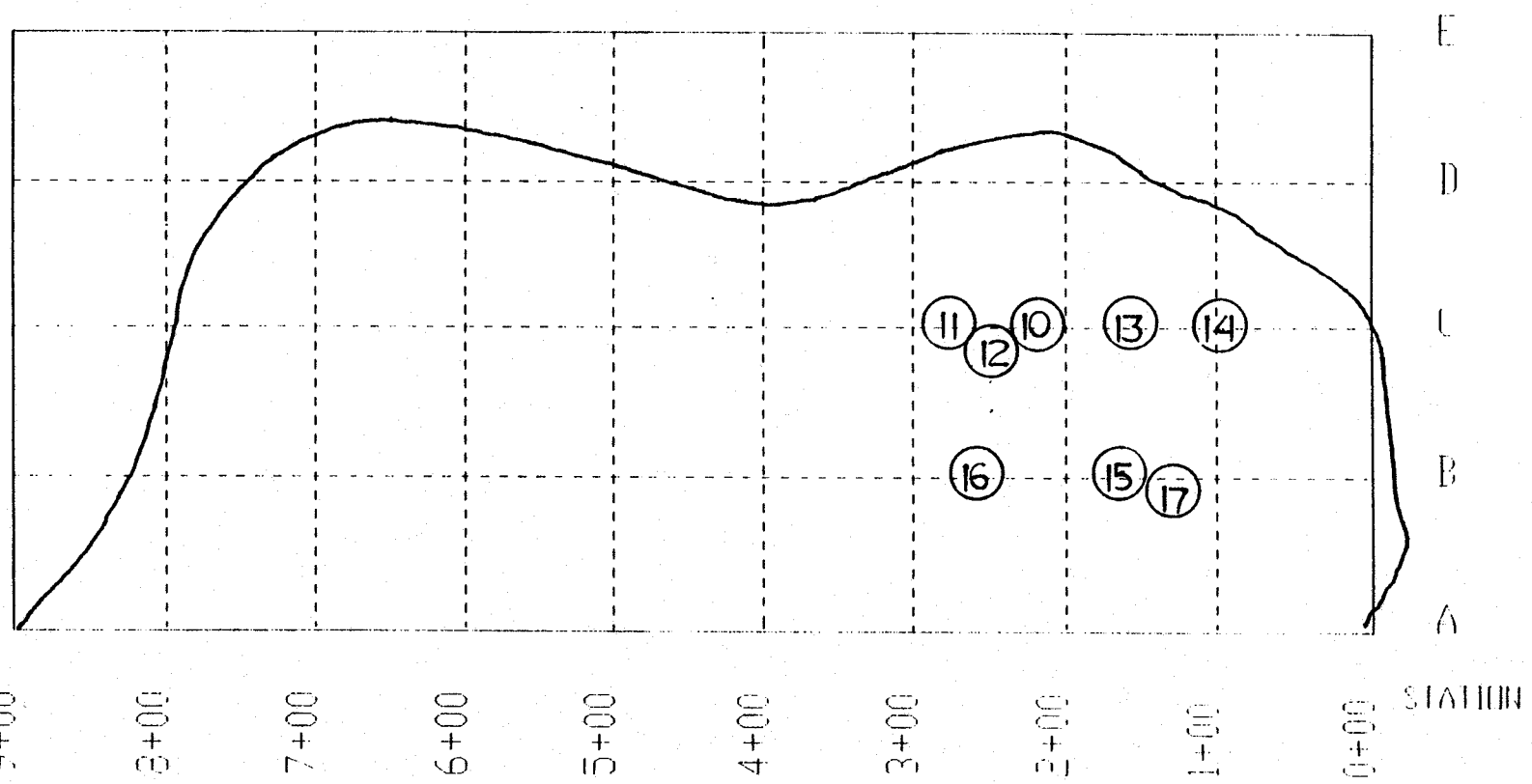
Tested by: TAL Reviewed by: JEC

Singleton Laboratories

The Critical Link.

TVA BULL RUN FOSSIL PLANT
5.5-ACRE ASH DISPOSAL AREA CLOSURE
TEST LOCATION PLAN

DATE: 8-14-95



TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 8/15/95 Weather: Hot - Clear 98F

Location: Ash Dike within Railroad Loop

==========

Observations: Left Singleton Labs 9:30 a.m. - Arrived at Bull Run S.P. 10:15 a.m. Ran a comparison sandcone & nuclear gauge at Sta. 1+75; line C. Recovered additional material for a 1 point proctor test. Also additional material for atterberg check tests. The material coming to the fill was very wet in places & average moisture in others. With the extreme heat the fill has to be monitored closely. 9 densities were performed this day. Left job site at 3:30 p.m. - Arrived at Singleton Labs 4:10 p.m.

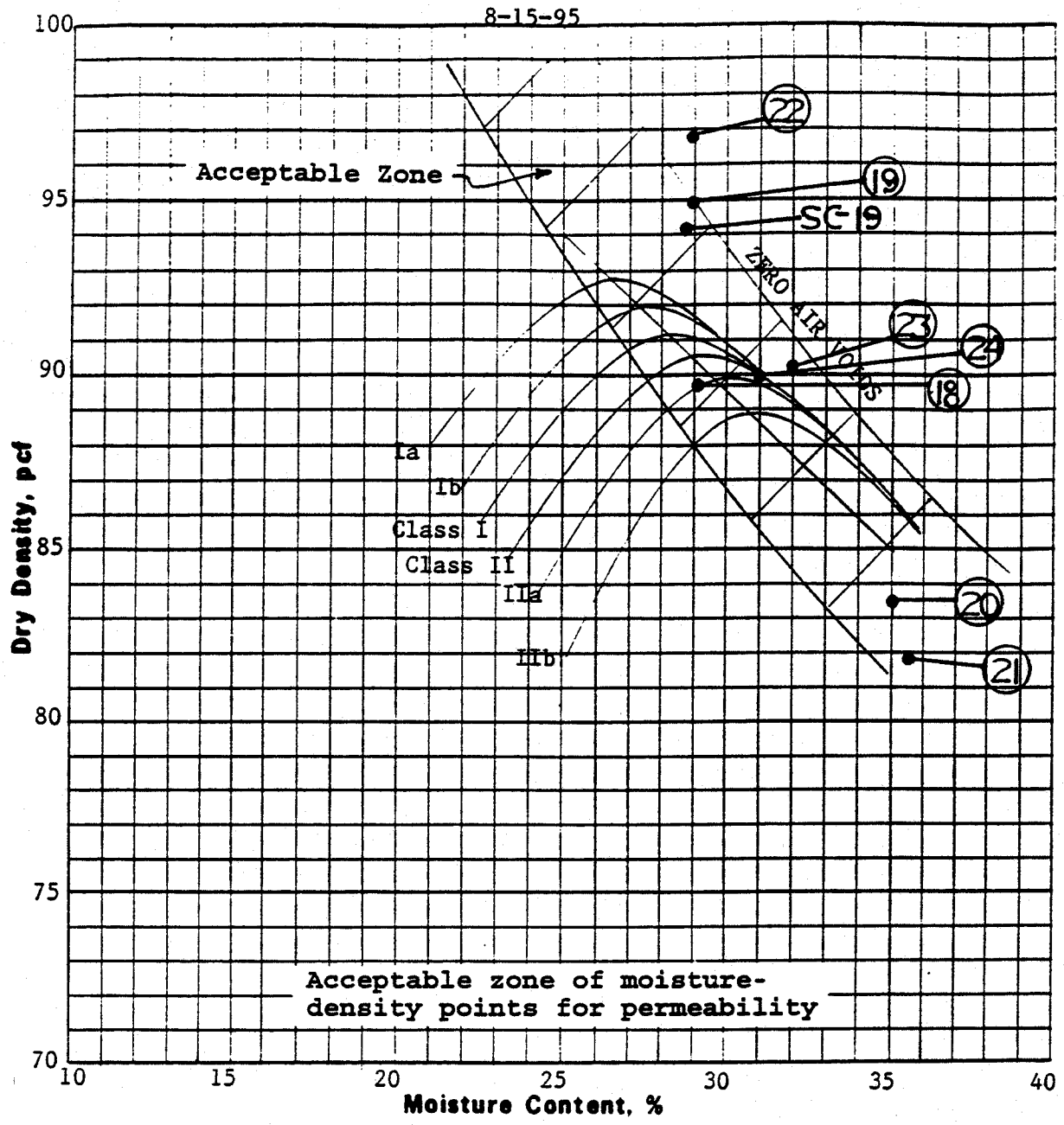
Inspector: CB Essex

SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Disposal Area (Inside Loop Track)
Tested By CB Essex
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
18	8/15/95	Station 3+00 C-Line	-0.0'	1.01/1.00	8"	115.7	26.1	29.1	89.6	98.2	95% required
19	8/15/95	Station 1+75 C-Line	-0.0'	1.01/1.00	8"	122.5	27.5	29.0	94.9	104.1	95% required
20	8/15/95	Station 3+00 B-Line	-0.0'	1.01/1.00	8"	111.6	29.0	35.1	82.6	91.1	95% required
21	8/15/95	Station 3+00 B-Line	-0.0'	1.01/1.00	8"	110.7	29.1	35.7	81.6	89.9	95% required
22	8/15/95	Station 3+00 B-Line	-0.0'	1.01/1.00	8"	125.0	28.4	29.4	96.7	106.0	95% required
23	8/15/95	Station 2+00 B-Line	-0.0'	1.01/1.00	8"	120.5	29.4	32.2	91.1	99.9	95% required
24	8/15/95	Station 4+00 B-Line	-0.0'	1.01/1.00	8"	117.9	28.0	31.2	89.9	98.6	95% required



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95

COMPACTION TEST (FAMILY OF CURVES)

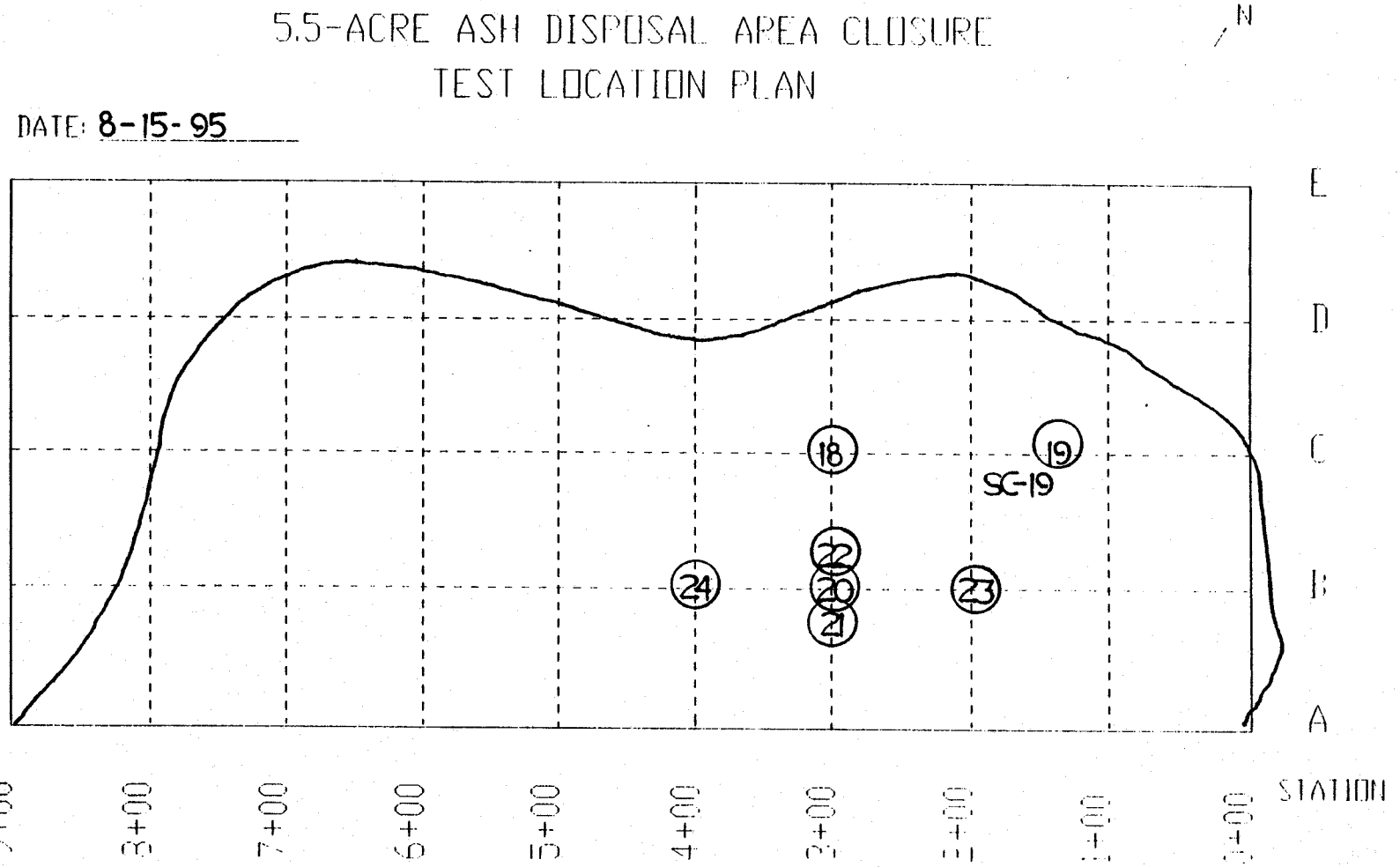
Tested by: TAL Reviewed by:

Singleton Laboratories

The Critical Link.

TVA BULL RUN FOSSIL PLANT
5.5-ACRE ASH DISPOSAL AREA CLOSURE
TEST LOCATION PLAN

DATE: 8-15-95



EARTHFILL COMPACTION TEST - SAND CONE METHOD

Project: Bull Run Steam Plant Feature: Ash Disposal Area Tested By: C. Essex
Date: 8/15/95 Station: 1+75 Offset: C-Line Sample Top Elevation: 0

1. Test Number	-	SC-19	
2. Borrow Source	-	Rogers	
3. Weight Sand & Cone Before Test	lb	18.31	
4. Weight Sand & Cone After Test	lb	9.65	
5. Weight Sand Used (3) - (4)	lb	8.66	
6. Cone Volume Weight Correction	lb	3.98	
7. Weight Sand in Test Hole (5)-(6)	lb	4.68	
8. Sand Calibration Factor	pcf	96.0	
9. Volume Test Hole (total sample) (7)/(8)	cf	.04875	
10. Weight Wet Total Sample & Tare	lb	6.93	
11. Weight Tare	lb	1.02	
12. Weight Wet Total Sample (10)-(11)	lb	5.91	
13. Weight Wet Plus 3/4 & Tare	lb	n/a	
14. Weight Dry Plus 3/4 & Tare	lb	n/a	
15. Weight Tare	lb	n/a	
16. Weight Wet Plus 3/4 (13)-(15)	lb	n/a	
17. Weight Dry Plus 3/4 (14)-(15)	lb	n/a	
18. Bulk Specific Gravity Plus #4 (SSD)	-	n/a	
19. Unit Weight Plus 3/4 (18)X 62.4	pcf	n/a	
20. Volume Plus 3/4 (16)/(19)	cf	n/a	
21. Weight Wet Minus 3/4 (12)-(16)	lb	5.91	
22. Volume Wet Minus 3/4 (9)-(20)	cf	.04875	
23. Wet Density Minus 3/4 (21)/(22)	pcf	121.2	
		Fill a	Mold b
24. Weight Wet Minus #4 and Tare	gm	243.1	487.0
25. Weight Dry Minus #4 and Tare	gm	210.2	406.2
26. Weight Tare	gm	95.6	95.6
27. Weight Water (24)-(25)	gm	114.6	80.8
28. Weight Dry Minus 3/4 (25)-(26)	gm	32.9	310.6
29. Moisture Content Minus 3/4 {(27)/(28)X100} W_f	%	28.7	26.0
30. Weight Total Dry Minus 3/4 (21)/{1+(29a)/100}	lb	4.59	-
31. Weight Total Dry Sample (17)+(30)	lb	4.59	-
32. Percentage Plus 3/4 {(17)/(31)} X 100	%	n/a	-
33. Dry Density Minus 3/4 (23)/{1+(29a)/100} Y_{df}	pcf	94.1	-
34. Weight 1/30 cf Compact Mold & Wet Minus	lb	-	8.47
35. Weight Compaction Mold	lb	-	4.46
36. Weight Wet Minus 3/4 (34)-(35)	lb	-	4.01
37. Wet Density (36) X 30	pcf	-	120.3
38. Dry Density (37)/{1+(29b)/100}	pcf	-	95.4
39. Soil Class {Control Curves with (29b) and (38b)}	-	I	-
40. Penetrometer Needle End Area	in^2	n/a	n/a
41. Average Needle Reading	lb	n/a	n/a
42. Penetration Resistance (41)-(40)	psi	n/a	n/a
43. Maximum Density (CONTROL CURVES) Y_{dL}	pcf	91.2	-
44. Optimum Moisture Content (CONTROL CURVES) W_o	%	28.1	-
45. (33)-(43) Y_{df}-Y_{dL}	pcf	+2.9	-
46. (29a)-(44) Required: to + W_f-W_o	%	+0.6	-
47. Compaction Minus #4 {(33)/(43)} X 100	%	103.2	-
48. Required Compaction: Minimum - 95% Maximum -	%	-	-
Corrective Action: Acceptable		*RETEST NO.*	

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 8/16/95 Weather: Hot (Mid 90's)

Location: Ash Disposal Area (Inside Loop Track)

==========

Observations: Left Singleton 8:00 a.m. - Arrived on site at 8:45 a.m. Material had been spread from trucks which dumped the evening before. Water truck ran over spread material and then compacted. Two tests showed material had high water content. This area later re-checked and moisture and density were to specs. Observed material being dumped and compacted from 9:15 a.m. to 10:30 a.m. Two different types of clay being dumped which makes moisture difficult to get to specs. Talked to Garland Corder about 11:00 a.m because of large amount of rock in material. Amount of rock decreased in the afternoon, but moisture still difficult to get to specs because of mixture of wet and dry material being dumped

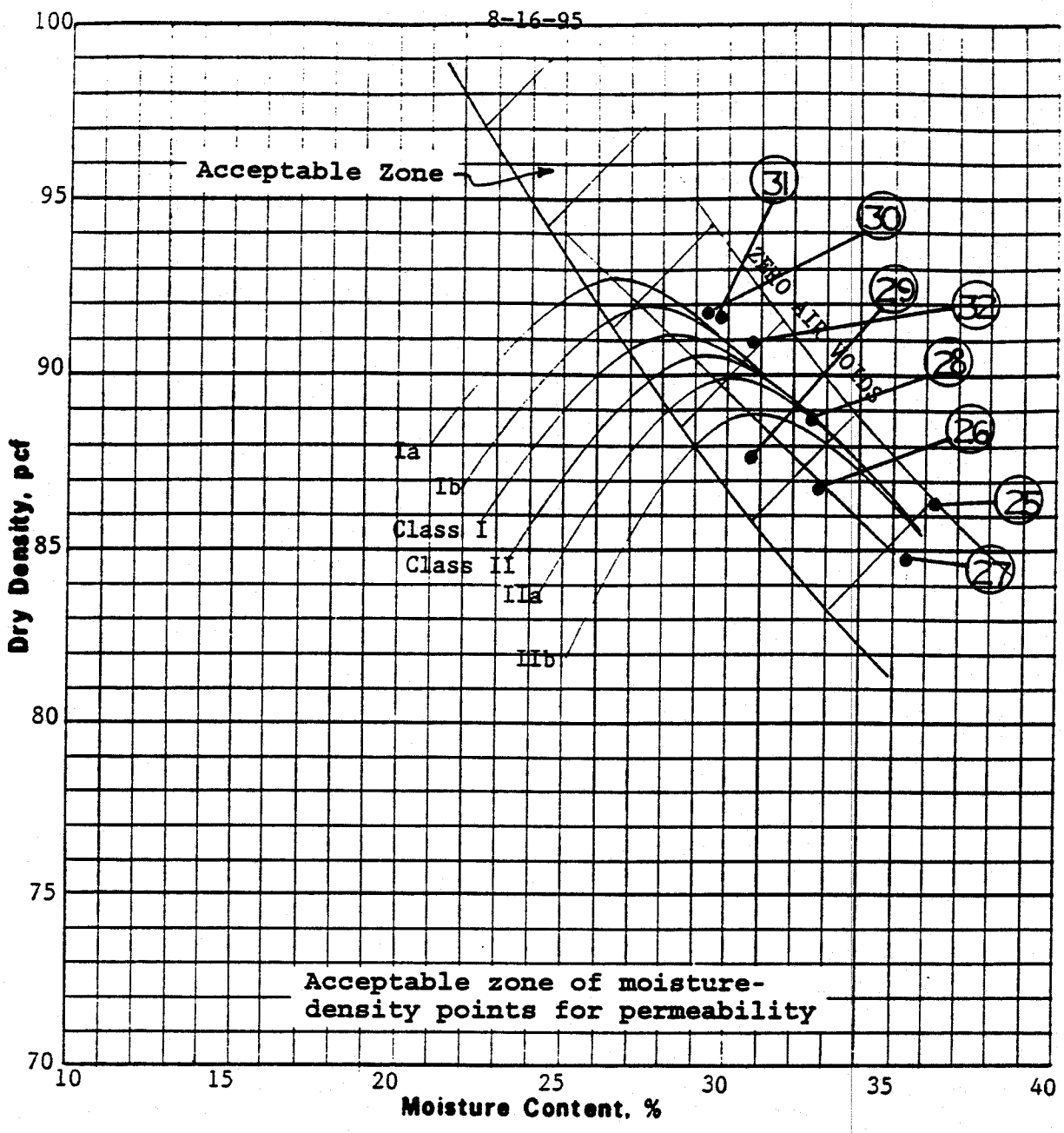
Inspector: Andrew S. Luttrell

SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Disposal Area (Inside Loop Track)
Tested By A. Luttrell
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.7
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
25	8/16/95	Station 5+50 C-Line	-0.0'	0.93/0.97	8"	117.7	31.3	36.2	86.4	95.3	95% Required
26	8/16/95	Station 5+00 B-Line	-0.0'	0.93/0.97	8"	115.5	28.6	32.9	86.9	95.8	95% Required
27	8/16/95	Station 5+50 B-Line	-0.0'	0.93/0.97	8"	114.8	30.0	35.4	84.8	93.5	*Failed
28	8/16/95	Station 5+00 C-Line	-0.0'	0.93/0.97	8"	117.7	29.0	32.7	88.7	97.8	*Retest 27
29	8/16/95	Station 6+00 C-Line	-0.0'	0.93/0.97	8"	114.5	27.0	30.9	87.5	96.4	95% Required
30	8/16/95	Station 6+50 C--Line	-0.0'	0.93/0.97	8"	118.7	27.0	29.4	91.7	100.5	95% Required
31	8/16/95	Station 7+00 C-Line	-0.0'	0.93/0.97	8"	119.0	27.3	29.8	91.7	100.5	95% Required
32	8/16/95	Station 6+50 C-Line	-0.0'	0.93/0.97	8"	119.0	28.1	30.9	90.7	99.7	95% Required



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95

COMPACTION TEST (FAMILY OF CURVES)

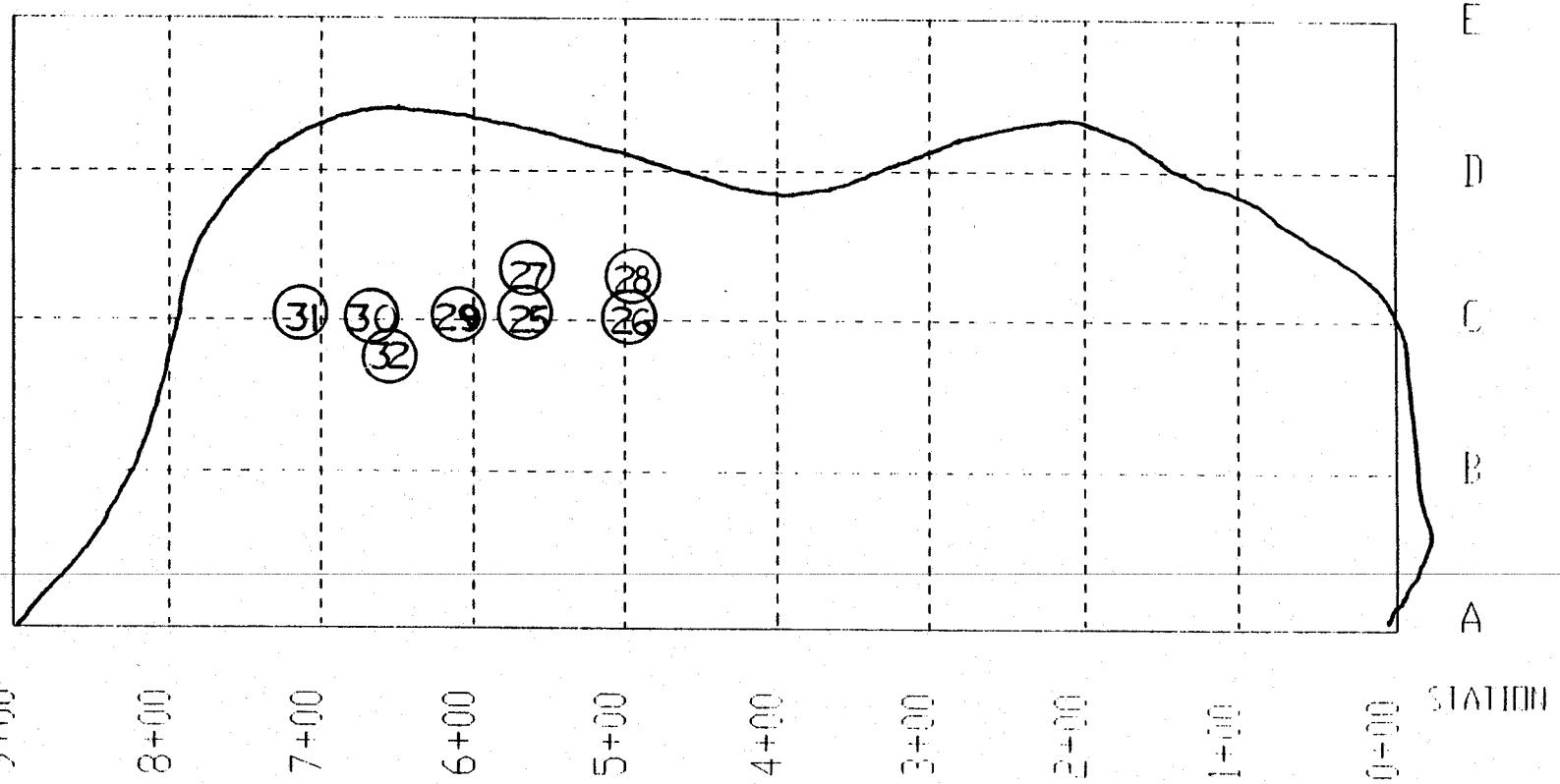
Tested by: TAL Reviewed by:

Singleton Laboratories

The Critical Link.

TVA BULL RUN FOSSIL PLANT
5.5-ACRE ASH DISPOSAL AREA CLOSURE
TEST LOCATION PLAN

DATE: 8-16-95



TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 8/17/95 Weather: Hot - 96F

Location: Ash Dike within railroad Loop

==========

Observations: Left Singleton Labs 9:20 a.m. - Arrived at Bull Run S.P. 10:00 a.m. Continued to fill in areas between Sta. 6 & 9 & Lines C & D. The trucks are coming more often & the compactor-spreader started pushing material between stations 0 & 4 to the middle ditch. The water truck broke down twice. Part of the fill may be ripped to add water as needed. Tested the ditch at the beginning of the 2nd half of the fill. GUBMK requested their crew work over this day, with the hopes of finishing the entire fill on Friday. Left job site at 3:40 p.m. - Arrived at Singleton Labs 4:15 p.m.

Inspector: Charles B. Essex

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 8/17/95 Weather: 95F

Location: Ash Disposal Area (Inside Loop Track)

==========

Observations: Arrived on site at 7:45 a.m. Material being spread and compacted from night before. Material still seems to be of two different types. Large volume of material being dumped all day. Samples taken during the morning show low H_2O. Left at 12:30 p.m.

Inspector: Andrew S. Luttrell

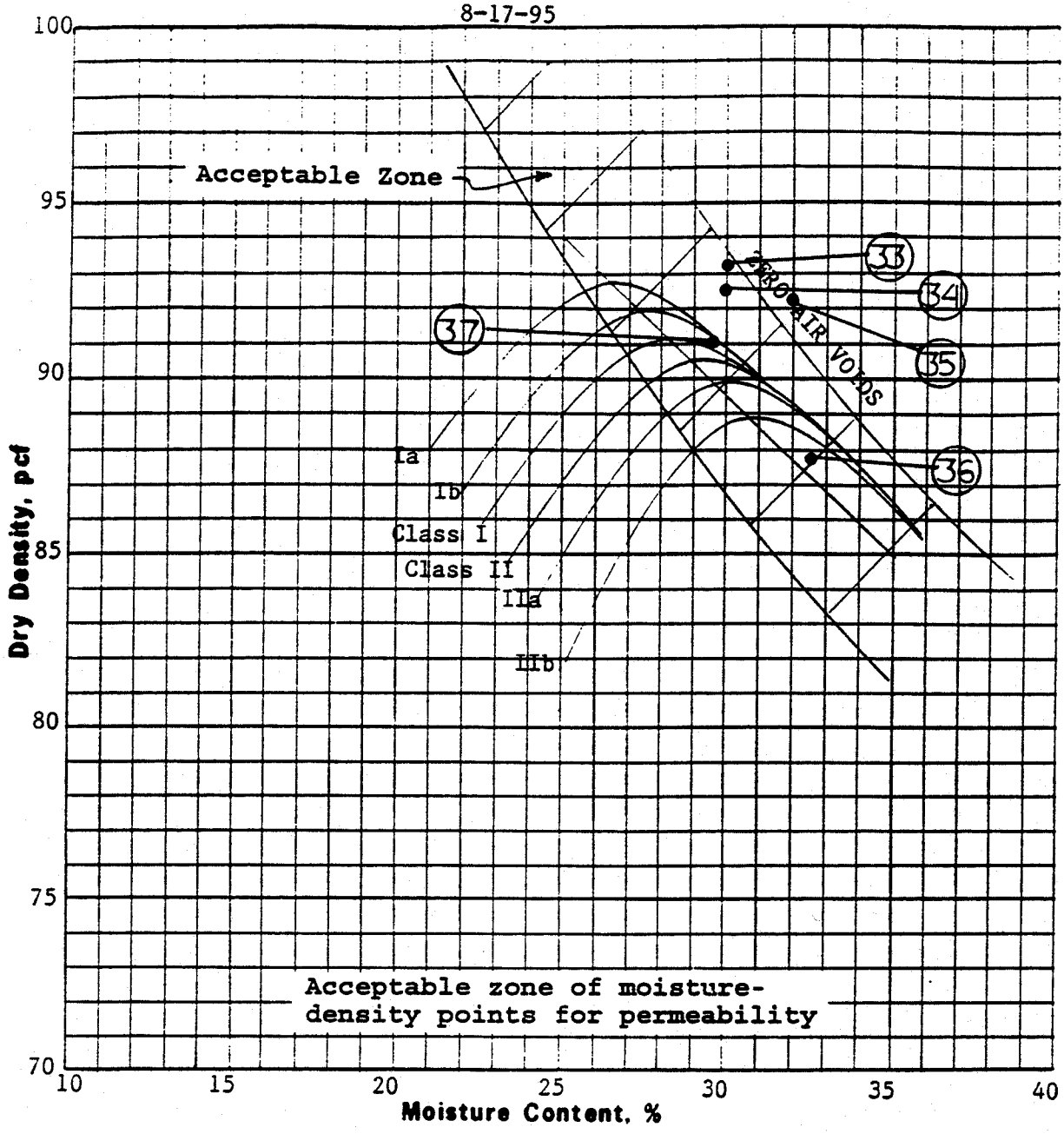
SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Disposal Area (Inside Loop Track)
Tested By A. Luttrell
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.7
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
33	8/17/95	Station 6+00 C-Line	-0.0'	0.93/1.02	8"	121.2	28.0	30.0	93.2	102.2	95% Required
34	8/17/95	Station 7+00 O-Line	-0.0'	0.93/1.02	8"	120.5	27.9	30.0	92.6	101.6	95% Required
35	8/17/95	Station 7+50 C-Line	-0.0'	0.93/1.02	8"	121.9	29.6	32.0	92.3	101.3	95% Required
36	8/17/95	Station 8+30 B-Line	-0.0'	0.93/1.02	8"	116.4	28.6	32.5	87.8	96.8	95% Required
37	8/17/95	Station 0+25 A-Line	-0.0'	0.93/1.02	8"	118.0	27.0	29.7	91.0	99.8	95% Required

8-17-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95

COMPACTION TEST (FAMILY OF CURVES)

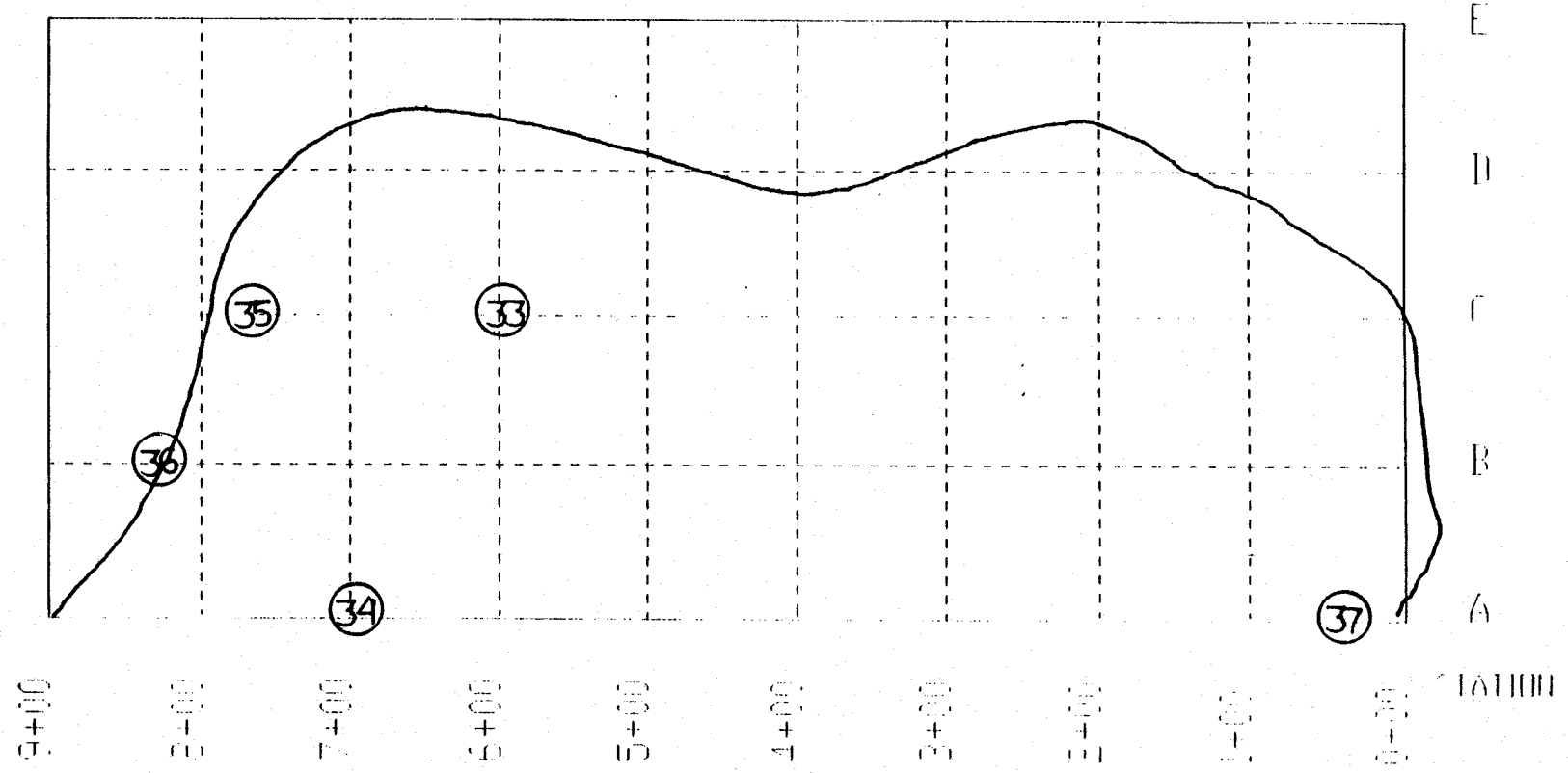
Tested by: TAL Reviewed by: [illegible]

Singleton Laboratories

The Critical Link.

TVA BULL RUN FOSSIL PLANT
5.5-ACRE ASH DISPOSAL AREA CLOSURE
TEST LOCATION PLAN

DATE: 8-17-95



TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 8/18/95 Weather: Hot

Location: Ash Disposal area (Inside Loop Track)

==========

Observations: Arrived on site at 7:15 a.m. Continuing to fill areas between A & B lines all day. Ran about 10 tests in this area before lunch. All of these tests passed without needing water on the area. The only area low in moisture was the ditch on the B-Line. Had water truck make about 2 passes over the whole fill to reduce mud cracks before weekend. Water truck left at 3:30 p.m. - compactor and grader remained until 5:30 p.m. to continue with material brought in late afternoon.

Inspector: Andrew S. Luttrell

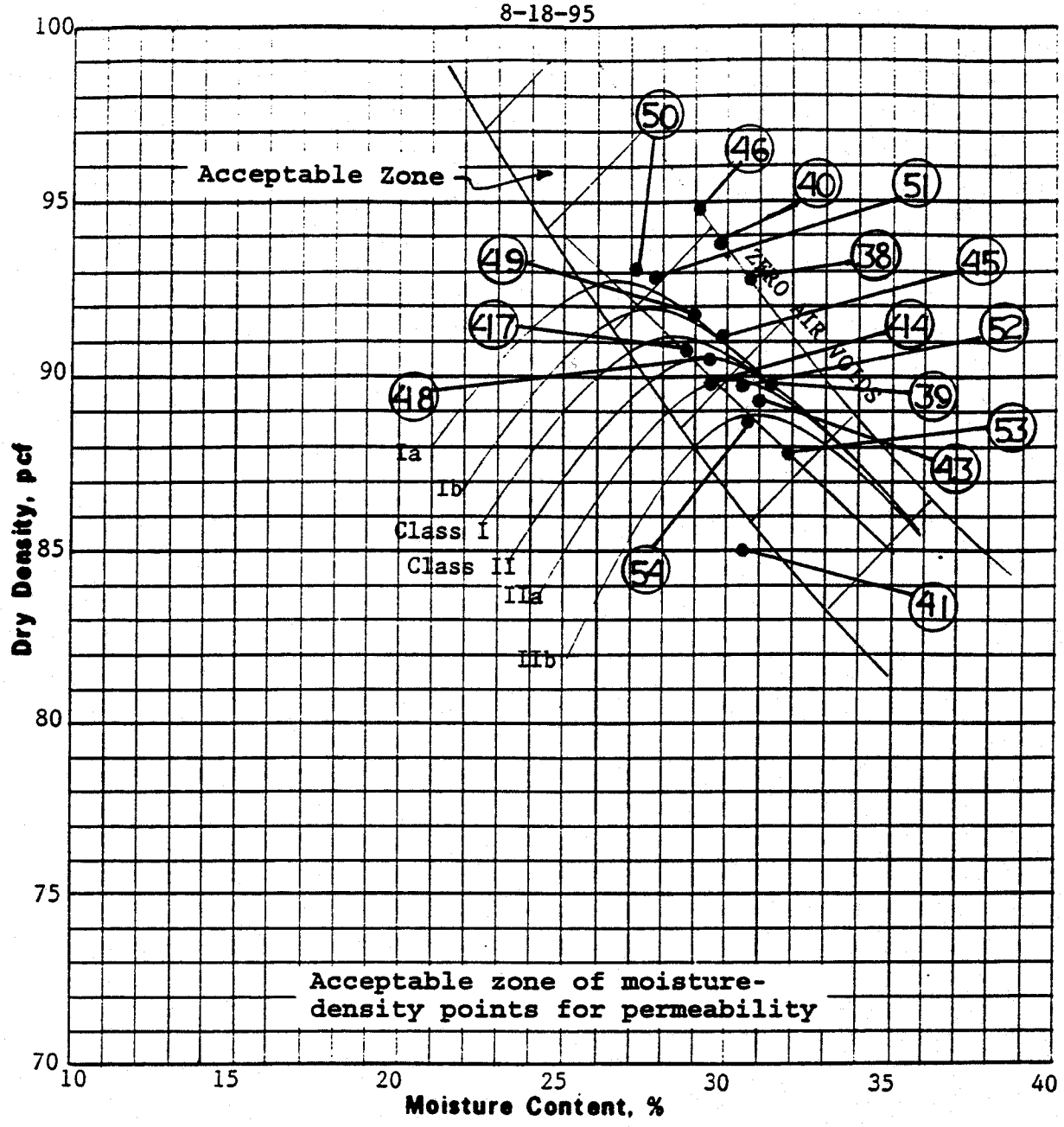
SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Disposal Area (Inside Loop Track)
Tested By A. Luttrell
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.7
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
38	8/18/95	Station 7+50 B-Line	-0.0'	0.99/0.98	8"	121.8	28.6	30.7	93.2	102.1	95% required
39	8/18/95	Station 0+80 A-Line	-0.0'	0.99/0.98	8"	118.1	28.2	31.4	89.8	98.5	95% required
40	8/18/95	Station 1+70 A-Line	-0.0'	0.99/0.98	8"	120.9	27.1	28.9	93.8	102.9	95% required
41	8/18/95	Staion 2+50 A-Line	-0.0'	0.99/0.98	8"	110.9	25.9	30.5	85.0	93.7	*Failed
42	8/18/95	Station 2+50 A-Line	-0.0'	0.99/0.98	8"	116.9	27.7	31.0	89.2	98.3	* Retest 41
43	8/18/95	Station 2+00 A-Line	-0.0'	0.99/0.98	8"	117.1	26.7	29.6	90.3	99.0	95% required
44	8/18/95	Station 3+50 A-Line	-0.0'	0.99/0.98	8"	116.1	26.4	29.4	89.8	98.5	95% required
45	8/18/95	Station 3+00 A-Line	-0.0'	0.99/0.98	8"	118.3	27.1	29.8	91.2	100.0	95% required
46	8/18/95	Station 3+80 A-Line	-0.0'	0.99/0.98	8"	122.5	27.7	29.2	94.8	103.9	95% required
47	8/18/95	Station 4+50 A-Line	-0.0'	0.99/0.98	8"	116.7	26.0	28.7	90.6	99.3	95% required
48	8/18/95	Station 5+90 A-Line	-0.0'	0.99/0.98	8"	117.3	26.7	29.5	90.6	99.3	95% required
49	8/18/95	Station 6+20 A-Line	-0.0'	0.99/0.98	8"	118.3	26.6	29.0	91.8	100.7	95% required
50	8/18/95	Station 6+50 A-Line	-0.0'	0.99/0.98	8"	118.3	25.2	27.1	93.0	101.9	95% required
51	8/18/95	Station 6+00 A-Line	-0.0'	0.99/0.98	8"	118.6	25.9	27.9	92.8	101.2	95% required
52	8/18/95	Station 4+50 B-Line	-0.0'	0.99/0.98	8"	116.9	27.3	30.5	89.6	98.2	95% required
53	8/18/95	Station 7+00 A-Line	-0.0'	0.99/0.98	8"	115.9	28.0	31.8	87.9	96.9	95% required
54	8/18/95	Station 7+30 A-Line	-0.0'	0.99/0.98	8"	116.0	27.3	30.8	88.7	97.3	95% required

8-18-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95

COMPACTION TEST (FAMILY OF CURVES)

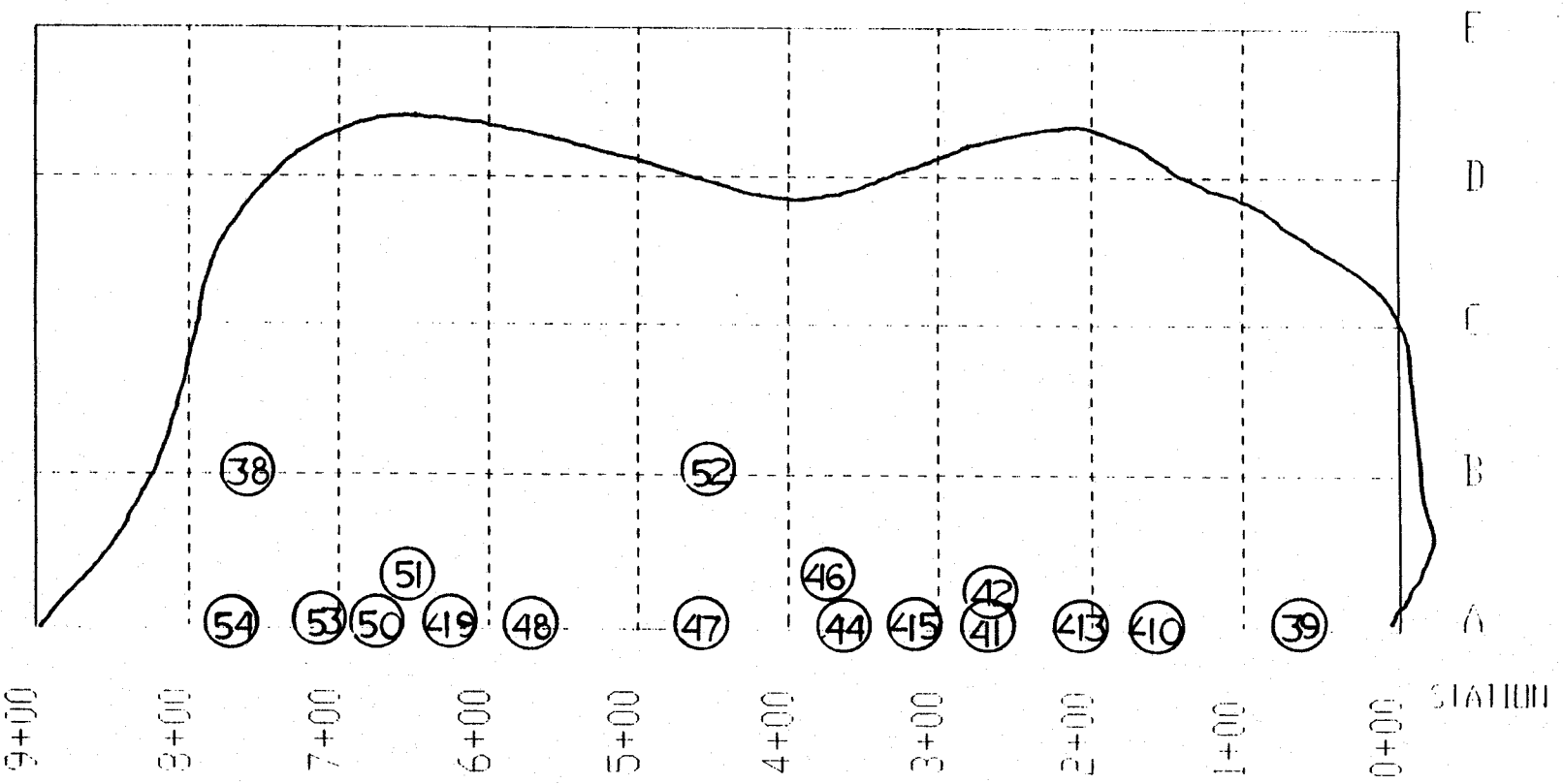
Tested by: TAL Reviewed by: [signature]

Singleton Laboratories

The Critical Link.

TVA BULL RUN FOSSIL PLANT
5.5-ACRE ASH DISPOSAL AREA CLOSURE
TEST LOCATION PLAN

DATE: 8-18-95



TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 8/21/95 Weather: Hot & Humid

Location: Ash Disposal Area (Inside Loop Track)

==========

Observations: Arrived on site about 8:45 a.m. Examined ash stack-stage II, the area started today. About 9:15 a.m. went to ash dike w/in R.R. Loop to take final tests between Stations 7+00 & 9+00 on the A-Line. Rain over the weekend made moisture content high, but all tests passed. 10:00 a.m. returned to Stage II. Material laid along Line-A of Stage II. 3' of material laid between 7:00 a.m. and 2:00 p.m. took several tests. Material was wet about 2:30 p.m., 6" of additional soil added. Material added along H & I-Lines starting about 2:30 p.m. until end of day.

Inspector: Andrew S. Luttrell

SINGLETON LABORATORIES

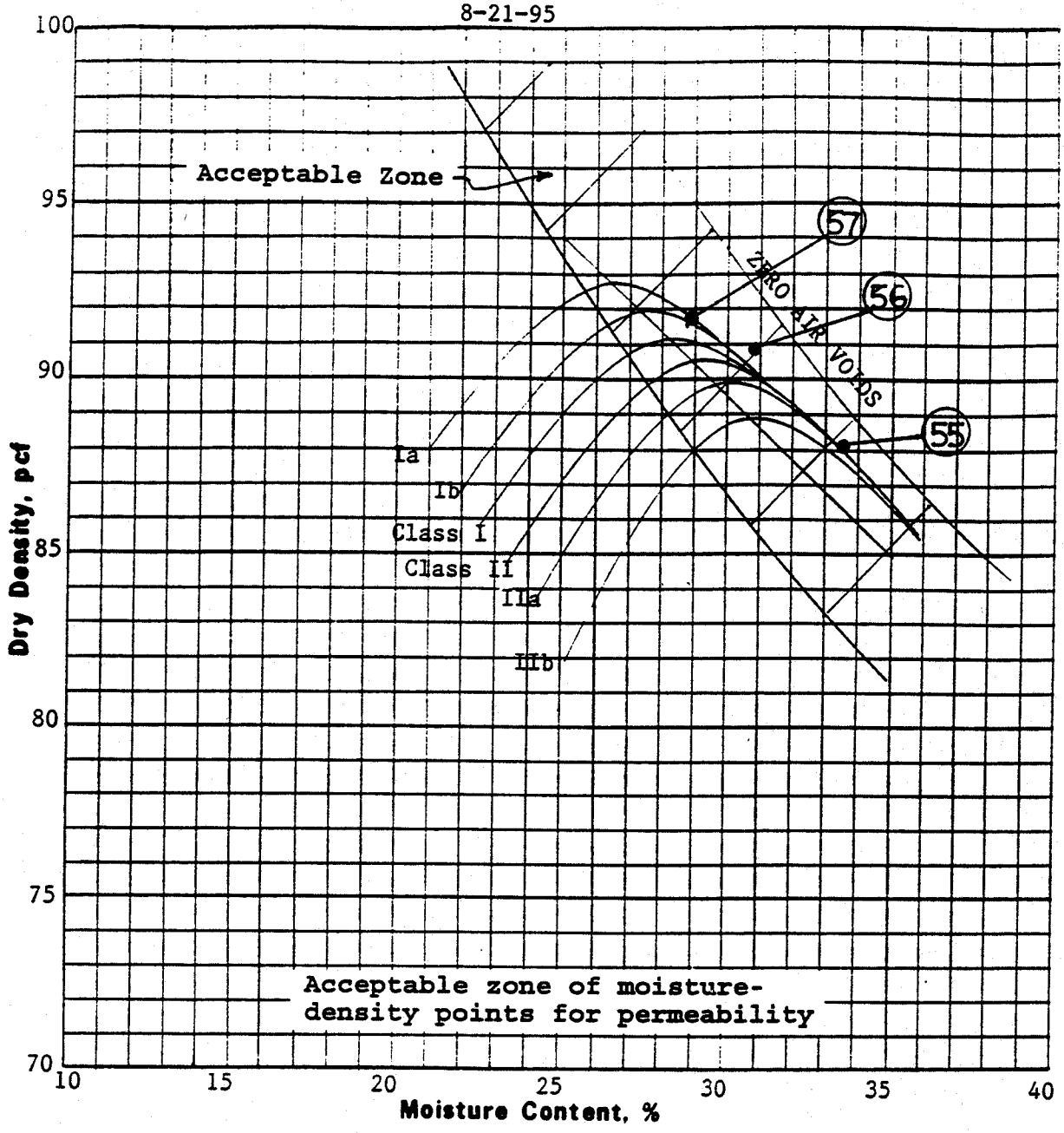
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Disposal Area (Inside Loop Track)
Tested By A. Luttrell
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
55	8/21/95	Station 7+60 A-Line	-0.0'	1.00/1.05	8"	117.9	29.7	33.6	88.2	97.2	95% required
56	8/21/95	Station 8+60 A-Line	-0.0'	1.00/1.05	8"	119.0	28.1	30.9	90.9	99.7	95% required
57	8/21/95	Station 8+90 A-Line	-0.0'	1.00/1.05	8"	117.7	26.4	28.9	91.3	100.1	95% required

8-21-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95
COMPACTION TEST (FAMILY OF CURVES)	

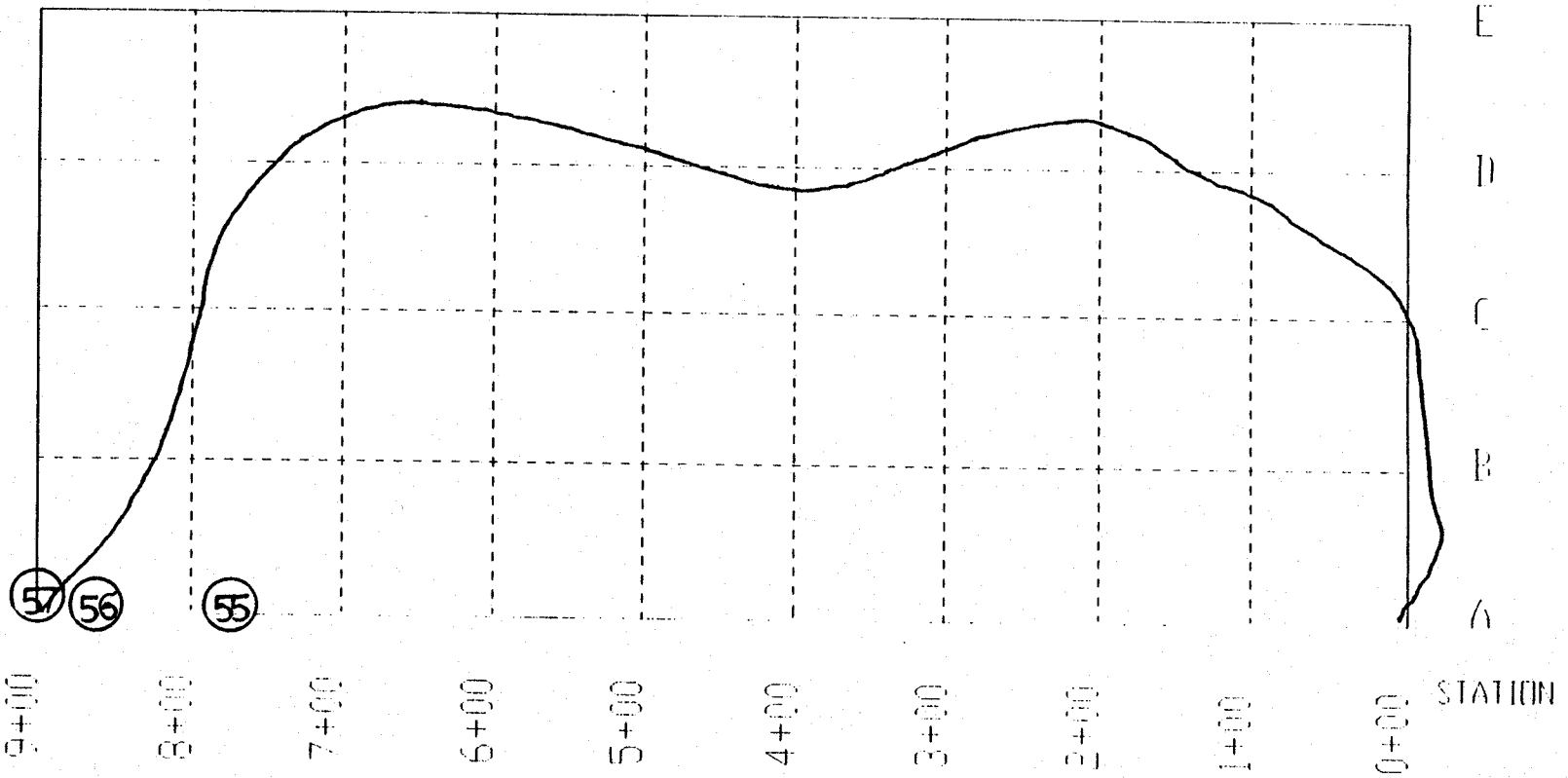
Tested by: TAL Reviewed by: [signature]

Singleton Laboratories

The Critical Link.

TVA BULL RUN FOSSIL PLANT
5.5 ACRE ASH DISPOSAL AREA CLOSURE
TEST LOCATION PLAN

DATE: 8-21-95



DAILY FIELD REPORT

Date: 8/22/95 Weather: Hot - 93F

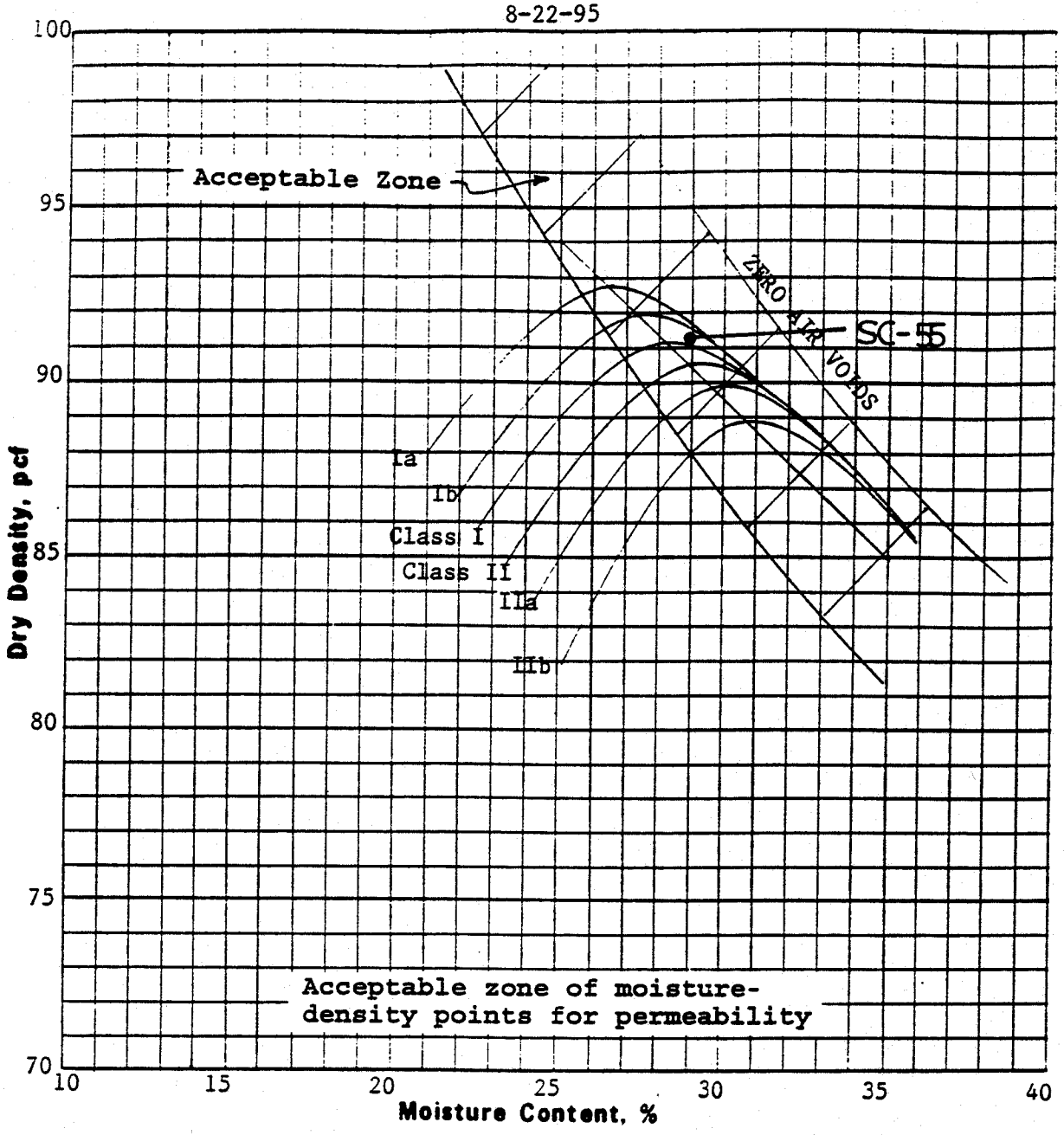
Location: Ash Disposal Area (Inside Loop Track)

==========

Observations: Left Singleton Labs 9:00 a.m. - Arrived 9:30 a.m. at job site. Contractor brought in & dumped two loads of topsoil & roots during lunch. These were disposed of. A third truck was sent back to the borrow area without dumping its load. Things got better after that. A sandcone density was run on Phase 2. Left job site 3:30 p.m. Arrived at Singleton Labs 4:10 p.m.

Inspector: Charles B. Essex

8-22-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95

COMPACTION TEST (FAMILY OF CURVES)

Tested by: TAL Reviewed by: [illegible]

EARTHFILL COMPACTION TEST - SAND CONE METHOD

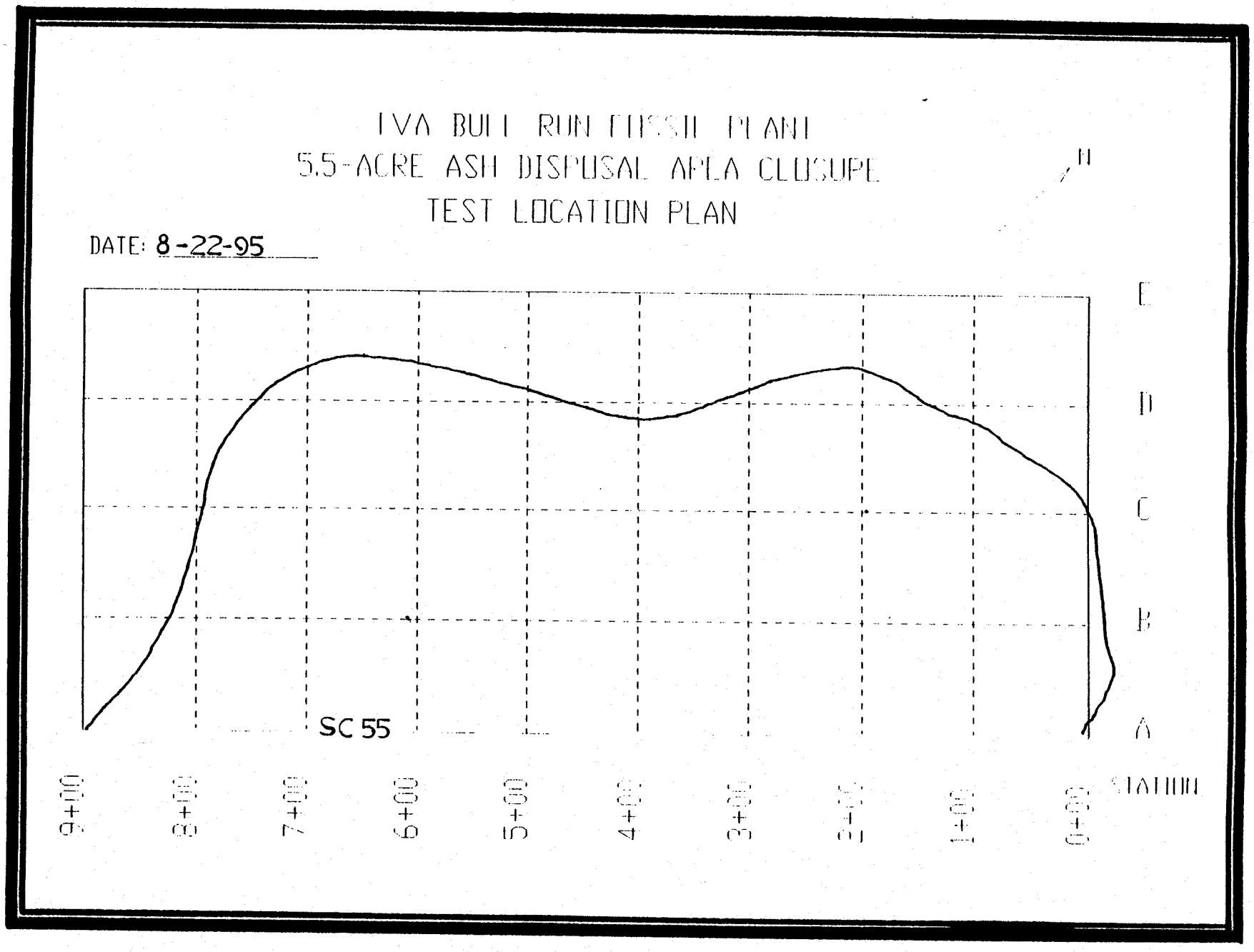
Project: Bull Run Steam Plant Feature: Ash Dike within the R. R. Loop Test CBE/AEL

Date: 8/22/95 Station: 7+60 Offset: Line-"A" Sample Top Elevation:

1. Test Number			-	SC-55
2. Borrow Source			-	
3. Weight Sand & Cone Before Test No.5	8300g		lb	18.30
4. Weight Sand & Cone After Test	4243g		lb	9.35
5. Weight Sand Used (3) - (4)			lb	8.95
6. Cone Volume Weight Correction			lb	3.98
7. Weight Sand in Test Hole (5)-(6)			lb	4.97
8. Sand Calibration Factor			pcf	96.0
9. Volume Test Hole (total sample) (7)/(8)			cf	0.0518
10. Weight Wet Total Sample & Tare	3224		lb	7.11
11. Weight Tare			lb	1.02
12. Weight Wet Total Sample (10)-(11)			lb	6.09
13. Weight Wet Plus 3/4 & Tare			lb	6.09
14. Weight Dry Plus 3/4 & Tare			lb	6.09
15. Weight Tare			lb	6.09
16. Weight Wet Plus 3/4 (13)-(15)			lb	6.09
17. Weight Dry Plus 3/4 (14)-(15)			lb	6.09
18. Bulk Specific Gravity Plus #4 (SSD)			-	6.09
19. Unit Weight Plus 3/4 (18)X 62.4			pcf	6.09
20. Volume Plus 3/4 (16)/(19)			cf	6.09
21. Weight Wet Minus 3/4 (12)-(16)			lb	6.09
22. Volume Wet Minus 3/4 (9)-(20)			cf	0.05
23. Wet Density Minus 3/4 (21)/(22)			pcf	117.6
				Fill a 125 / Mold b
24. Weight Wet Minus #4 and Tare			gm	330.1 / 335.1
25. Weight Dry Minus #4 and Tare			gm	279.4 / 288.9
26. Weight Tare			gm	104.5 / 104.5
27. Weight Water (24)-(25)			gm	174.9 / 184.4
28. Weight Dry Minus 3/4 (25)-(26)			gm	50.7 / 46.2
29. Moisture Content Minus 3/4 {(27)/(28)X100}		W_f	%	29.0 / 25.1
30. Weight Total Dry Minus 3/4 (21)/{1+(29a)/100}			lb	4.72 / -
31. Weight Total Dry Sample (17)+(30)			lb	4.72 / -
32. Percentage Plus 3/4 {(17)/(31)} X 100			%	n/a / -
33. Dry Density Minus 3/4 (23)/{1+(29a)/100}		Y_{df}	pcf	91.2 / -
34. Weight 1/30 cf Compact Mold & Wet Minus			lb	- / 8.48
35. Weight Compaction Mold			lb	- / 4.45
36. Weight Wet Minus 3/4 (34)-(35)			lb	- / 4.03
37. Wet Density (36) X 30			pcf	- / 120.9
38. Dry Density (37)/{1+(29b)/100}			pcf	- / 96.7
39. Soil Class {Control Curves with (29b) and (38b)}			-	I / -
40. Penetrometer Needle End Area			in^2	n/a / n/a
41. Average Needle Reading			lb	n/a / n/a
42. Penetration Resistance (41)-(40)			psi	n/a / n/a
43. Maximum Density (CONTROL CURVES)		Y_{dL}	pcf	91.2 / -
44. Optimum Moisture Content (CONTROL CURVES)		W_o	%	28.1 / -
45. (33)-(43)		Y_{df}-Y_{dL}	pcf	0 / -
46. (29a)-(44) Required: - to +		W_f-W_o	%	+0.9 / -
47. Compaction Minus #4 {(33)/(43)} X 100			%	100.0 / -
48. Required Compaction: Minimum - 95% Maximum -			%	- / -
Corrective Action:				

Singleton Laboratories

The Critical Link.



TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 8/24/95 Weather: _____

Location: Ash Disposal Area (Inside Loop Track)

==========

Observations: Arrived on job-site met with Charles Essex also of Singleton, and Alan Myers of G UB MK. With the aid of track-hoe and Mr. Essex and Mr. Myers, excavated the clay cap placed over the ash disposal area at Railroad Loop. All areas tested revealed a clay cap cover of 13 inches or greater. Then proceeded to re-compact excavated area with a self-propelled roller, also requested that Mr. Myers wet down entire 5 acres of clay cap cover with a water truck. Observed the wetting of area with water tanker 2 passes over 5 acres of clay cap, also observed a smooth drum steel roller sealing the area. Left job-site enroute for Singleton Laboratories.

Inspector: Tony A. Luttrell

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 8/25/95 Weather: Hot -85F

Location: Ash Disposal Area (Inside Loop Track)

==========

Observations: Left Singleton Labs 7:40 a.m. - Arrived at job site 8:15 a.m. Continued to fill with the possibility of finishing the Phase 2 by Monday. Returned to the ash dike within the railroad loop & pushed two shelby tubes at Station 7+00 on the "B"line. Two of the trucks are hauling rock #57 stone for the drainage. On Phase 2 we had less trucks hauling backfill & the job is therefore slowing down. Only two tests run today at quitting time. Left job site at 3:25 p.m., Arrived at Singleton Labs 4:10 p.m.

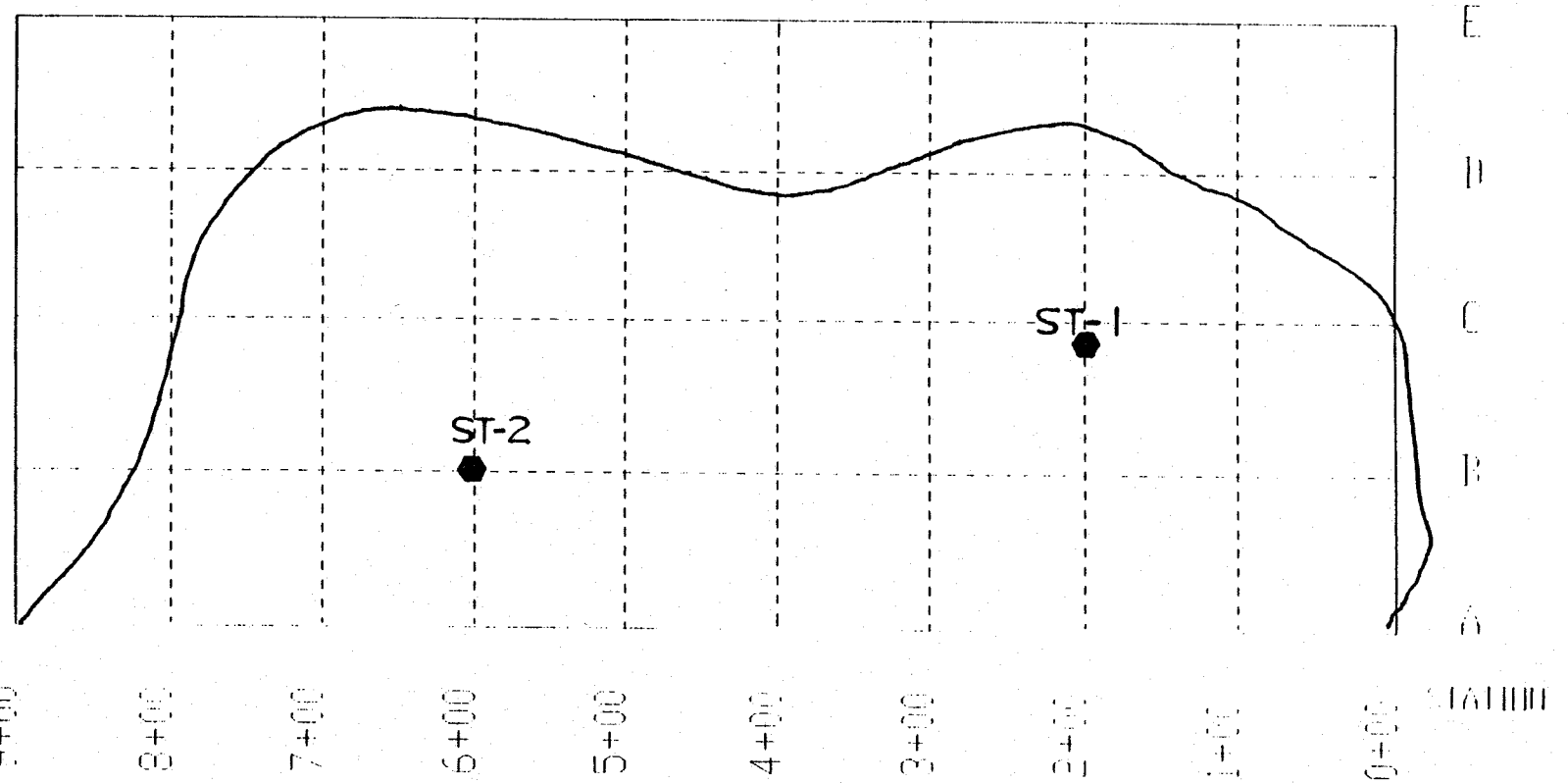
Inspector: Charles B. Essex

Singleton Laboratories

The Critical Link.

TVA BULL RUN FOSSIL PLANT
5.5-ACRE ASH DISPOSAL AREA CLOSURE
TEST LOCATION PLAN

DATE: 8-24-95



TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 8/30/95 Weather: Sunny

Location: Ash Disposal Area (Inside Loop Track)

==========

Observations: Arrived on job-site, met with Alan Myers of G UB MK. Then proceeded to set grade stakes from Station 1+00 to 2+50 on F & G-Lines where six inches of additional fill will be needed for the Stage II Geologic buffer. Then proceeded to Ash Disposal area at Railroad Loop. Visually inspected the clay cap that had been placed on the upper ash area. There were visual signs of desication of clay cap. Requested that Mr. Myers wet down entire 5 acres of clay cap cover with a water truck. Observed the wetting of area with water truck, 1 pass over the 5 acres of clay cap. Left job-site enroute for Singleton Laboratories.

Inspector: Tony A. Luttrell

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/7/95 Weather: Sunny

Location: Ash Disposal Area (West Pond)

==========

Observations: Left Singleton Laboratories at 12:00 Met Jack Hilliard also of Singleton Laboratories at gate. Proceeded to Ash Disposal area and surveyed 400' of the west pond for initial survey before the placement clay cap. Met with Terry Hannigan and Alan Myers of G UB Mk and discussed results of survey. Left Bull Run S.P. at 3:30 enroute for Singleton Laboratories.

Inspector: Tony A. Luttrell

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/11/95 Weather: Overcast 85F

Location: Dry stacking & within the railroad loop ash dikes

==========

Observations: Left Singleton Labs at 8:25 a.m. - Arrived at job site 9:05 a.m. The B-6 area, in the dry stacking Phase 2 was rerolled & retested. All the 4 tests passed. Clay capping began on the west ash pond within the railroad loop. In the morning hours there were only 8 or 9 trucks hauling from the offsite borrow area. Tested 3 areas in the new. By 2:45 p.m.only filled to Sta 2+50. Used the compactor for grading as well as compaction. Left job site at 3:00 p.m., Arrived at lab 3:35 p.m.

Inspector: Charles B. Essex

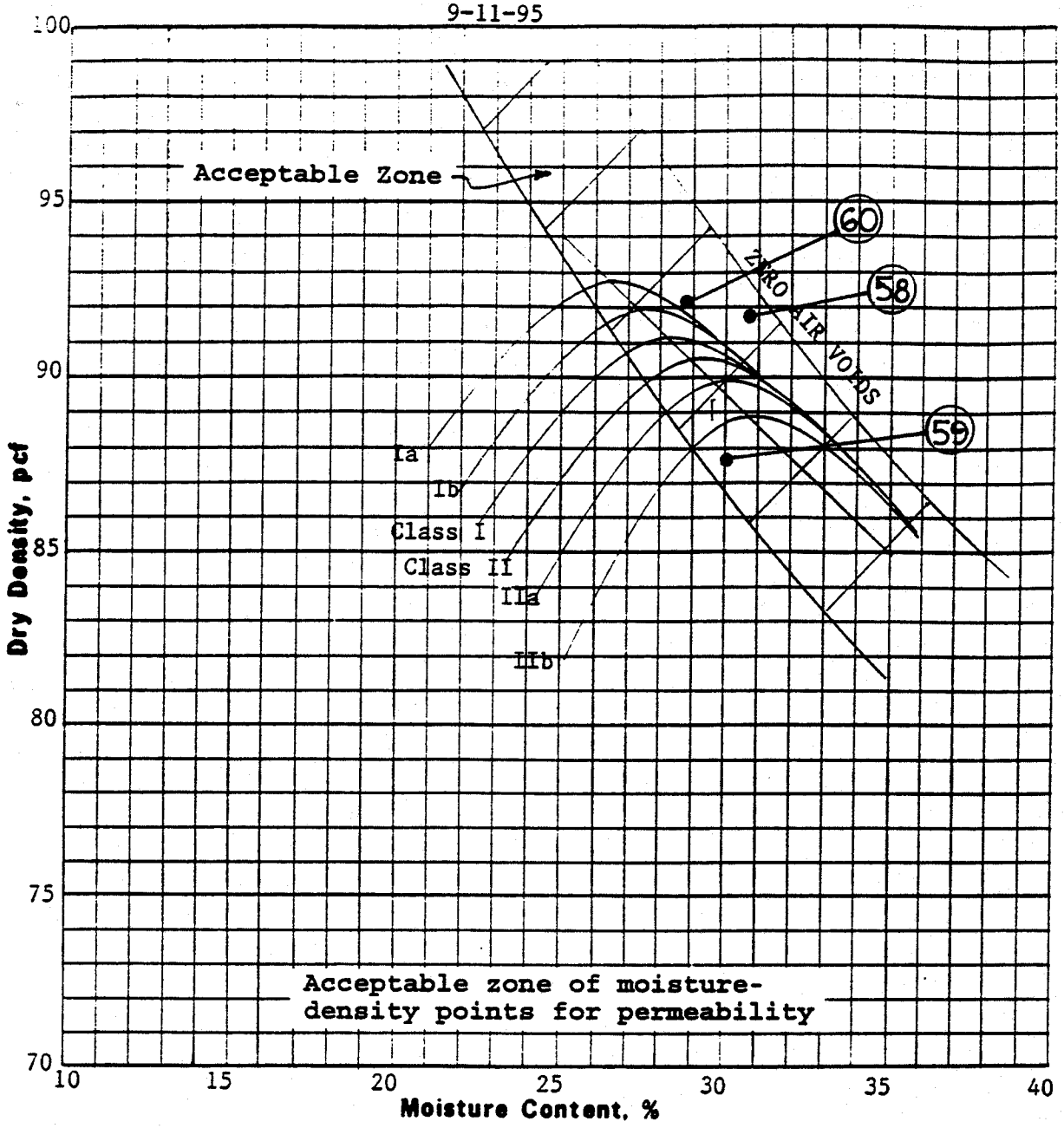
SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Dosposal Area (Inside Loop Track)
Tested By CB Essex
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
58	9/11/95	Station 0+50 D-Line	-0.0'	0.93/1.06	12"	120.0	28.2	30.7	91.8	100.6	95 % required
59	9/11/95	Station 2+00 E-Line	-0.0'	0.93/1.06	12"	114.2	26.4	30.1	87.8	96.8	95 % required
60	9/11/95	Station 1+75 F-Line	-0.0'	0.93/1.06	12"	118.3	26.2	28.5	92.1	101.5	95 % required

9-11-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

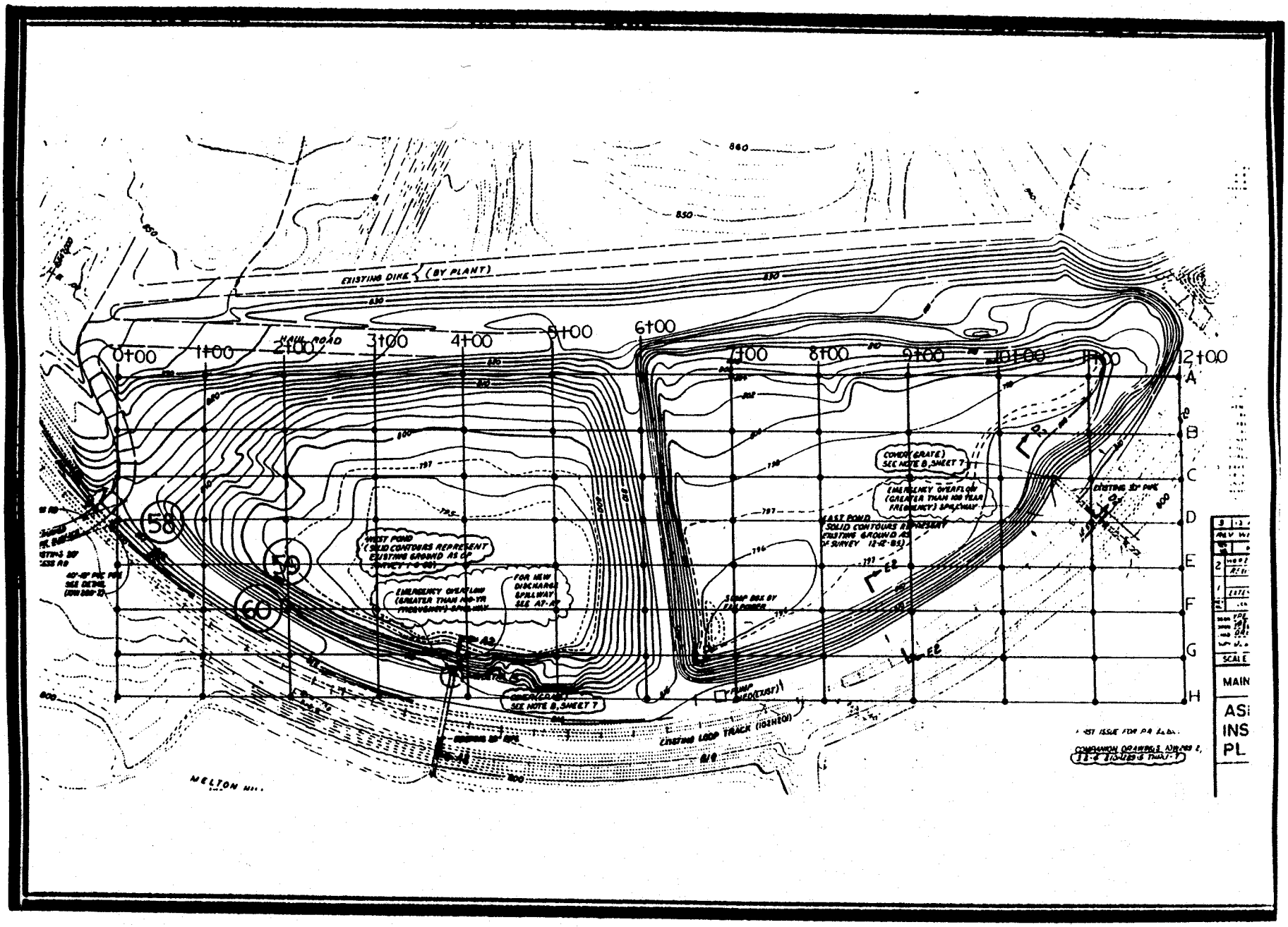
Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95
COMPACTION TEST (FAMILY OF CURVES)	

Tested by: TAL Reviewed by: See

Bull Run S.P. Ash Disposal Area In[illegible] Railroad Loop Test Location Plan
9-11-95

Singleton Laboratories

The Critical Link.®



TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/12/95 Weather: Overcast-Lt. Rain

Location: West Ash Dike W/in the Railroad Loop

==========

Observations: Left the lab at 7:50, arrived at job site 8:40 a.m. The project received a light to moderate rain over night. There was only 7 to 8 trucks hauling backfill this morning. Most of the fill is being placed in the ditch on the south side of the west ash dike. On the north end of the dike, 100 feet wide, is being used for a haul road to the east dike. A light rain started falling about 10:15 a.m. Rain lasted about 20 minutes. Ran a sandcone at Sta. 0+50 on the "D" line. Left job site at 3:25 p.m., arrived at lab 4:10 p.m.

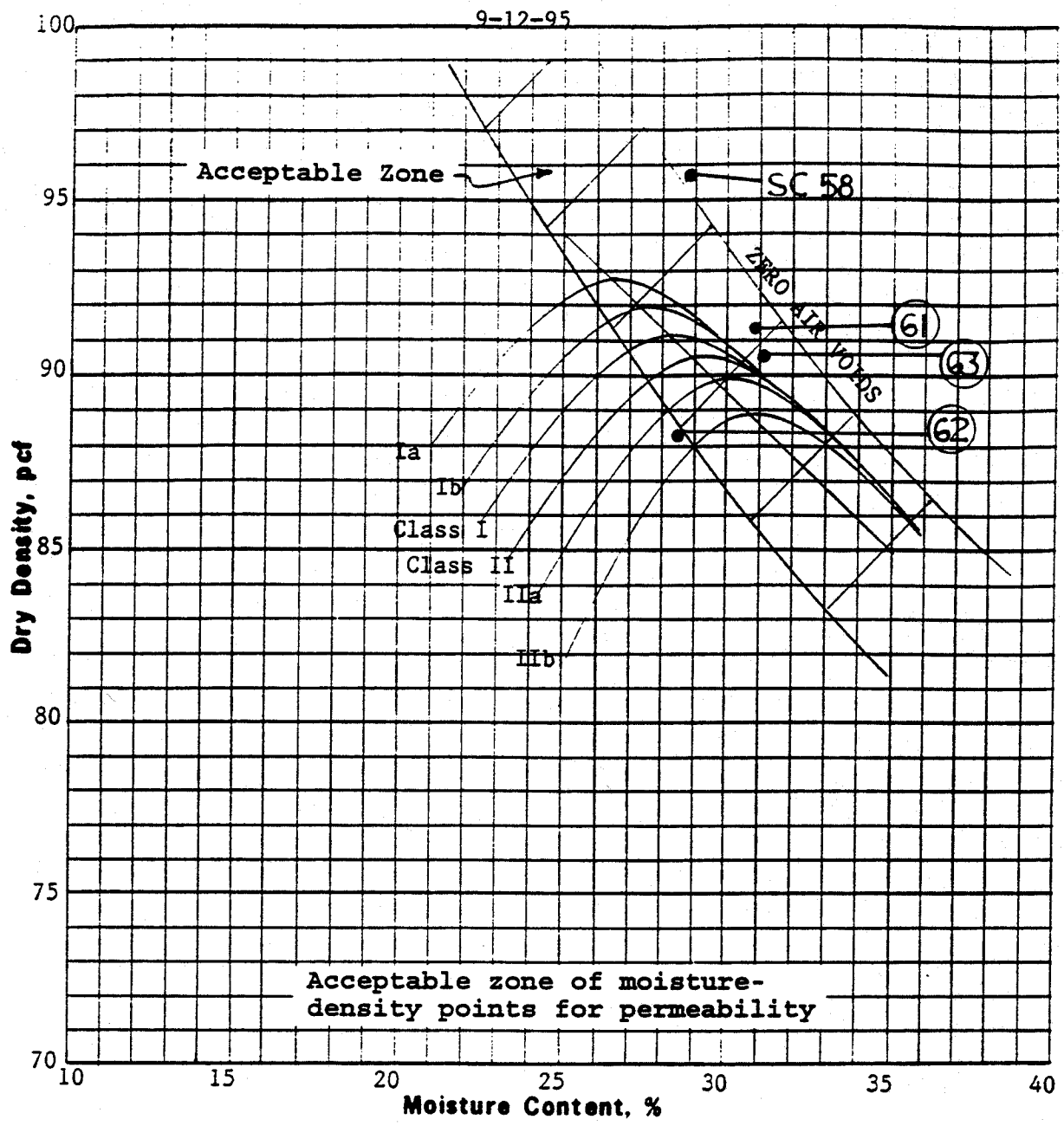
Inspector: Charles B. Essex

SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Dosposal Area (Inside Loop Track)
Tested By CB Essex
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
61	9/12/95	Station 2+00 F-Line	-0.0'	0.93/1.06	12"	119.2	28.0	30.7	91.2	100.0	95 % required
62	9/12/95	Station 2+00 E-Line	-0.0'	0.93/1.06	12"	113.5	25.2	28.6	88.3	97.4	95 % required
63	9/12/95	Station 2+00 D-Line	-0.0'	0.93/1.06	12"	119.3	28.3	31.1	90.9	100.2	95 % required



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95
COMPACTION TEST (FAMILY OF CURVES)	

Tested by: TAL Reviewed by: [signature]

Bull Run S.P. Ash Disposal Area Ins[illegible] Railroad Loop Test Location Plan
9-12-95

Singleton Laboratories

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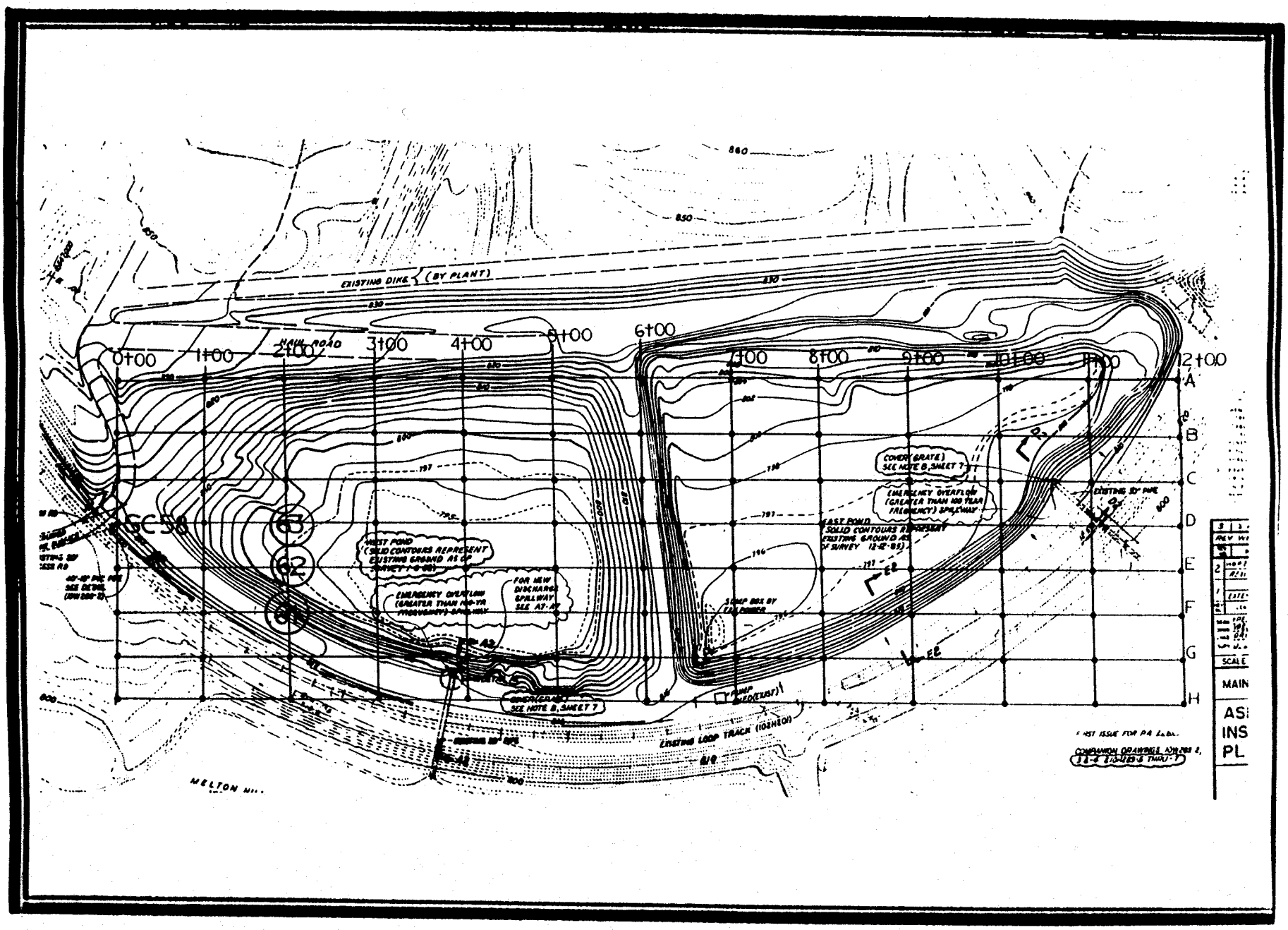


EARTHFILL COMPACTION TEST - SAND CONE METHOD

Project: Bull Run Steam Plant Feature: West Ash Dike W/in Loop Tested by CBE
Date: 9/12/95 Station: 0+50 Offset: Line "D" Sample Top Elevation:

1. Test Number		-	SC-58	
2. Borrow Source		-		
3. Weight Sand & Cone Before Test No.1	8043g	lb	17.73	
4. Weight Sand & Cone After Test	4156g	lb	9.16	
5. Weight Sand Used (3) - (4)		lb	8.57	
6. Cone Volume Weight Correction		lb	3.91	
7. Weight Sand in Test Hole (5)-(6)		lb	4.66	
8. Sand Calibration Factor		pcf	96.0	
9. Volume Test Hole (total sample) (7)/(8)		cf	.0485	
10. Weight Wet Total Sample & Tare	3314	lb	7.06	
11. Weight Tare		lb	1.06	
12. Weight Wet Total Sample (10)-(11)		lb	6.00	
13. Weight Wet Plus 3/4 & Tare		lb	n/a	
14. Weight Dry Plus 3/4 & Tare		lb	n/a	
15. Weight Tare		lb	n/a	
16. Weight Wet Plus 3/4 (13)-(15)		lb	n/a	
17. Weight Dry Plus 3/4 (14)-(15)		lb	n/a	
18. Bulk Specific Gravity Plus #4 (SSD)		-	n/a	
19. Unit Weight Plus 3/4 (18)X 62.4		pcf	n/a	
20. Volume Plus 3/4 (16)/(19)		cf	n/a	
21. Weight Wet Minus 3/4 (12)-(16)		lb	6.00	
22. Volume Wet Minus 3/4 (9)-(20)		cf	.0485	
23. Wet Density Minus 3/4 (21)/(22)		pcf	123.7	
			Fill a 113	Mold b58
24. Weight Wet Minus 3/4 and Tare		gm	330.1	838.1
25. Weight Dry Minus 3/4 and Tare		gm	271.3	669.3
26. Weight Tare		gm	68.3	68.5
27. Weight Water (24)-(25)		gm	58.8	168.8
28. Weight Dry Minus 3/4 (25)-(26)		gm	203.0	600.8
29. Moisture Content Minus 3/4 {(27)/(28)X100}	W_f	%	29.0	28.1
30. Weight Total Dry Minus 3/4 (21)/{1+(29a)/100}		lb	4.84	-
31. Weight Total Dry Sample (17)+(30)		lb	4.84	-
32. Percentage Plus 3/4 {(17)/(31)} X 100		%	n/a	-
33. Dry Density Minus 3/4 (23)/{1+(29a)/100}	Y_{df}	pcf	95.9	-
34. Weight Compact Mold & Wet Minus 3/4		lb	-	15.22
35. Weight Compaction Mold		lb	-	6.33
36. Weight Wet Minus 3/4 (34)-(35)		lb	-	8.89
37. Wet Density (36) X 30		pcf	-	118.6
38. Dry Density (37)/{1+(29b)/100}		pcf	-	92.5
39. Soil Class {Control Curves with (29b) and (38b)}		-	I	-
40. Penetrometer Needle End Area		in^2	n/a	-
41. Average Needle Reading		lb	n/a	-
42. Penetration Resistance (41)-(40)		psi	n/a	-
43. Maximum Density (CONTROL CURVES)	Y_{dL}	pcf	91.2	-
44. Optimum Moisture Content (CONTROL CURVES)	W_o	%	28.1	-
45. (33)-(43)	Y_{df}-Y_{dL}	pcf	+8.7	-
46. (29a)-(44) Required: - to +	W_f-W_o	%	+0.9	-
47. Compaction Minus #4 {(33)/(43)} X 100		%	105.1	-
48. Required Compaction: Minimum - 95% Maximum -		%	-	-
Corrective Action:				

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/13/95 Weather: Sunny-Hot 80-85F

Location: West Ash Dike W/in the Railroad Loop

==========

Observations: Left Singleton Labs 7:50 a.m., arrived at job site 8:30 a.m. Talked with Garland Corder about the possibility of using the borrow area, used for Phase I, for top soil. It's a short distance from the construction gate. He will contact American Fly Ash for details about the borrow site. There are 8 to 10 trucks hauling borrow material. Tuesday there were 69 truck loads = 828 yds^3. Equipment being used, self-propelled sheepfoot compactor, motor graded vibrating roller-self propelled. Started filling in the ditch on the south end. Left job site at 3:30 p.m. - Arrive at lab at 4:10 p.m.

Inspector: Charles B. Essex

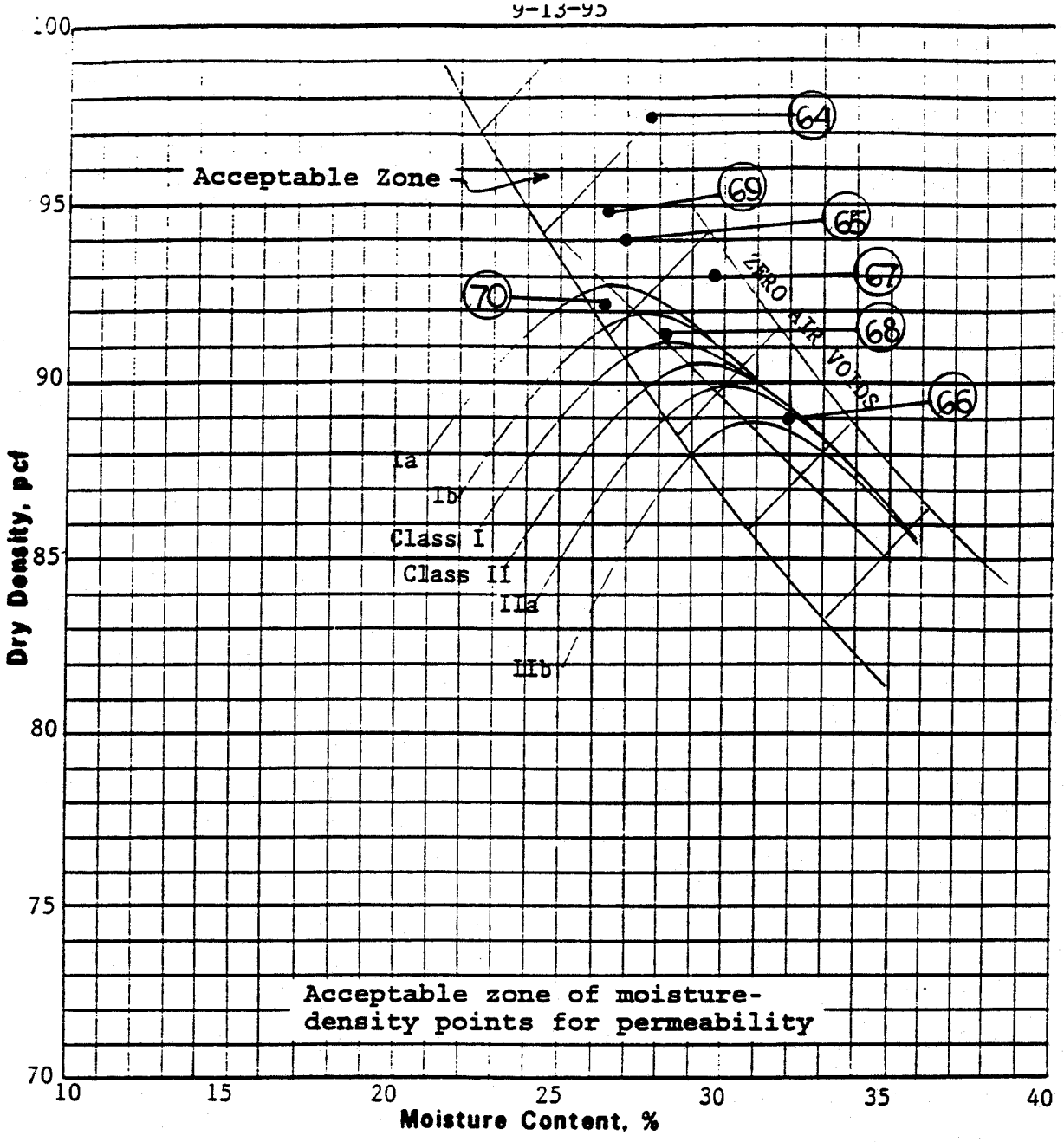
SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Dosposal Area (Inside Loop Track)
Tested By CB Essex
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II -	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
64	9/13/95	Station 1+75 B-Line	-0.0'	0.96/1.04	12"	124.7	27.2	27.9	97.5	106.9	95 % required
65	9/13/95	Station 2+00 C-Line	-0.0'	0.96/1.04	12"	119.4	25.4	27.0	94.0	103.0	95 % required
66	9/13/95	Station 2+00 D-Line	-0.0'	0.96/1.04	12"	117.6	28.6	32.1	89.0	97.6	95 % required
67	9/13/95	Station 1+00 C-Line	-0.0'	0.96/1.04	12"	120.7	27.7	29.8	93.0	101.9	95 % required
68	9/13/95	Station 1+00 D-Line	-0.0'	0.96/1.04	12"	117.2	25.9	28.4	91.3	100.1	95 % required
69	9/13/95	Station 1+00 G-Line	-0.0'	0.96/1.04	12"	120.0	25.1	26.5	94.9	104.0	95 % required
70	9/13/95	Station 2+00 G-Line	-0.0'	0.96/1.04	12"	116.5	24.3	26.3	92.2	101.1	95 % required

9-13-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95

COMPACTION TEST (FAMILY OF CURVES)

Tested by: TAL Reviewed by: [signature]

Bull Run S.P. Ash Disposal Area In[illegible]e Railroad Loop Test Location Plan
9-13-95

Singleton Laboratories

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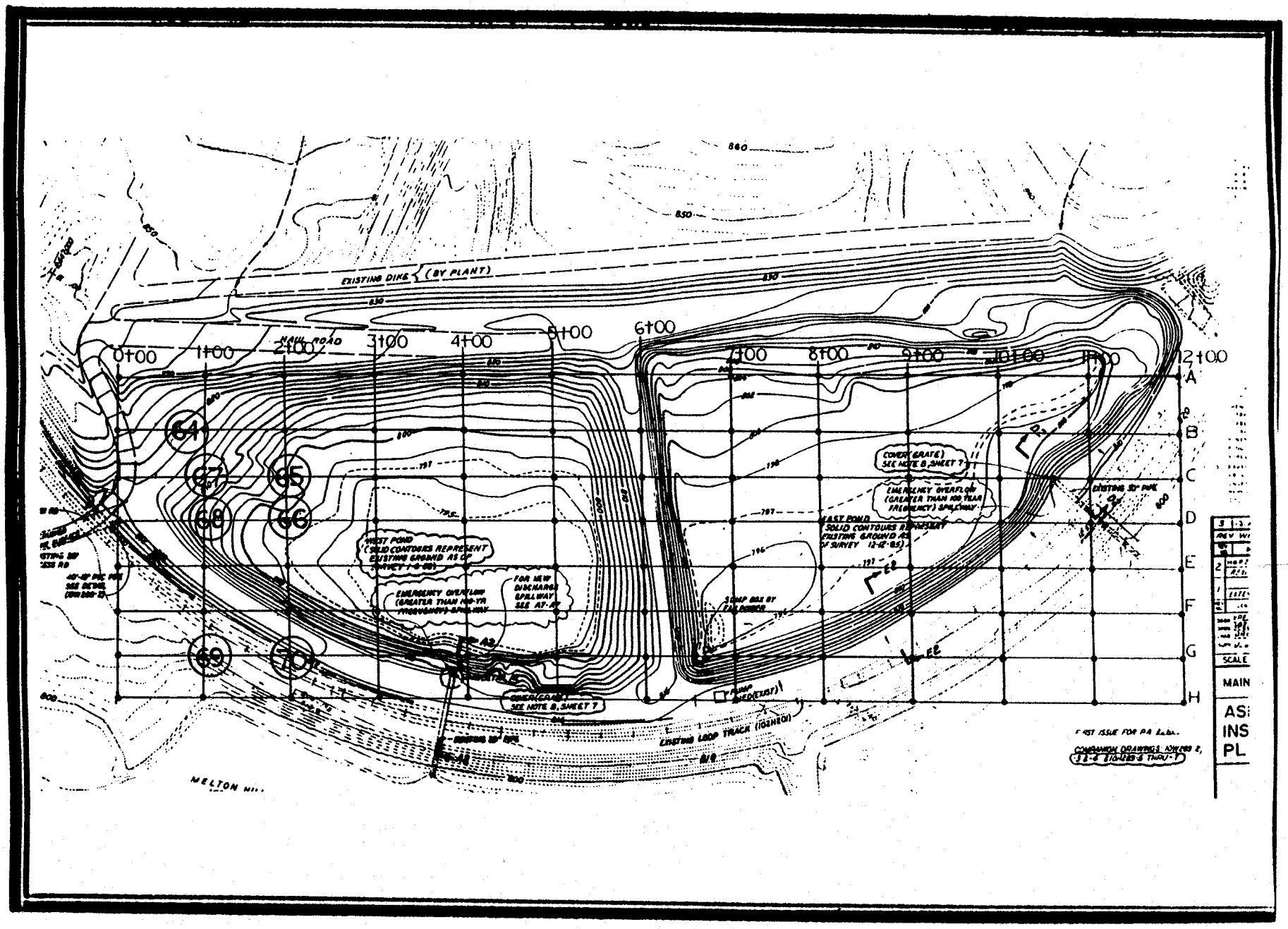


TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/14/95 Weather: Overcast-Drizzle

Location: West Ash Dike W/in the Railroad Loop

==========

Observations: Left Singleton labs 7:50 a.m. Arrived at job site 8:30 a.m. The west ash dike had a heavy rain, so did the offsite borrow area. The contractor said they would not haul fill today. The south ditch contained a large quantity of rain water. Pan was still backfilling the ash pond with flyash. With the help of a grader operator we pushed 3 undisturbed tubes at different locations in the dry stack area, Phase 2. Left job site at 10:45 a.m., arrived at lab 11:20 a.m.

Inspector: Charles B. Essex

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/14/95 Weather: Cloudy

Location: Ash Disposal Area (Inside Loop Track)

==========

Observations: Left Singleton Laboratories at 3:00 accompanied by Raul Gonzalez also of Singleton, arrived Bull Run S.P. Then proceeded to ash disposal area at Railroad Loop. Set grade stakes from station 5+00 to 12+00. Then surveyed 100' of the west pond for initial measurement before the placement of clay cap. Proceeded to Stage II Dry Stack area and surveyed the depth of clay at Station 2+00 between F & G lines. Left Bull Run S.P. at 5:00 p.m. enroute for Singleton Laboratories

Inspector: Tony A. Luttrell

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/15/95 Weather: Overcast - 85F

Location: West Ash Dike W/in the Railroad Loop

==========

Observations: Left Singleton Labs 8:25 a.m., arrived at job at 9:05 a.m. The material for the fill had been rained on & was just right for compacting. I noticed an increase in the gravel content & the size of rock. I rode to the borrow area & asked them to move to a different location, which they did. Pushed clay into the south ditch. It was pumping when rolled. May have to take the wet clay out & replace with dryer material. Today there were 85 truck loads x 12=1020 yds.^{3} Left job site 3:30 p.m., arrived at Singleton Labs 4:10 p.m.

Inspector: Charles B. Essex

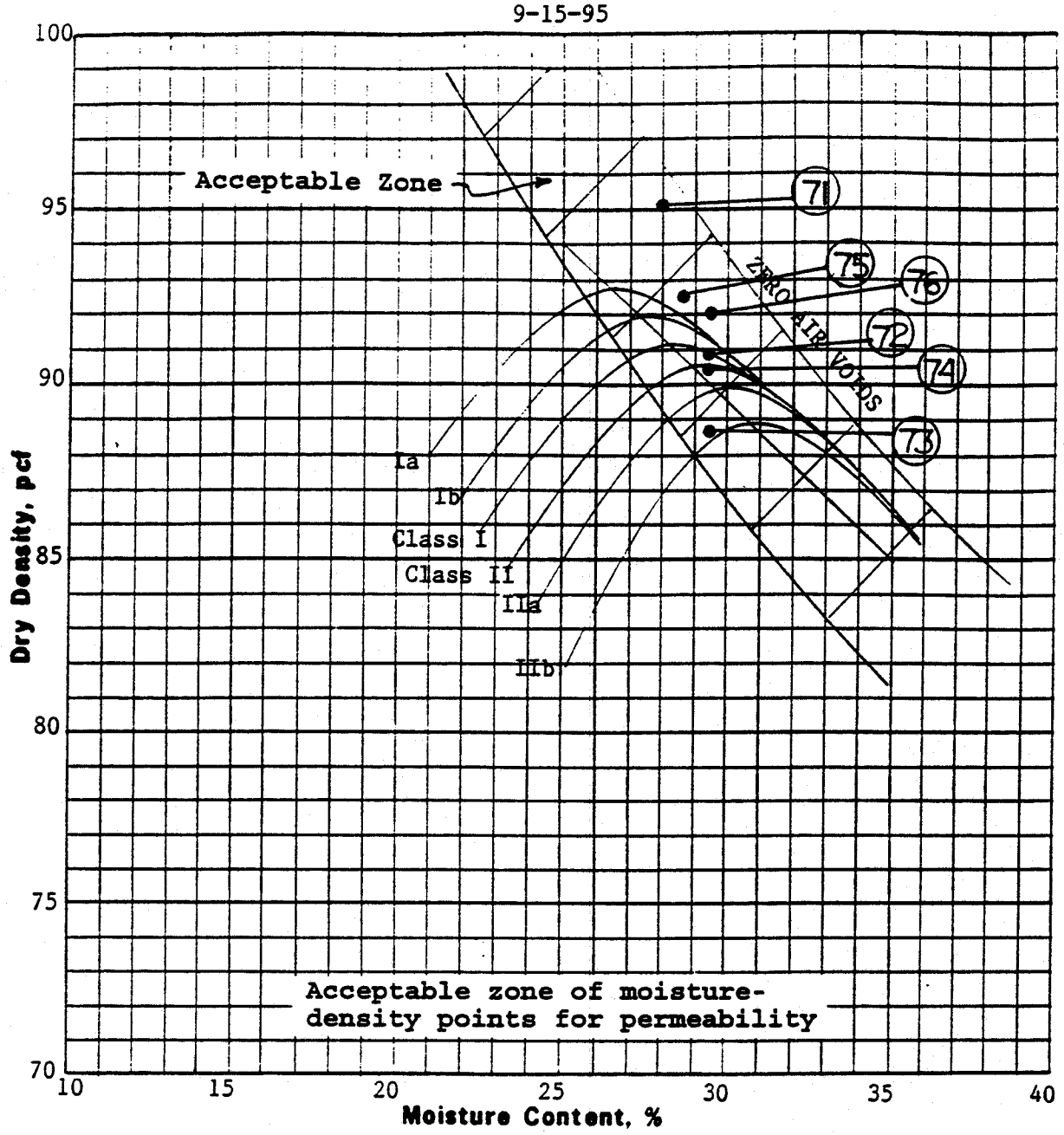
SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Dosposal Area (Inside Loop Track)
Tested By CB Essex
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
71	9/15/95	Station 3+00 C-Line	-0.0'	0.89/1.00	12"	121.8	26.7	28.1	95.1	104.2	95 % required
72	9/15/95	Station 2+50 D-Line	-0.0'	0.89/1.00	12"	117.8	26.8	29.5	90.9	99.7	95 % required
73	9/15/95	Station 2+50 E-Line	-0.0'	0.89/1.00	12"	115.2	26.3	29.6	88.8	97.5	95 % required
74	9/15/95	Station 3+00 E-Line	-0.0'	0.89/1.00	12"	117.2	26.6	29.4	90.6	99.4	95 % required
75	9/15/95	Station 3+00 F-Line	-0.0'	0.89/1.00	12"	119.1	26.6	28.8	92.5	101.4	95 % required
76	9/15/95	Station 3+50 E-Line	-0.0'	0.89/1.00	12"	119.1	27.1	29.5	92.0	100.9	95 % required

9-15-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95

COMPACTION TEST (FAMILY OF CURVES)

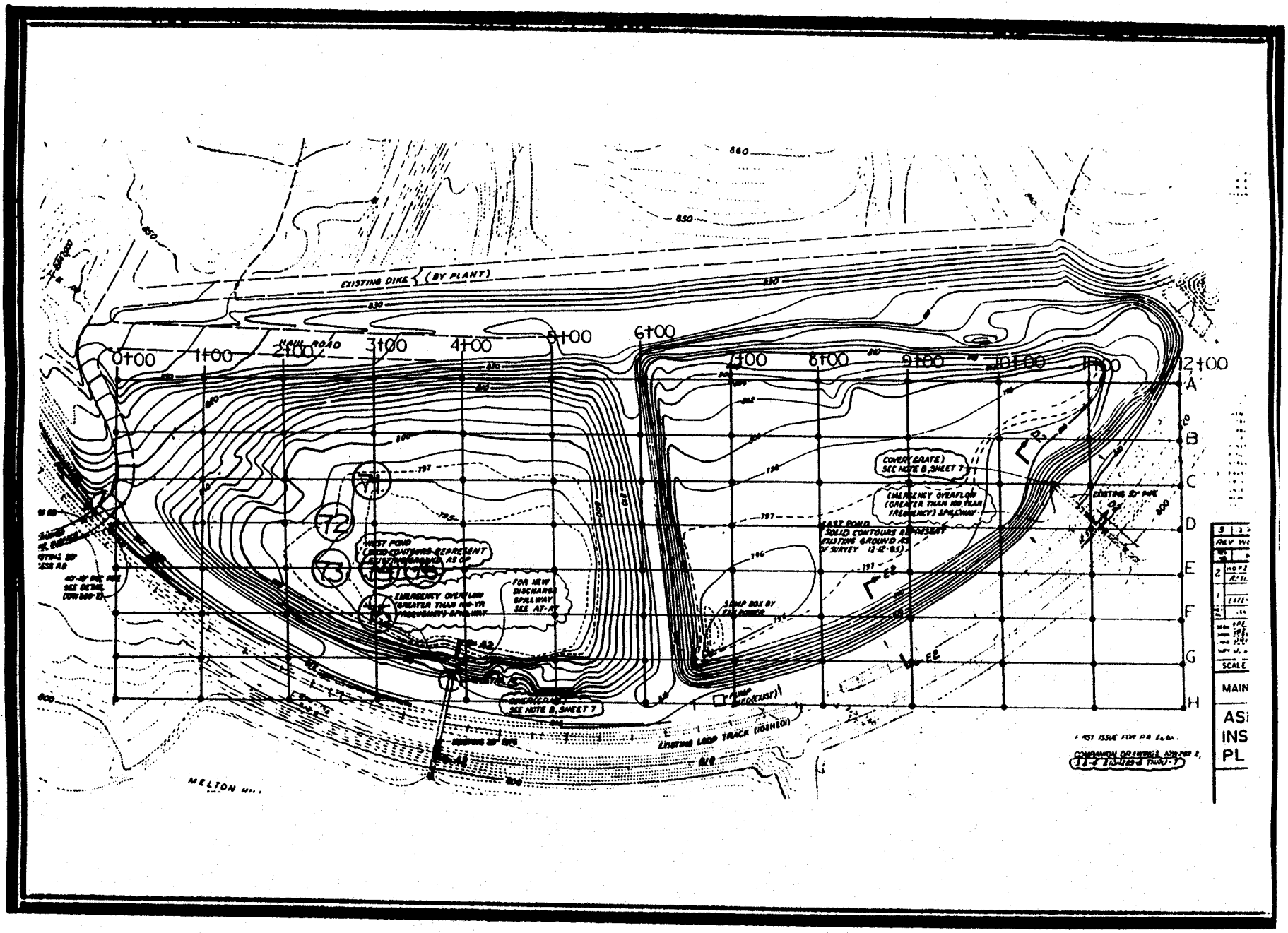
Tested by: TAL Reviewed by: See

Bull Run S.P. Ash Disposal Area In[illegible] Railroad Loop Test Location Plan

9-15-95

Singleton Laboratories

The Critical Link.®



TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/18/95 Weather: Partly Cloudy - 80F

Location: West Ash Dike W/in the Railroad Loop

==========

Observations: Left Singleton Labs 9:20 a.m., arrived at job at 9:55 a.m. The weekend rain left water standing on the clap. There was water covering the bottom of the south ditch. There was also an accumulation of water in the fly ash which caused a very spongy condition. Truck began hauling fill about 9:40 a.m. A few trucks contained several large rocks, which were buried in the fly ash. The borrow loaders were notified & so was Mr. Corder of TVA who reinforced my complaint to the Rogers Group. Left job site at 3:40 p.m. arrived at the lab at 4:15 p.m.

Inspector: Charles B. Essex

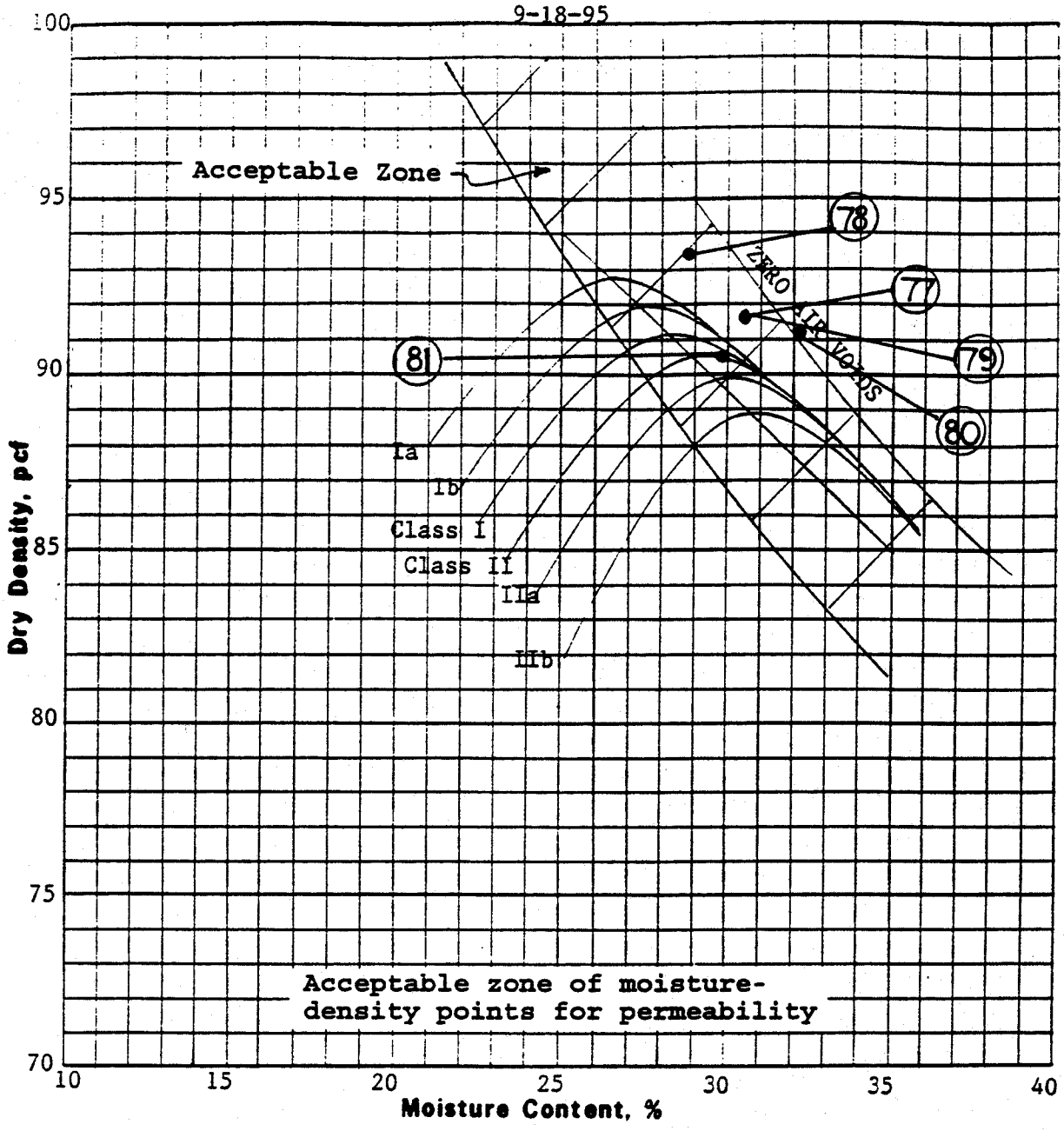
SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Dosposal Area (Inside Loop Track)
Tested By CB Essex
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
77	9/18/95	Station 4+00 C-Line	-0.0'	0.92/1.05	8"	119.7	28.0	30.5	91.7	100.5	95 % required
78	9/18/95	Station 3+50 D-Line	-0.0'	0.92/1.05	8"	120.4	27.0	28.9	93.4	102.4	95 % required
79	9/18/95	Station 4+00 E-Line	-0.0'	0.92/1.05	8"	119.8	28.0	30.5	91.8	100.7	95 % required
80	9/18/95	Station 4+00 F-Line	-0.0'	0.92/1.05	8"	121.2	29.6	32.3	91.6	100.4	95 % required
81	9/18/95	Station 4+00 G-Line	-0.0'	0.92/1.05	8"	117.4	27.0	29.9	90.4	99.1	95 % required

9-18-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95
COMPACTION TEST (FAMILY OF CURVES)	

Tested by: TAL Reviewed by: See

Bull Run S.P. Ash Disposal Area Ins Railroad Loop Test Location Plan

9-18-95

Singleton Laboratories

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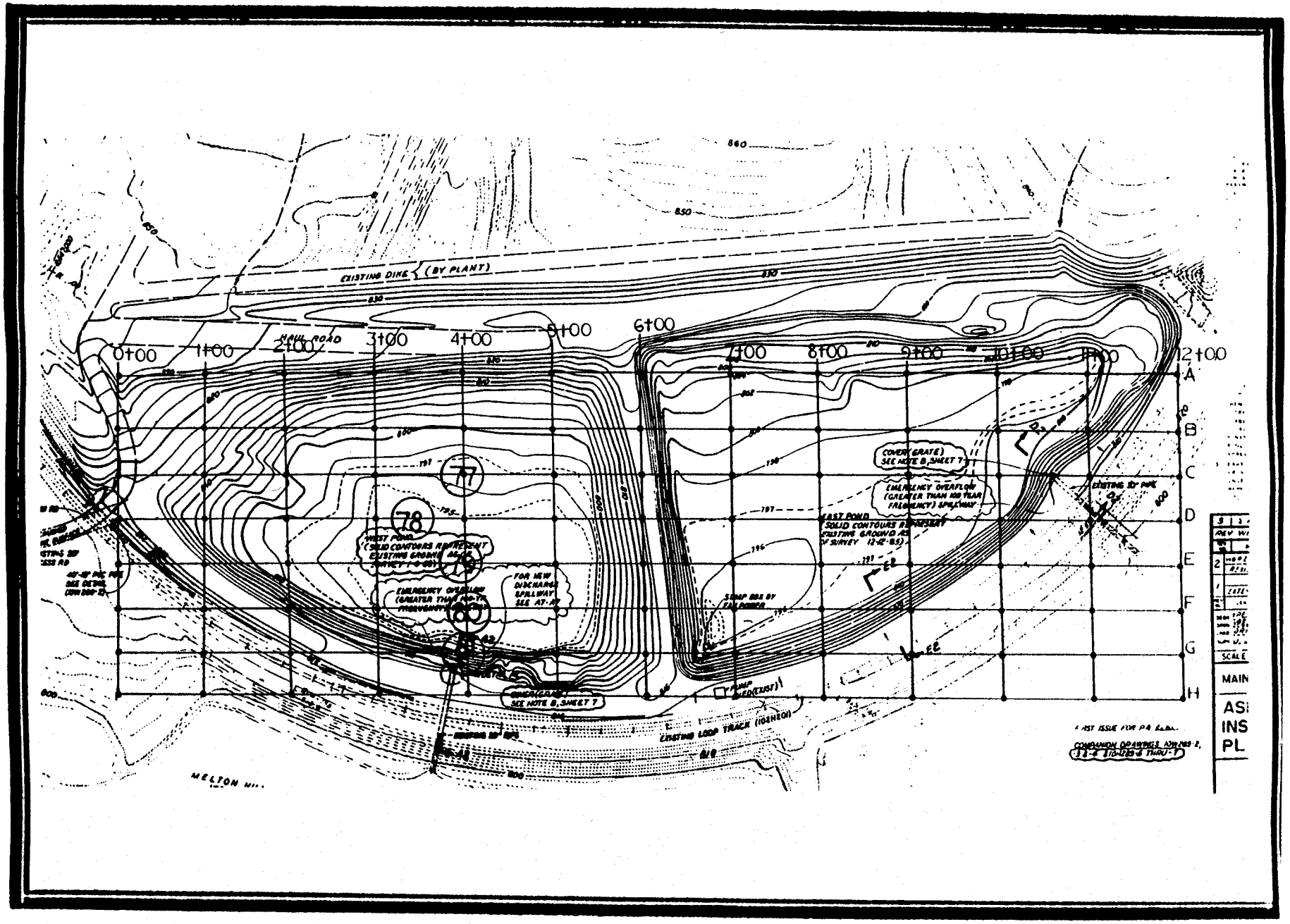


TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/19/95 Weather: Sunny 85F

Location: West Ash Dike W/in the Railroad Loop

==========

Observations: Left Singleton Labs at 8:50 a.m., arrived at the job site at 8:30 a.m. By noon we had filled in Sta. 4+00 to Sta. 5+00, between lines B-C & the south ditch. After lunch returned to Sta. 1+00 & filled in between lines A-B & B-C to Sta. 5+00. At 3 p.m. we started pushing from Sta. 5+00 to the dike between east & west ash dikes. The material placed today was in large chunks which had to be rolled to just break it up. The fill was clipped by the grader & uneven. There was a sandcone density test performed at Sta. 4+00; line G-H. Samples were taken for atterberg limits. Singleton labs will survey another portion of the dikes on Thursday September 21, 1995.

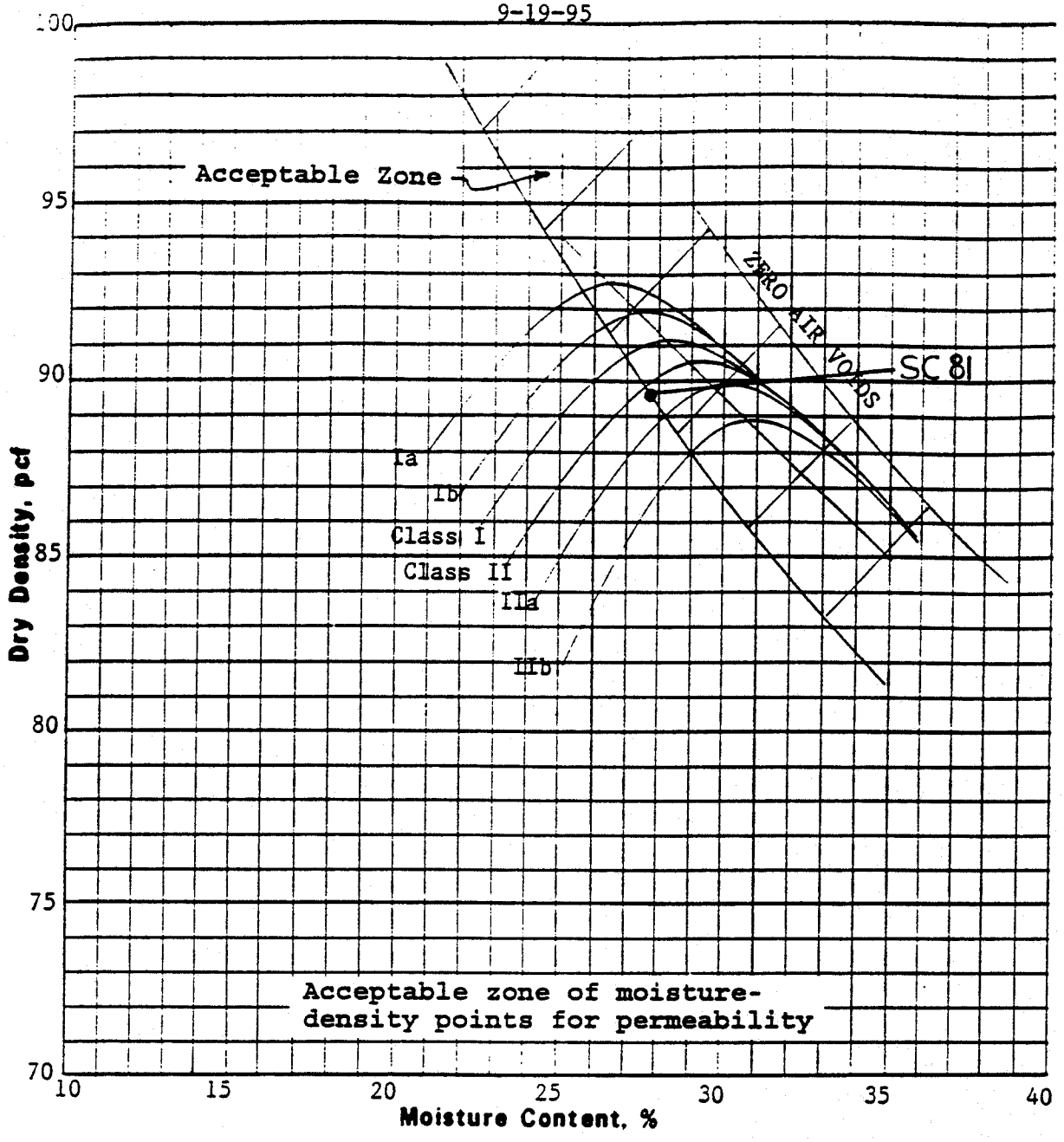
Inspector: Charles B. Essex

EARTHFILL COMPACTION TEST - SAND CONE METHOD

Project: Bull Run Steam Plant Feature: West Ash Dike Tested By: CBE
Date: 9/19/95 Station: 4+00 Offset: "G-H" Line Sample Top Elevation:

1. Test Number	-	SC-81	
2. Borrow Source	-		
3. Weight Sand & Cone Before Test	lb	17.78	
4. Weight Sand & Cone After Test	lb	8.35	
5. Weight Sand Used (3) - (4)	lb	9.43	
6. Cone Volume Weight Correction	lb	3.91	
7. Weight Sand in Test Hole (5)-(6)	lb	5.52	
8. Sand Calibration Factor	pcf	96.0	
9. Volume Test Hole (total sample) (7)/(8)	cf	.0575	
10. Weight Wet Total Sample & Tare	lb	7.61	
11. Weight Tare 466.1g	lb	1.03	
12. Weight Wet Total Sample (10)-(11)	lb	6.58	
13. Weight Wet Plus 3/4 & Tare	lb	n/a	
14. Weight Dry Plus 3/4 & Tare	lb	n/a	
15. Weight Tare	lb	n/a	
16. Weight Wet Plus 3/4 (13)-(15)	lb	n/a	
17. Weight Dry Plus 3/4 (14)-(15)	lb	n/a	
18. Bulk Specific Gravity Plus #4 (SSD)	-	n/a	
19. Unit Weight Plus 3/4 (18)X 62.4	pcf	n/a	
20. Volume Plus 3/4 (16)/(19)	cf	n/a	
21. Weight Wet Minus 3/4 (12)-(16)	lb	6.58	
22. Volume Wet Minus 3/4 (9)-(20)	cf	.0575	
23. Wet Density Minus 3/4 (21)/(22)	pcf	114.4	
		Fill a 1	Mold b
24. Weight Wet Minus #4 and Tare	gm	405.0	405.0
25. Weight Dry Minus #4 and Tare	gm	331.7	331.6
26. Weight Tare	gm	68.3	68.3
27. Weight Water (24)-(25)	gm	73.3	73.4
28. Weight Dry Minus 3/4 (25)-(26)	gm	263.4	263.3
29. Moisture Content Minus 3/4 {(27)/(28)X100} W_f	%	27.8	27.9
30. Weight Total Dry Minus 3/4 (21)/{1+(29a)/100}	lb	5.15	-
31. Weight Total Dry Sample (17)+(30)	lb	5.15	-
32. Percentage Plus 3/4 {(17)/(31)} X 100	%	n/a	-
33. Dry Density Minus 3/4 (23)/{1+(29a)/100} Y_{df}	pcf	89.5	-
34. Weight 1/30 cf Compact Mold & Wet Minus	lb	-	8.40
35. Weight Compaction Mold	lb	-	4.46
36. Weight Wet Minus 3/4 (34)-(35)	lb	-	3.94
37. Wet Density (36) X 30	pcf	-	118.2
38. Dry Density (37)/{1+(29b)/100}	pcf	-	92.4
39. Soil Class {Control Curves with (29b) and (38b)}	-	I	-
40. Penetrometer Needle End Area	in^2	n/a	n/a
41. Average Needle Reading	lb	n/a	n/a
42. Penetration Resistance (41)-(40)	psi	n/a	n/a
43. Maximum Density (CONTROL CURVES) Y_{dL}	pcf	91.2	-
44. Optimum Moisture Content (CONTROL CURVES) W_o	%	28.1	-
45. (33)-(43) Y_{df}-Y_{dL}	pcf	-1.7	-
46. (29a)-(44) Required: - to + W_f-W_o	%	-0.3	-
47. Compaction Minus #4 {(33)/(43)} X 100	%	98.1	-
48. Required Compaction: Minimum - 95% Maximum -	%	-	-
Corrective Action: Moisture content low-more H2O added in future			

9-19-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95

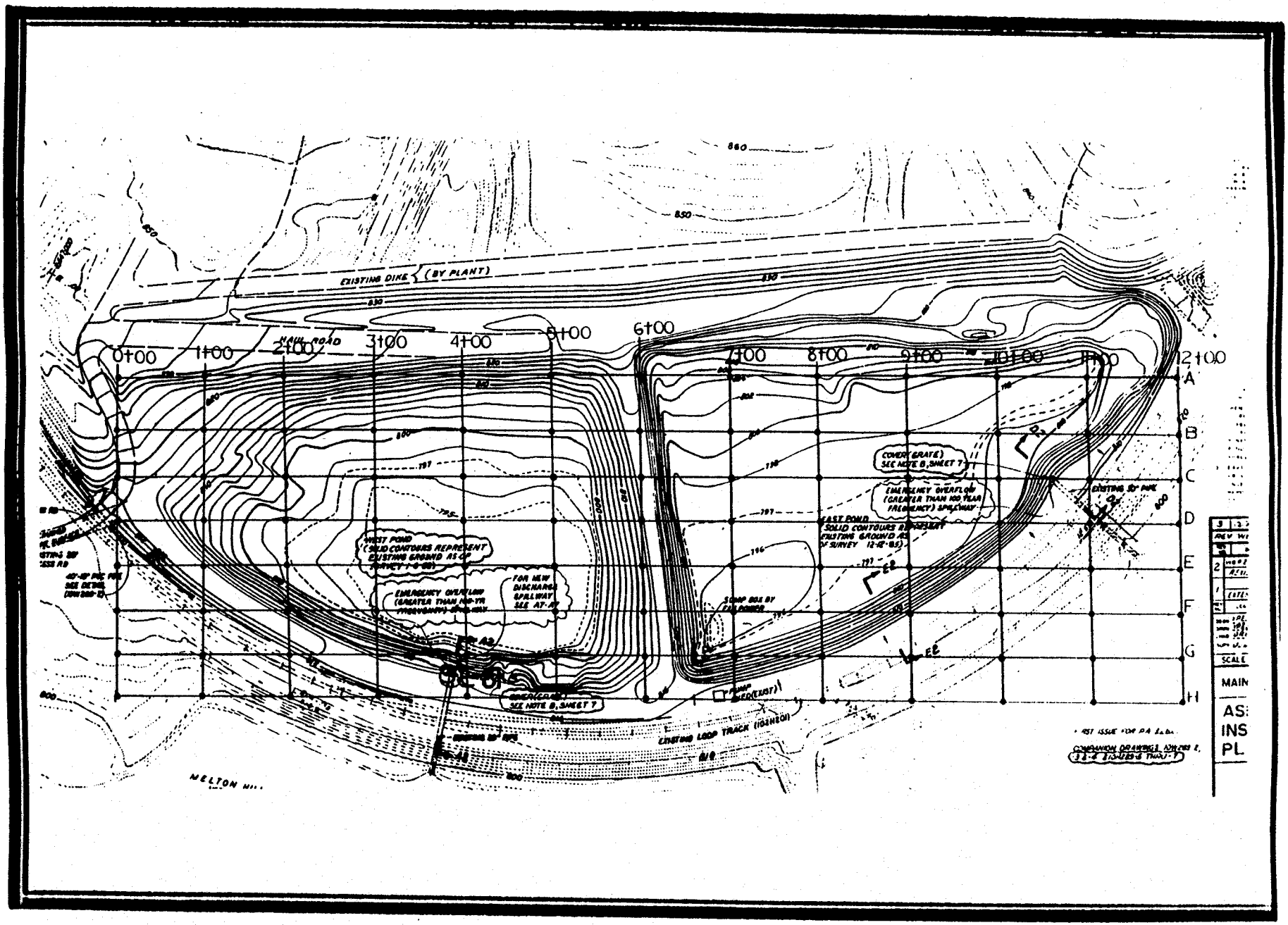
COMPACTION TEST (FAMILY OF CURVES)

Tested by: TAL Reviewed by: [illegible]

Bull Run S.P. Ash Disposal Area Ins[illegible] Railroad Loop Test Location Plan
9-19-95

Singleton Laboratories

The Critical Link.®



TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/20/95 Weather: Overcast 70F

Location: East & West Ash Dikes W/in the railroad Loop

==========

Observations: Left Singleton Labs at 6:30 a.m., arrived at job site at 7:05 a.m. Raul Gonzalez & I surveyed from Sta. 6+00 to Sta. 12+00 & set stakes 50 ft. on line with the stations. We set offsets as far as the dike was grade. Raul left about 9:30 a.m. to return to John Sevier S.P. The survey was explained to Alan Myers. It started raining at 1 p.m. today, only lasted about 15 minutes. Today we're tying into the dike between the east & west dike. The flyash was inundated & we used drier material to shut out the water. The fill pumps quite a lot. Left job site at 3:25 p.m., arrived at lab at 4:05 p.m. Worked 9 hours this day.

Inspector: Charles B. Essex

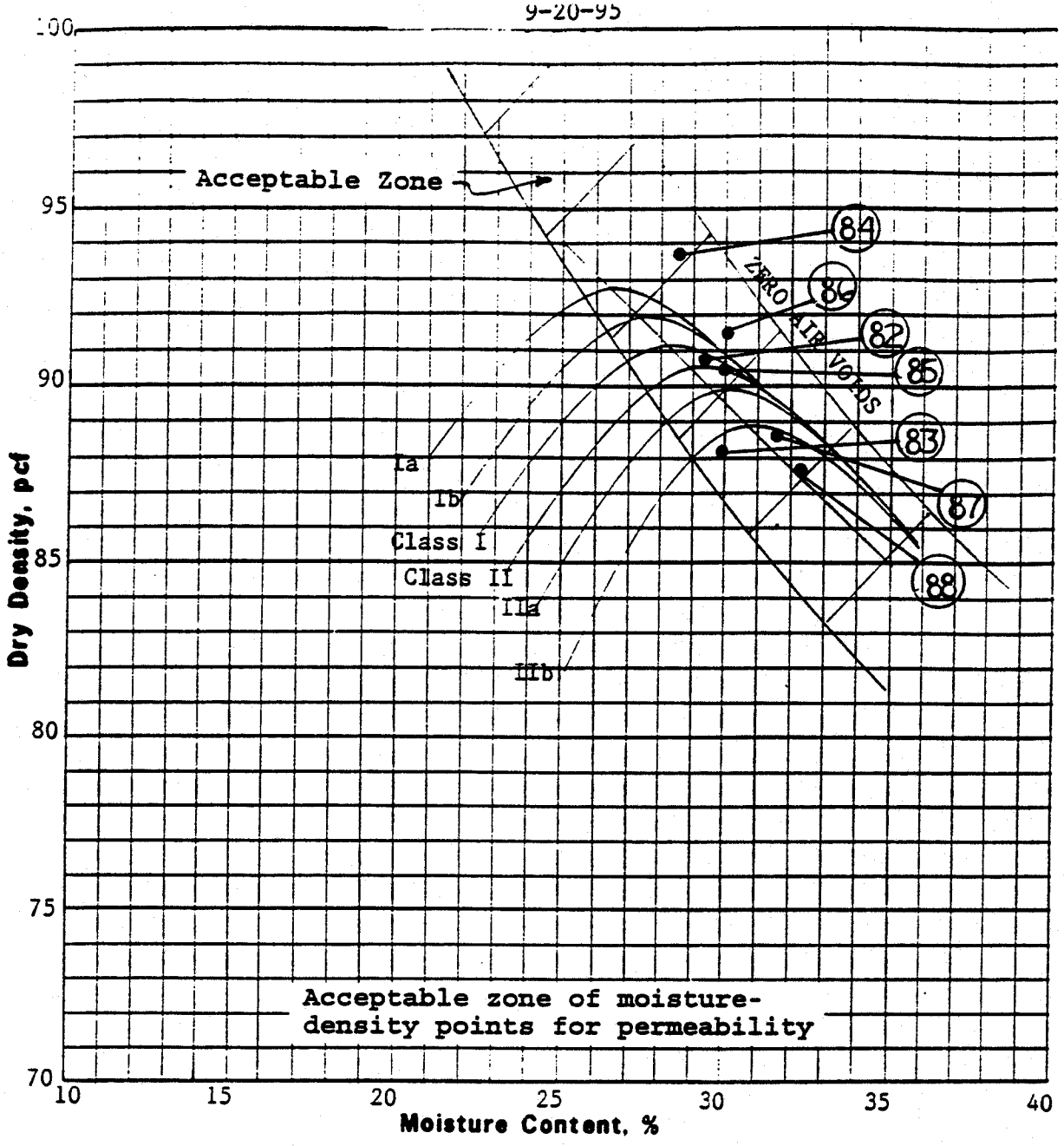
SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Dosposal Area (Inside Loop Track)
Tested By CB Essex
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
82	9/20/95	Station 4+50 C-line	-0.0'	1.06/0.94	8"	117.6	26.7	29.4	90.8	99.6	95 % required
83	9/20/95	Station 1+00 B-C Line	-0.0'	1.06/0.94	8"	114.8	26.5	30.0	88.3	96.8	95 % required
84	9/20/95	Station 2+00 B-C Line	-0.0'	1.06/0.94	8"	120.8	27.0	28.8	93.8	102.8	95 % required
85	9/20/95	Station 3+00 B-C Line	-0.0'	1.06/0.94	8"	118.6	28.1	31.0	90.5	99.2	95 % required
86	9/20/95	Station 4+00 B-C Line	-0.0'	1.06/0.94	8"	119.3	27.6	30.3	91.7	100.5	95 % required
87	9/20/95	Station 5+00 G-Line	-0.0'	1.06/0.94	8"	116.7	28.0	31.6	88.7	97.3	95 % required
88	9/20/95	Station 5+00 F-Line	-0.0'	1.06/0.94	8"	116.0	28.4	32.4	87.6	96.1	95 % required

9-20-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95
COMPACTION TEST (FAMILY OF CURVES)	

Tested by: TAL Reviewed by: [signature]

Bull Run S.P. Ash Disposal Area In[illegible] Railroad Loop Test Location Plan
9-20-95

Singleton Laboratories

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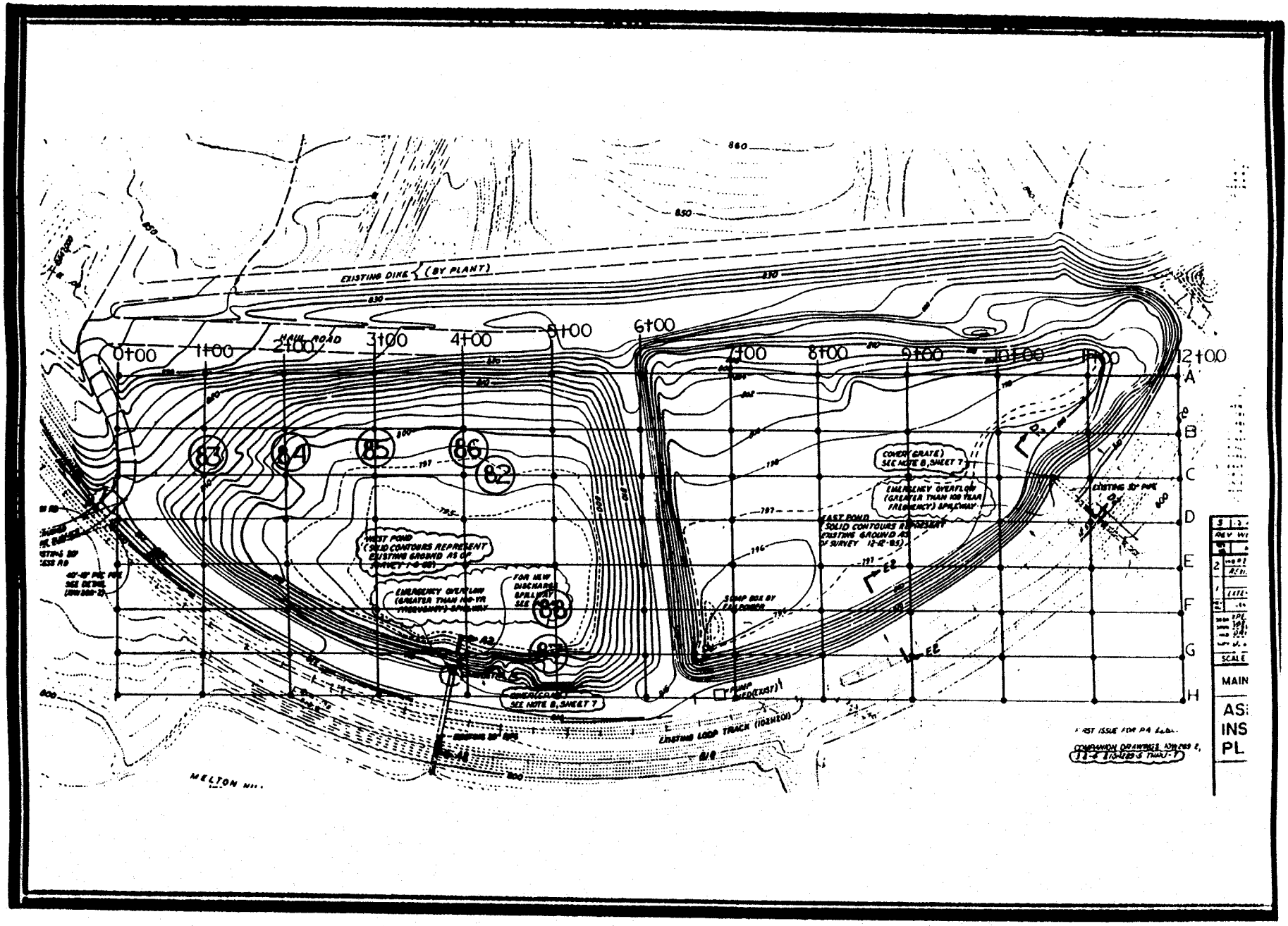


TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/21/95 Weather: Rain 70F

Location: East & West Ash Dikes W/in the railroad Loop

==========

Observations: Telephoned Bull Run, Garland Corder said we would be placing backfill today. Traveled to Bull Run, no backfill today. Returned to Singleton Labs 9:30 a.m.

Inspector: Charles B. Essex

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/22&25/95 Weather: Rain

Location: East & West Ash Dikes W/in the railroad Loop

==========

Observations: Friday, 22nd no backfill, too wet. Monday afternoon Garland Corder said they would truck in backfill for approximately 1 1/2 hours. They plan to haul backfill all day Tuesday.

Inspector: Charles B. Essex

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/27/95 Weather: Sunny 75F

Location: West Ash Dike W/in the railroad loop

==========

Observations: Left Singleton Labs at 8:20 a.m., arrived at job site at 8:55 a.m. The fill was very wet from the weekend rain. Today they are filling in the north ditch & along line "A" from Sta. 5+00 to Sta. 0.00. Jack Hilliard & Allen Luttrell came to survey the depth of clay in ash dike west. I marked the areas where there was a shortage of clay. The rest of the west dike will be surveyed upon completion. The initial survey was made again on east ash dike because additional ash was removed. On this dike, between stations 11+00 & 12+00, between lines A & B, there was soil placed on Tuesday afternoon. Left job site at 4:20 p.m., arrived at Singleton Labs at 5:00 p.m. Worked 9 hours.

Inspector: Charles B. Essex

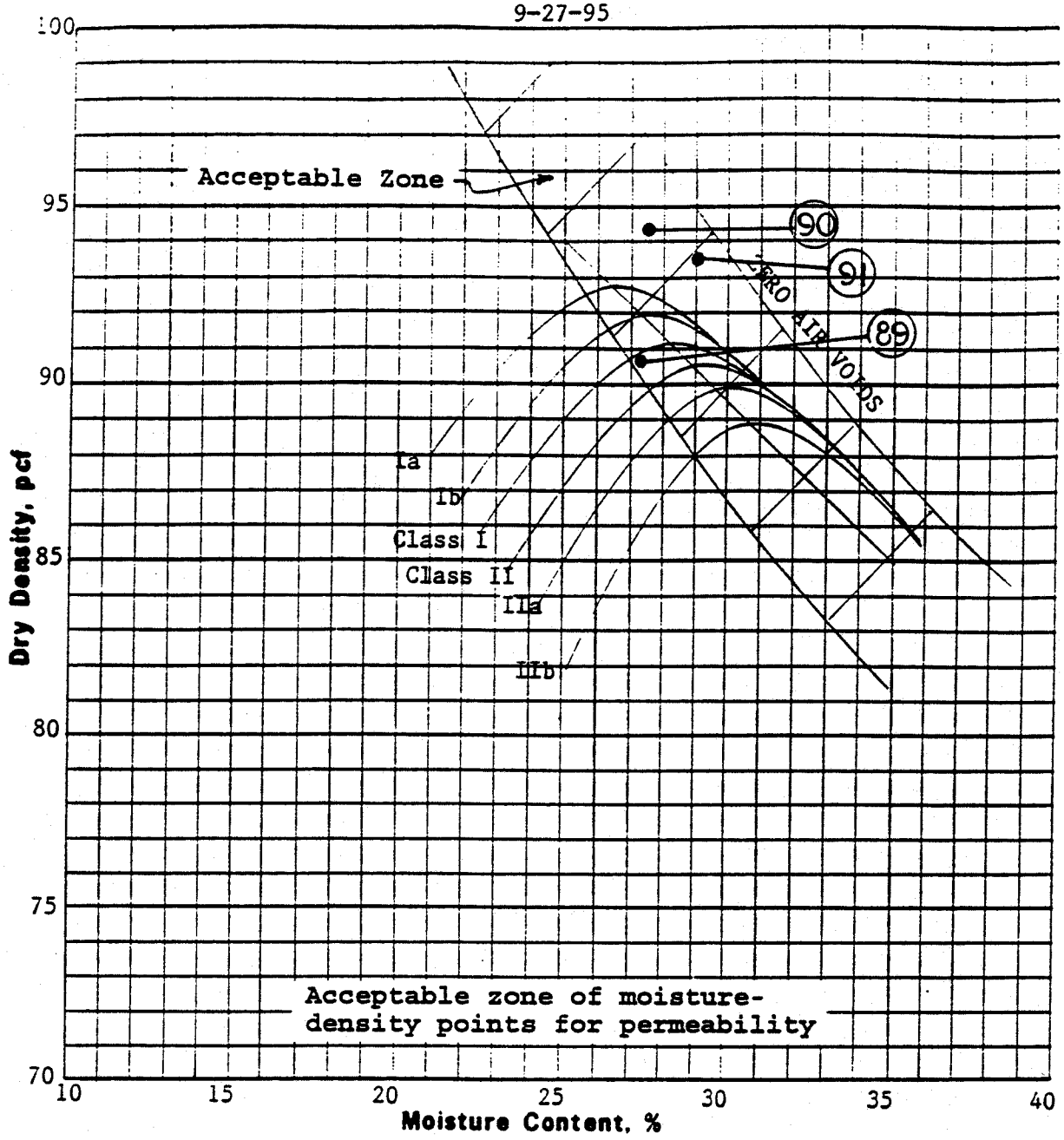
SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Dosposal Area (Inside Loop Track)
Tested By CB Essex
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
89	9/27/95	Station 12+00 A-Line	-0.0'	0.90/1.06	8"	115.5	24.7	27.3	90.7	99.5	95 % required
90	9/27/95	Station 11+00 A-Line	-0.0'	0.90/1.06	8"	120.5	26.2	27.8	94.3	103.3	95 % required
91	9/27/95	Station 12+00 B-Line	-0.0'	0.90/1.06	8"	120.7	27.1	29.0	93.6	102.6	95 % required

9-27-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95
COMPACTION TEST (FAMILY OF CURVES)	

Tested by: TAL Reviewed by: See

Bull Run S.P. Ash Disposal Area Ins[illegible] Railroad Loop Test Location Plan
9-27-95

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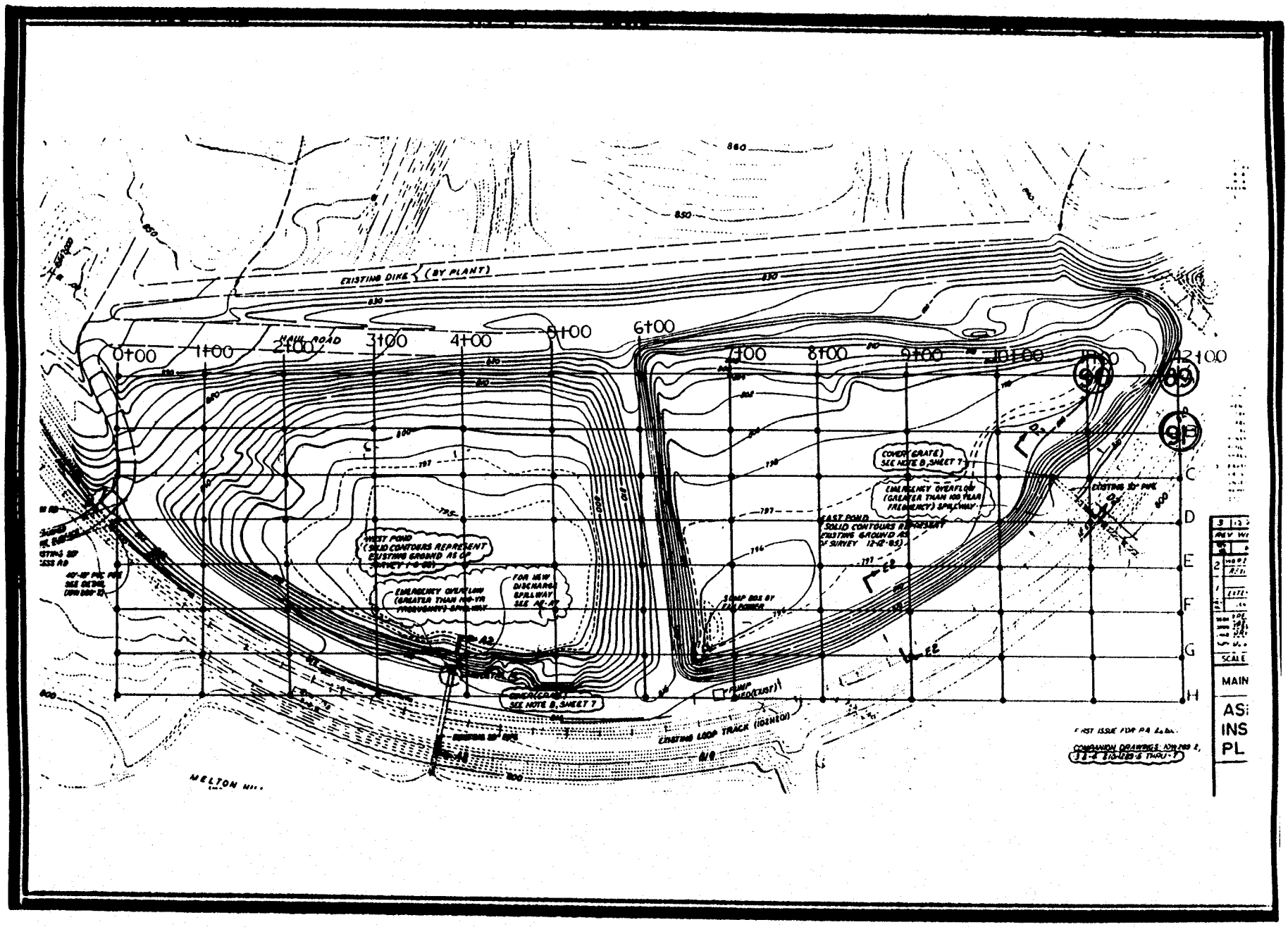


TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/28/95 Weather: Sunny 75F

Location: West Ash Dike W/in the railroad loop

==========

Observations: Left Singleton Labs at 8:20 a.m., arrived at job site at 8:55 a.m. Continued backfilling from Sta. 3+00 to 0+00 line "A-B". At 11:30 a.m. the trucks started hauling backfill to the East Ash Dike. The area at Sta. 5+00, between lines E & H shows a very soft & wet spot about 100 ft. by 50 ft. In the East dike area there are at least 2 water springs. We requested dried material for the base. Left job site at 3:30 p.m., arrived at Singleton Labs 4:10 p.m.

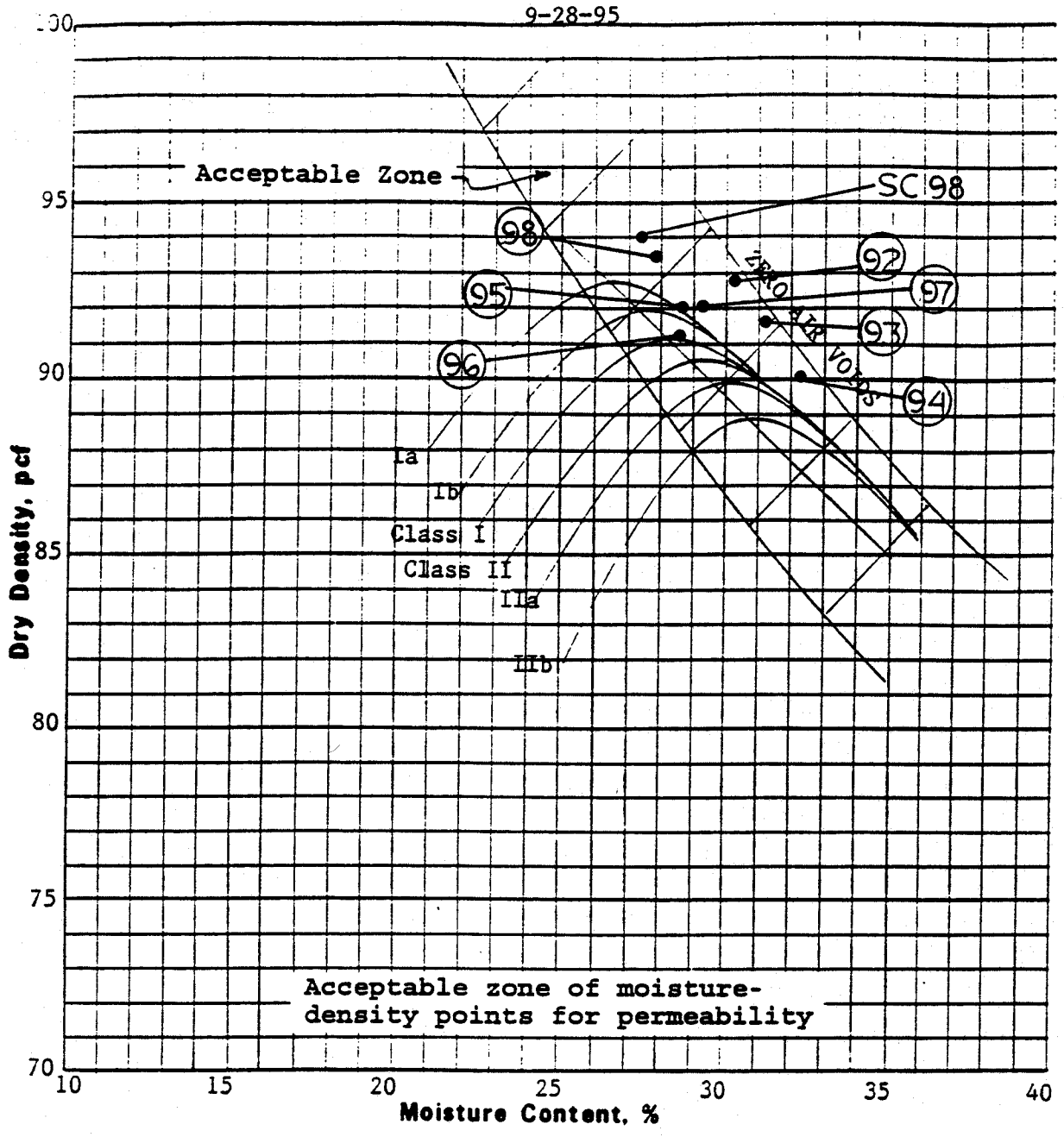
Inspector: Charles B. Essex

SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Dosposal Area (Inside Loop Track)
Tested By CB Essex
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
92	9/28/95	Station 5+00 A-B Line	-0.0'	0.98/1.00	8"	120.9	28.1	30.3	92.8	101.8	95 % required
93	9/28/95	Station 4+00 A-B Line	-0.0'	0.98/1.00	8"	120.3	28.6	31.1	91.7	100.5	95 % required
94	9/28/95	Station 3+00 A-B Line	-0.0'	0.98/1.00	8"	119.2	29.2	32.4	90.0	98.7	95 % required
95	9/28/95	Station 5+00 D-Line	-0.0'	0.98/1.00	8"	118.4	26.4	28.7	92.0	100.9	95 % required
96	9/28/95	Station 2+00 A-B Line	-0.0'	0.98/1.00	8"	117.2	26.0	28.5	91.2	100.0	95 % required
97	9/28/95	Station 1+00 A-B Line	-0.0'	0.98/1.00	8"	118.8	26.8	29.2	92.0	100.9	95 % required
98	9/28/95	Station 0+00 A-B Line	-0.0'	0.98/1.00	8"	119.5	26.0	27.8	93.5	102.5	95 % required



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95
COMPACTION TEST (FAMILY OF CURVES)	

Tested by: TAL Reviewed by:

Bull Run S.P. Ash Disposal Area Ins[illegible], Railroad Loop Test Location Plan

9-28-95

Singleton Laboratories

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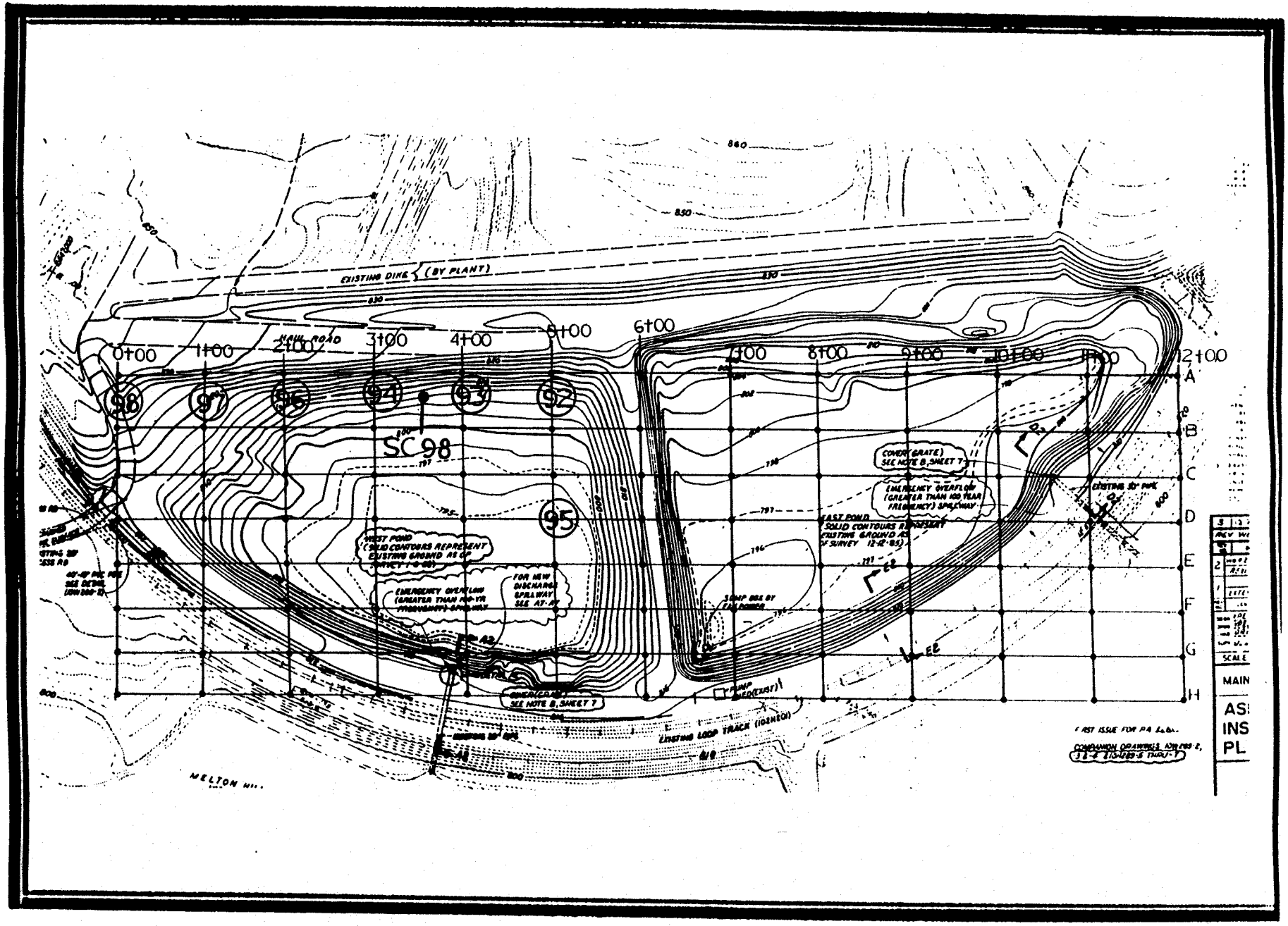


EARTHFILL COMPACTION TEST - SAND CONE METHOD

Project: Bull Run Steam Plant Feature: West Ash Dike Tested By: CBE
Date: 9/28/95 Station: 3 + 50 Offset: "A-B" Line Sample Top Elevation: 0.0

1. Test Number			-	SC-98
2. Borrow Source			-	
3. Weight Sand & Cone Before Test Jar No.1		8145g	lb	17.96
4. Weight Sand & Cone After Test		4095	lb	9.03
5. Weight Sand Used (3) - (4)			lb	8.93
6. Cone Volume Weight Correction			lb	3.91
7. Weight Sand in Test Hole (5)-(6)			lb	5.02
8. Sand Calibration Factor			pcf	96.0
9. Volume Test Hole (total sample) (7)/(8)			cf	.0523
10. Weight Wet Total Sample & Tare		3320	lb	7.32
11. Weight Tare		479.8	lb	1.06
12. Weight Wet Total Sample (10)-(11)			lb	6.26
13. Weight Wet Plus 3/4 & Tare			lb	6.26
14. Weight Dry Plus 3/4 & Tare			lb	6.26
15. Weight Tare			lb	6.26
16. Weight Wet Plus 3/4 (13)-(15)			lb	6.26
17. Weight Dry Plus 3/4 (14)-(15)			lb	6.26
18. Bulk Specific Gravity Plus #4 (SSD)			-	6.26
19. Unit Weight Plus 3/4 (18)X 62.4			pcf	6.26
20. Volume Plus 3/4 (16)/(19)			cf	6.26
21. Weight Wet Minus 3/4 (12)-(16)			lb	6.26
22. Volume Wet Minus 3/4 (9)-(20)			cf	.0523
23. Wet Density Minus 3/4 (21)/(22)			pcf	119.7
				Fill a 113 / Mold b
24. Weight Wet Minus #4and Tare			gm	286.6 / 286.6
25. Weight Dry Minus #4 and Tare			gm	239.7 / 239.7
26. Weight Tare			gm	68.3 / 68.3
27. Weight Water (24)-(25)			gm	46.9 / 46.9
28. Weight Dry Minus 3/4 (25)-(26)			gm	171.4 / 171.4
29. Moisture Content Minus 3/4 {(27)/(28)X100}		W_f	%	27.4 / 27.4
30. Weight Total Dry Minus 3/4 (21)/{1+(29a)/100}			lb	4.91 / -
31. Weight Total Dry Sample (17)+(30)			lb	4.91 / -
32. Percentage Plus 3/4 {(17)/(31)} X 100			%	n/a / -
33. Dry Density Minus 3/4 (23)/{1+(29a)/100}		Y_{df}	pcf	94.0 / -
34. Weight 1/30 cf Compact Mold & Wet Minus			lb	- / 8.50
35. Weight Compaction Mold			lb	- / 4.46
36. Weight Wet Minus 3/4 (34)-(35)			lb	- / 4.04
37. Wet Density (36) X 30			pcf	- / 121.2
38. Dry Density (37)/{1+(29b)/100}			pcf	- / 95.1
39. Soil Class {Control Curves with (29b) and (38b)}			-	I / -
40. Penetrometer Needle End Area			in^2	n/a / n/a
41. Average Needle Reading			lb	n/a / n/a
42. Penetration Resistance (41)-(40)			psi	n/a / n/a
43. Maximum Density (CONTROL CURVES)		Y_{dL}	pcf	91.2 / -
44. Optimum Moisture Content (CONTROL CURVES)		W_o	%	28.1 / -
45. (33)-(43)		Y_{df}-Y_{dL}	pcf	+2.8 / -
46. (29a)-(44) Required: - to +		W_f-W_o	%	-0.7 / -
47. Compaction Minus #4 {(33)/(43)} X 100			%	103.0 / -
48. Required Compaction: Minimum - 95% Maximum -			%	- / -
Corrective Action: Moisture content low				

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/29/95 Weather: Sunny

Location: East Ash Dike W/in the railroad loop

==========

Observations: Left Singleton Labs at 8:00 a.m., arrived at job site at 8:35 a.m. Continued filling on east ash dike. Ken Burnett visited the site. He was satisfied with what he saw. There were some wet spots in the clay fill overnight. G UB Mk will work on Saturday. Left job site at 3:40 p.m., arrived at the lab 4 p.m.

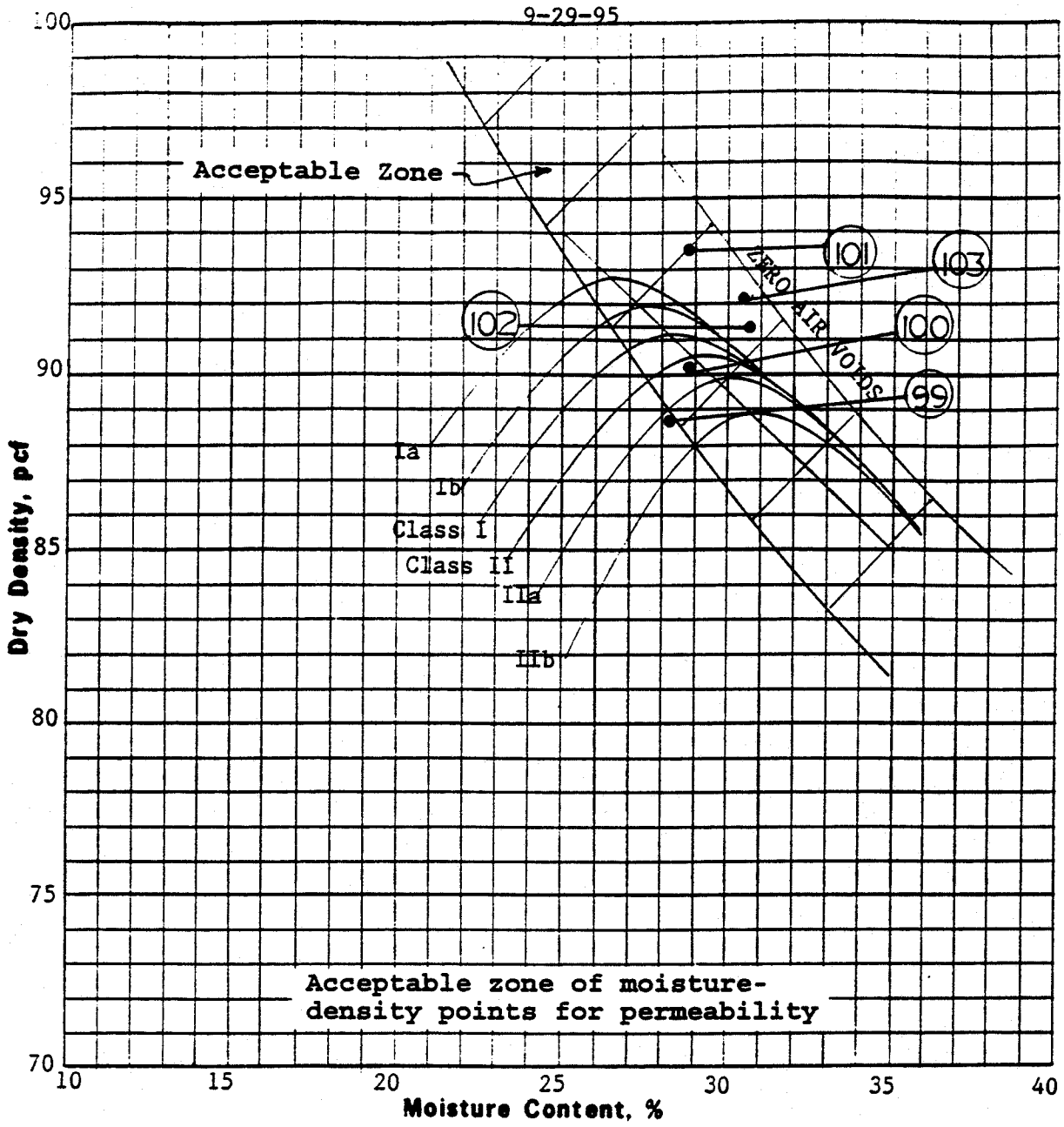
Inspector: Charles B. Essex

SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Dosposal Area (Inside Loop Track)
Tested By CB Essex
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
99	9/29/95	Station 11+00 B-Line	-0.0'	0.96/1.01	8"	113.8	25.0	28.2	88.8	97.4	95 % required
100	9/29/95	Station 12+00 C-Line	-0.0'	0.96/1.01	8"	116.1	26.0	28.9	90.1	99.3	95 % required
101	9/29/95	Station 11+00 C-Line	-0.0'	0.96/1.01	8"	120.7	27.0	28.8	93.7	102.7	95 % required
102	9/29/95	Station 11+00 D-Line	-0.0'	0.96/1.01	8"	119.3	28.0	30.7	91.3	100.1	95 % required
103	9/29/95	Station 12+00 D-Line	-0.0'	0.96/1.01	8"	120.2	28.1	30.5	92.1	100.9	95 % required



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95
COMPACTION TEST (FAMILY OF CURVES)	

Tested by: TAL Reviewed by: See

Bull Run S.P. Ash Disposal Area Ins Railroad Loop Test Location Plan

9-29-95

Singleton Laboratories

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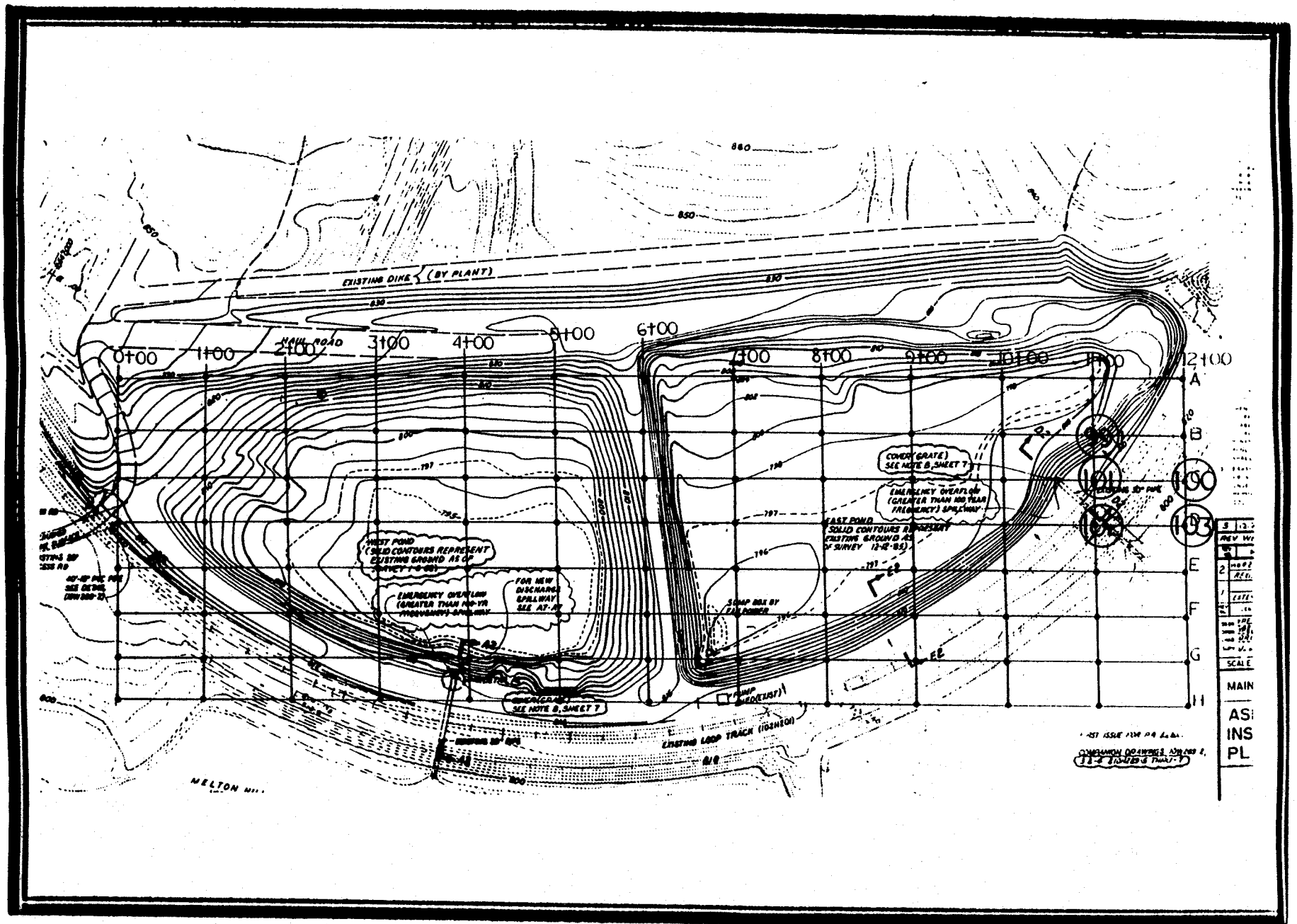


TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 9/30/95 Weather: Sunny

Location: East Ash Dike

==========

Observations: I arrived on site at 8:05. I met with Alan Myers to discuss area being filled and tested. They were filling on east ash dike. Soil was fat red clay and was being hauled on site by Tandem dump trucks. The soil was spread and compacted in a 1 foot lift by a self propelled 816B Sheep Foot roller. There was a wet spot in the fly ash between 9+00 to 10+00. They worked around this spot, not putting any clay on this area. There was standing water in this area. I conducted 6 density test using the nuclear method in the area filled. They continued to fill in area. There was a 14G grader leveling off areas all ready filled and a vibrating steel drum roller sealing off area. I met with Alan Myers to discuss test results. I departed from site 4:00 and arrived back at Lab at 4:45.

Inspector: Allen E. Luttrell

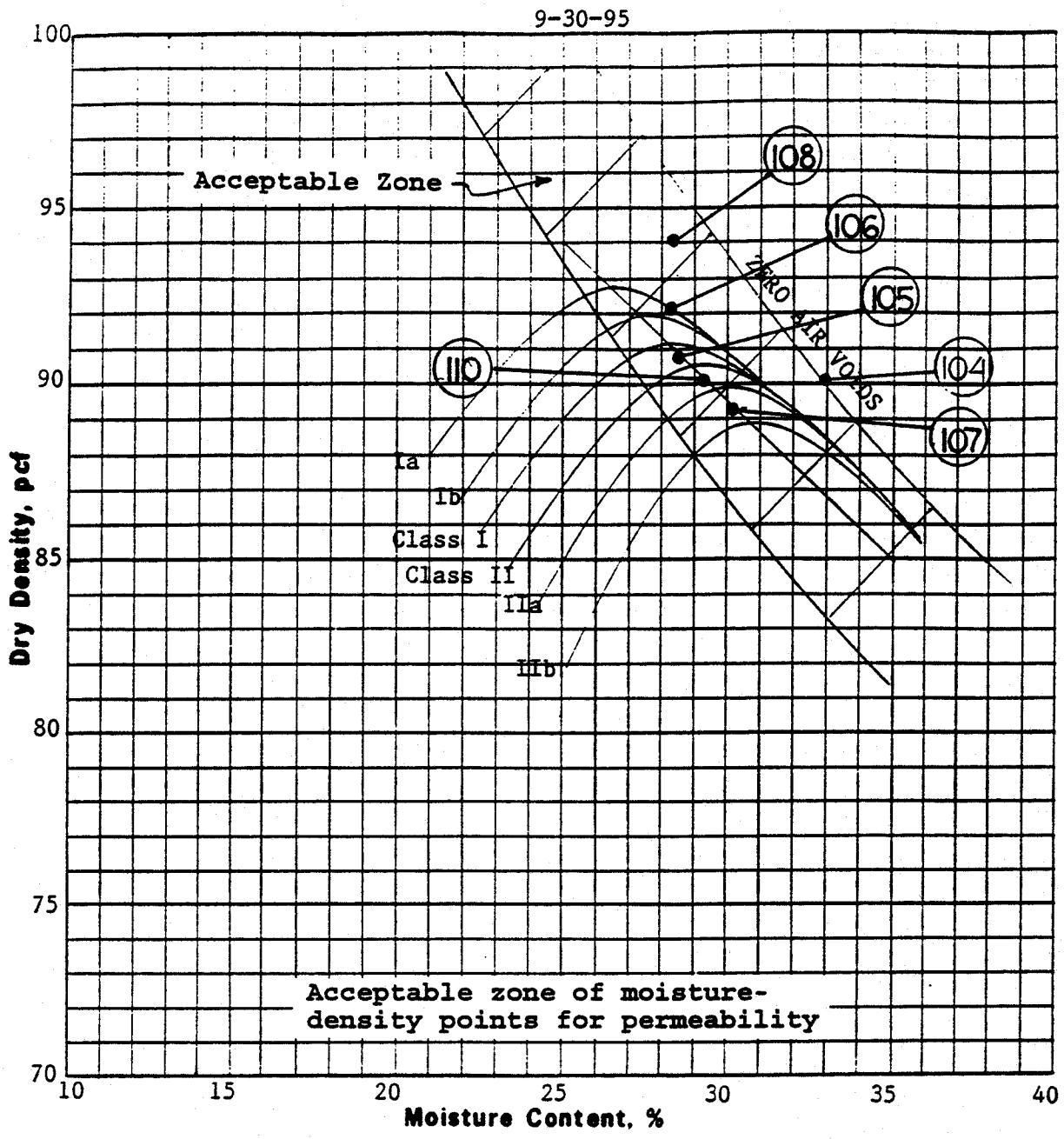
SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Dosposal Area (Inside Loop Track)
Tested By A. Luttrell
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
104	9/30/95	Station 10+00 B-Line	-0.0'	0.96/1.00	8"	119.7	29.6	32.9	90.1	98.7	95 % required
105	9/30/95	Station 9+00 B-Line	-0.0'	0.96/1.00	8"	116.8	25.9	28.5	90.9	99.6	95 % required
106	9/30/95	Station 8+00 A-Line	-0.0'	0.96/1.00	8"	118.1	26.0	28.2	92.1	101.0	95 % required
107	9/30/95	Station 8+00 B-Line	-0.0'	0.96/1.00	8"	116.4	27.0	30.2	89.4	98.0	95 % required
108	9/30/95	Station 7+00 A-Line	-0.0'	0.96/1.00	8"	120.7	26.7	28.4	94.0	103.0	95 % required
109	9/30/95	Station 7+00 B-Line	-0.0'	0.96/1.00	8"	116.5	26.5	29.4	90.0	98.7	95 % required

9-30-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95
COMPACTION TEST (FAMILY OF CURVES)	

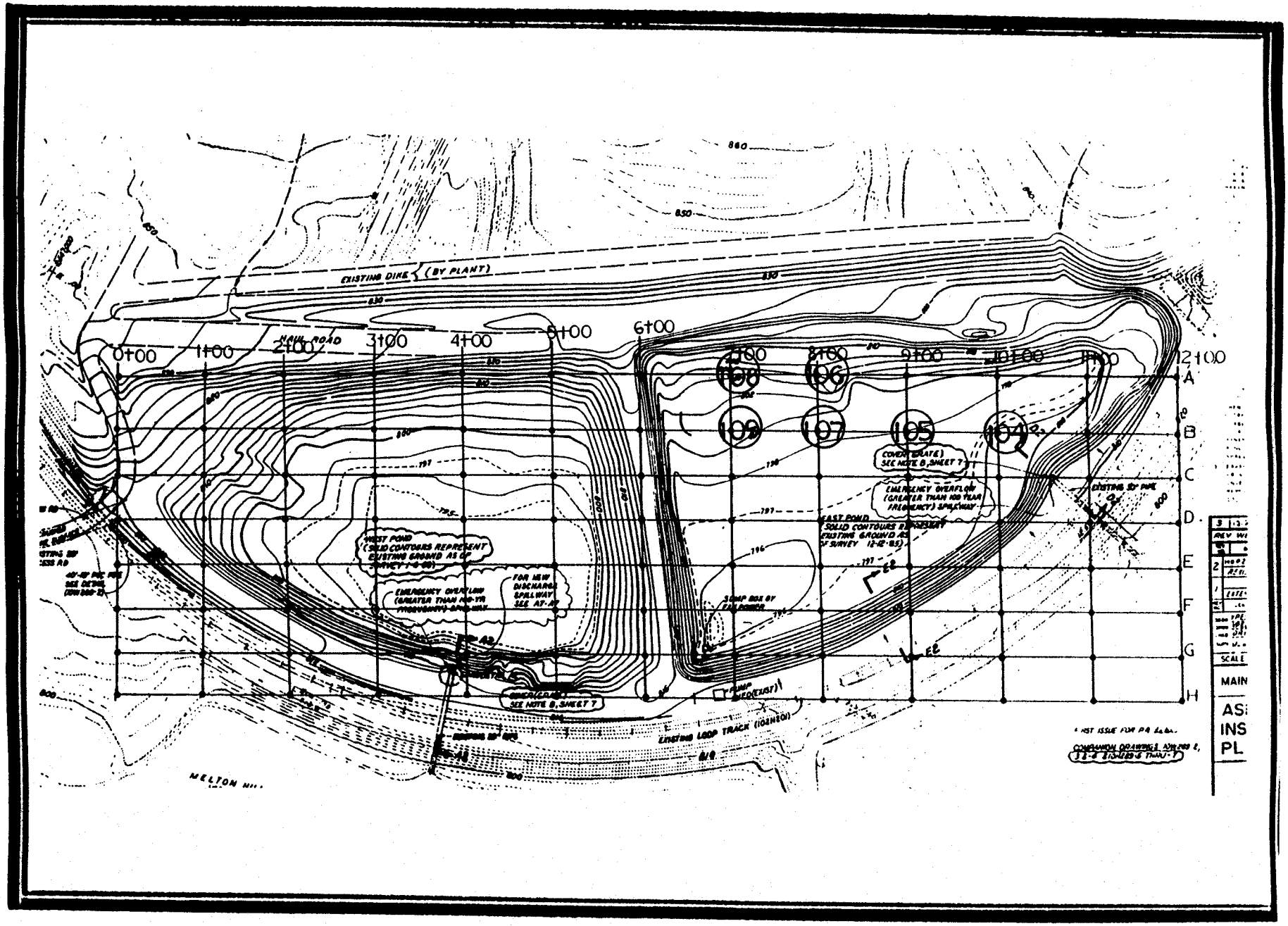
Tested by: TAL Reviewed by: RLC

Bull Run S.P. Ash Disposal Area Ins[illegible] Railroad Loop Test Location Plan

9-30-95

Singleton Laboratories

The Critical Link.®



TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 10/2/95 Weather: Sunny

Location: East Ash Dike

==========

Observations: I departed Singleton Lab at 7:30am and arrived on site at 8:10am. I met with Allen Myers to discuss area being filled. They were filling on the east ash dike. Soil was being hauled in Tandem dump trucks to site. The soil was a fat red clay. There was an 816B self-propelled sheepfoot roller spreading and compacting clay in a 1 foot lift, the wet spot that was between 9+00 and 10+00A. There was no standing water in this area and has appeared to have dried up. They are going to cover this area with clay today. I conducted 9 density tests using the nuclear method in the 8" mode. There was a vibrating steel drum roller sealing fill area. I met with Alan Myers to discuss test results. I departed site at 3:30 and arrived back at Lab at 4:10.

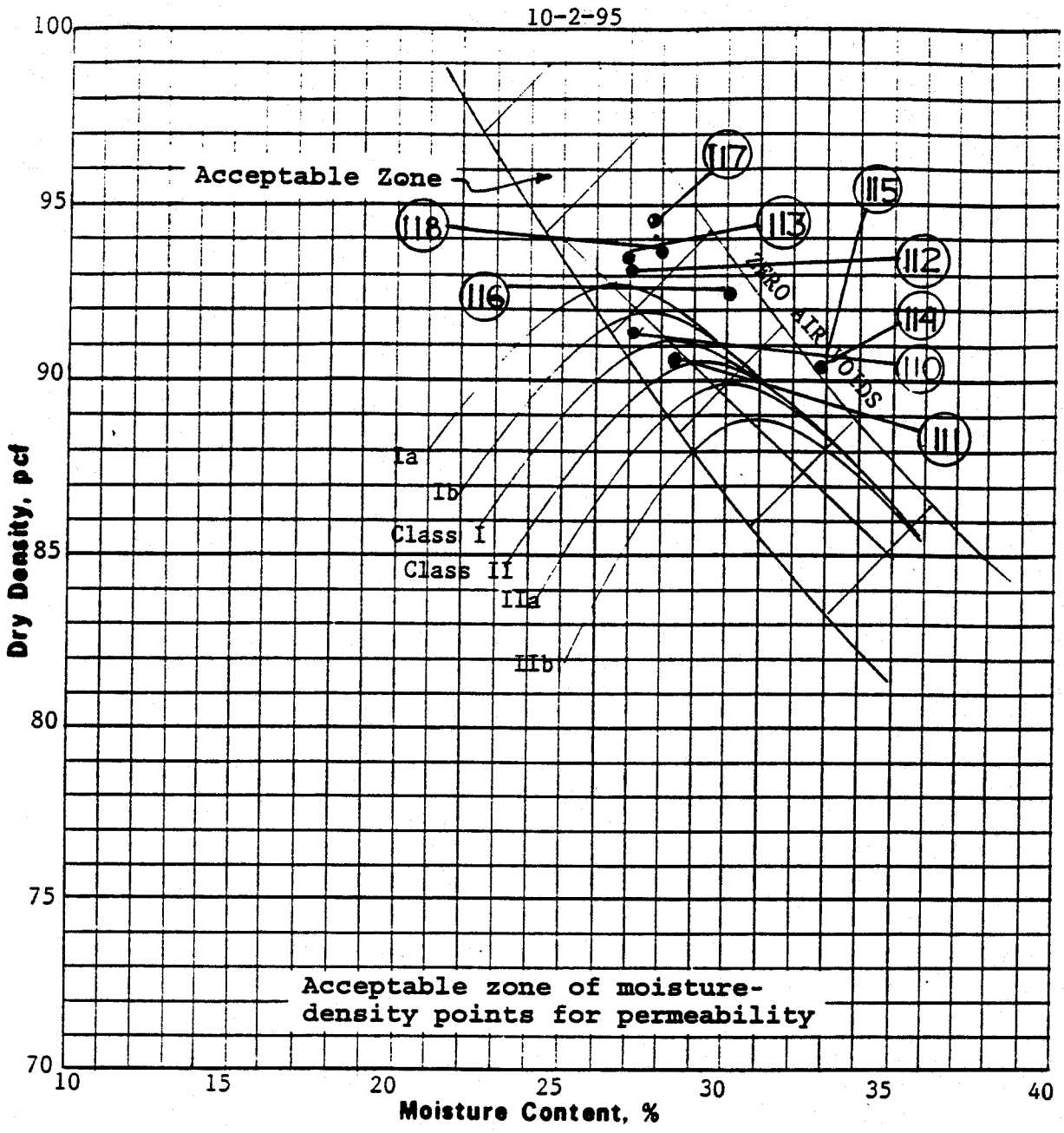
Inspector: Allen E. Luttrell

SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Dosposal Area (Inside Loop Track)
Tested By A. Luttrell
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
110	10/2/95	Station 9+00 A-Line	-0.0'	1.06/0.98	8"	116.2	24.8	27.2	91.4	100.1	95 % required
111	10/2/95	Station 10+00 A-Line	-0.0'	1.06/0.98	8"	116.5	25.8	28.4	90.7	99.4	95 % required
112	10/2/95	Station 10+00 C-Line	-0.0'	1.06/0.98	8"	118.2	25.2	27.1	93.0	101.9	95 % required
113	10/2/95	Station 10+00 D-Line	-0.0'	1.06/0.98	8"	118.7	25.3	27.0	93.4	102.4	95 % required
114	10/2/95	Station 9+00 C-Line	-0.0'	1.06/0.98	8"	120.4	29.9	33.0	90.5	99.2	95 % required
115	10/2/95	Station 9+00 D-Line	-0.0'	1.06/0.98	8"	120.2	30.0	33.3	90.2	98.9	95 % required
116	10/2/95	Station 9+00 E-Line	-0.0'	1.06/0.98	8"	120.6	28.0	30.2	92.6	101.5	95 % required
117	10/2/95	Station 8+00 C-Line	-0.0'	1.06/0.98	8"	120.8	26.3	27.8	94.5	103.6	95 % required
118	10/2/95	Station 7+00 C-Line	-0.0'	1.06/0.98	8"	120.2	26.3	28.0	93.9	102.9	95 % required



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95

COMPACTION TEST (FAMILY OF CURVES)

TAL

Reviewed by: RLC

Bull Run S.P. Ash Disposal Area Ins[illegible] Railroad Loop Test Location Plan
10-2-95

Singleton Laboratories

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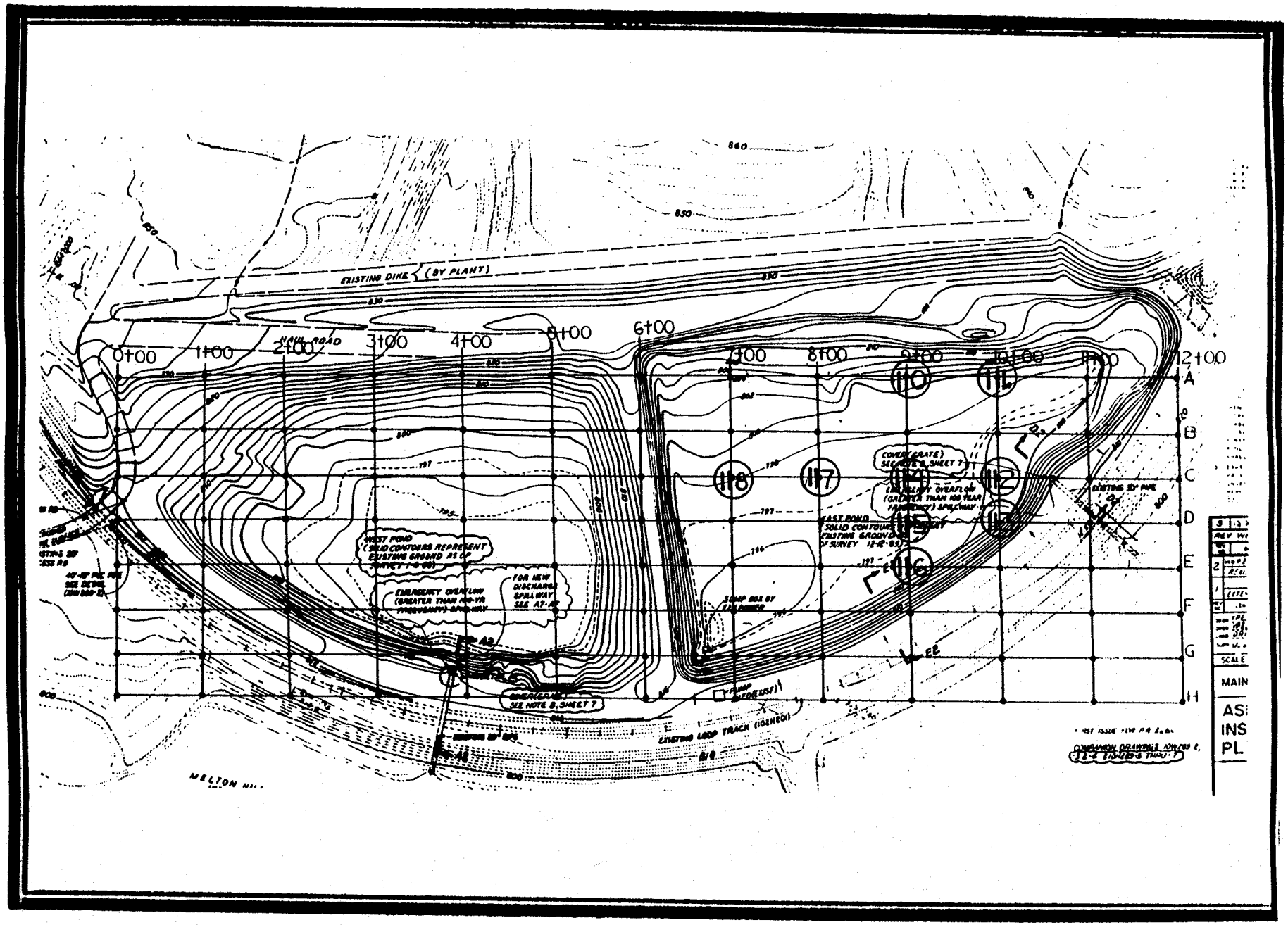


TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 10/3/95 Weather: Overcast

Location: East Ash Dike

==========

Observations: I departed Lab at 8:00 and arrived on site at 8:45. I met with Alan Myers to discuss area being filled. They are hauling clay on site in Tandem dump trucks. Soil is a fat red clay and is being spread in a 1 foot lift by a self propelled Sheepfoot roller which is a 815, it is also compacting soil. Charlie Essex and Jack Hilliard arrived on site to survey elevation of clay already filled. It is starting to drizzle rain. Rain is starting to quit. I was getting ready to conduct testing when an employee got run over by the train. I drove up to the guard shack to call ambulance. I waited for ambulance to get there and then lead it to site. It started to rain heavy after that and they quit because of rain. I departed site at 1:30 and arrived back at Lab at 2:10.

Inspector: Allen E. Luttrell

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 10/9/95 Weather: Sunny

Location: East Ash Dike

==========

Observations: I departed Singleton Lab. at 8:00 and arrived on site at 8:45. I met with Allen Myers to discuss area being filled and tested. Area being filled is on the east ash dike. Soil is being hauled on site by Tandem dump trucks. Soil is a fat red clay and is being spread and compacted by a 816B self propelled Sheepfoot roller. Soil is being spread in a 1 foot lift. Soil that is being hauled on site this morning is very wet and sticky. It is being dumped out of trucks in big clumps. Soil is being broken up and spread out by 816B to let it dry out before trying to compact it. They are having trouble spreading it out it is so wet and sticky. They said at Borrow area they would move and try to find some drier soil. Soil being hauled on site is still too wet to compact properly. Soil will have to dry out a couple of days before being ready to compact. I didn't conduct any testing today. I departed site at 3:30 and arrived back at Lab at 4:15.

Inspector: Allen E. Luttrell

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 10/10/95 Weather: Sunny

Location: East Ash Dike

==========

Observations: I departed Singleton Lab. at 8:00 and arrived on site at 8:45. I met with Allen Myers to discuss area being filled. Area being filled is on east ash dike. Soil is being hauled on site by Tandem dump trucks. Soil is a fat red clay. Soil being hauled on site is still wet and sticky. Soil is being spread out by 816B self propelled Sheepfoot roller to dry out enough to compact. Soil that was hauled on site yesterday is still too wet. This soil is being plowed and turned over by a grader to dry out some more. This soil is going to be mixed up through out the day to help the sun dry it out enough to compact and test. Soil being hauled on site today is a little drier but is still too wet to compact. Soil continues to be spread out by 816B to let it dry out. Soil is still arriving on site too wet. I can't conduct any testing today. I met with Alan Myers to discuss area. I departed site at 3:30 and arrived back at the Lab at 4:15.

Inspector: Allen E. Luttrell

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 10/11/95 Weather: Sunny

Location: East Ash Dike

==========

Observations: I met with Alan Myers to discuss area being filled. Area being filled is the East Ash dike. Soil is being hauled on site by Tandem dump trucks. Soil is a fat red clay. Soil that is being hauled on site is still very wet. Soil is being spread out by a 816B self propelled Sheepfoot roller so the soil can dry out enough to compact. Soil that was hauled on site the last couple days is still wet and is being ripped up and turned over so it can dry out. Soil is continuing to be hauled on site and is still very wet and being spread out to dry. I did not conduct any test today due to soil being wet. At the end of the day they sealed off area with a steel drum vibrating roller. I met with Alan Myers to discuss area. I departed site at 3:30 and arrived back at Lab at 4:15.

Inspector: Allen E. Luttrell

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 10/12/95 Weather: Sunny

Location: East Ash Dike

==========

Observations: I departed Lab at 8:00 and arrived on site at 8:45. I met with Alan Myers to discuss area being filled. Area being filled is the East Ash dike. Soil is being hauled on site by Tandem dump trucks. Soil being hauled on site is still very wet and is being spread out so it can dry out. Soil is also being ripped up and turned over so it can dry out more. This is the soil that has been spread out through out the week and is still too wet. Jack Hilliard arrived on site to survey clay elevation that has already been put down. I helped Jack survey East Ash dike and upper Ash dike. There was a couple of low elevations in the following areas. On B line 6+00 to 9+00 and D 10+00 to 12+00 that were 3 inches low. We put in grade stake in these areas with fill lines on them. In the afternoon they filled these areas. I observed that 3 inches was put in these areas. I didn't conduct any tests today, soil is still too wet. I departed site at 3:30 and arrived back at Lab at 4:15.

Inspector: Allen E. Luttrell

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 10/13/95 Weather: Overcast Light Rain

Location: East Ash Dike

==========

Observations: I departed Lab at 8:00 and arrived on site at 8:45. I met with Alan Myers to discuss area being filled. Area being filled is the East Ash dike. Soil is being hauled on site by Tandem dump trucks and being spread out by a bulldozer. Soil is still a little wet to compact, but the flyash is a little wet and when clay is spread over flyash the clay sinks with weight of bulldozer and when bulldozer drives off it comes back up. I'm going to conduct some tests on soil that was put in at first of week but it is sprinkling rain. If rain lets up I'm going to conduct some tests. Soil continues to be spread out. They are spreading soil thicker in this area because we think clay will sink after water is pushed from under clay. At 1:00 it began to rain very heavy. The last trucks being dumped have to be pushed by bulldozer up small incline up off clay. I met with Alan Myers, they are quitting work for day due to rain. I departed site at 1:45 and arrived back at lab at 2:30.

Inspector: Allen E. Luttrell

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 10/16/95 Weather: Sunny

Location: East Ash Dike

==========

Observations: I departed Lab at 8:30 and arrived on site at 9:15. I met with Alan Myers to discuss area being filled. Area being filled is the East Ash dike. Soil is being hauled on site by Tandem dump trucks. Soil is a red fat clay. Area that is being filled with the flyash is still wet. They are scooping out soupy flyash with a track hoe and loading it in a pan. The area they're working now is all they lack finishing East ash dike. Clay is being spread out with a bulldozer. Clay is pumping down under the weight of bulldozer but then comes back up when bulldozer moves off it. They can't put the compactor or roller on it until water under clay is pushed out. There are several puddles standing on clay that has already been put in around area from rain Friday and Saturday. I can't take any test today. I should be able to test areas tomorrow with sun drying up standing water today. They are close to finishing covering area with clay. I met with Alan Myers to discuss area. I departed site at 3:30 and arrived back at Lab at 4:15.

Inspector: Allen E. Luttrell

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 10/17/95 Weather: Sunny

Location: East Ash Dike

==========

Observations: I departed Lab at 8:00 and arrived on site at 8:45. I met with Alan Myers to discuss area being filled. Area being filled is the East Ash dike. They are finishing covering area with clay now. They are rolling over area already filled, so I can conduct density test. There is a wet spot in clay at E. 6+00 where water and fly ash are seeping up through clay. They can't roll this area. They are rolling area with a steel drum vibrating roller. I conducted 15 density tests using the nuclear method in the 8" mode. They have finished filling area with clay that was spread with a bulldozer. I conducted test over all of East Ash dike area except for E. 6+00 where wet spot is. They are sowing grass and putting down straw and lime on West Ash dike today. I met with Alan Myers to discuss tests results and area. I departed site at 3:30 and arrived back at Lab at 4:15.

Inspector: Allen E. Luttrell

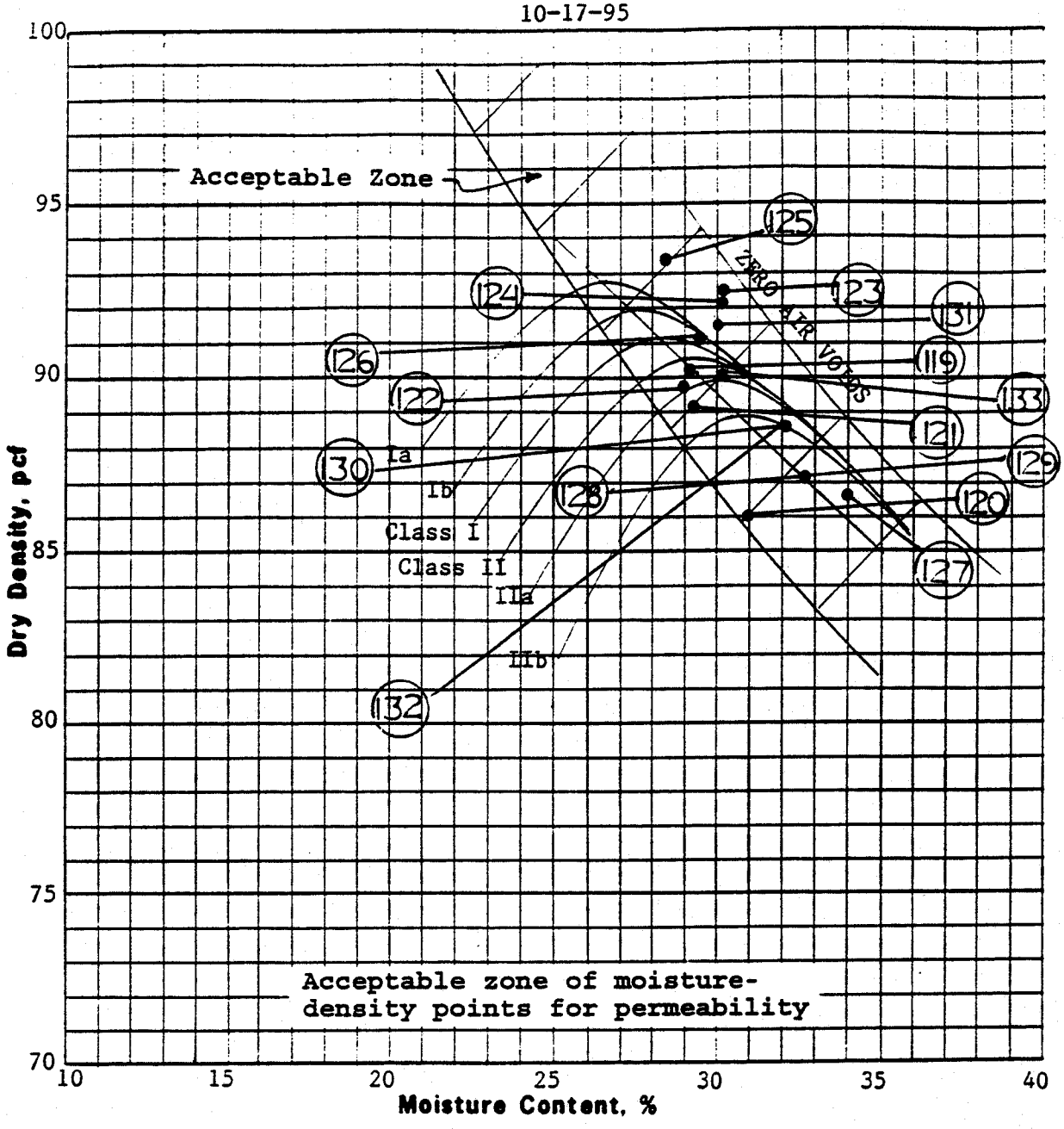
SINGLETON LABORATORIES
FIELD MOISTURE-DENSITY TEST SHEET

Project Number 209-078-001
Project Name TVA Bull Run Steam Plant
Facility I.D. Ash Dosposa! Area (Inside Loop Track)
Tested By A. Luttrell
Gauge No. 2602

Curve No.	Soil Description	Max. Dry Density PCF	Optimum Moisture %
1	Class I	91.2	28.1
2	Class II	90.7	29.0
3			
4			

Test No.	Date	Test Coordinates	Elev. (ft)	Std. Count Dens./Moist.	Mode and Depth	Wet Density PCF	Moisture Count	Moisture Content %	Dry Density PCF	Rel. Comp. %	Soil Type and Remarks
119	10/17/95	Station 10+00 E-Line	-0.0'	1.06/0.98	8"	116.4	26.3	29.2	90.1	98.8	95 % required
120	10/17/95	Station 9+00 F-Line	-0.0'	1.06/0.98	8"	112.9	26.8	31.1	86.1	95.0	95 % required
121	10/17/95	Station 8+00 D-Line	-0.0'	1.06/0.98	8"	115.2	26.2	29.4	89.0	97.5	95 % required
122	10/17/95	Station 8+00 E-Line	-0.0'	0.96/1.02	8"	116.0	26.1	29.0	89.8	98.5	95 % required
123	10/17/95	Station 8 +00 F-Line	-0.0'	0.96/1.02	8"	120.3	27.9	30.2	92.5	101.3	95 % required
124	10/17/95	Station 8 +00 G-Line	-0.0'	0.96/1.02	8"	120.3	27.9	30.3	92.3	101.2	95 % required
125	10/17/95	Station 9+00 D-Line	-0.0'	0.96/1.02	8"	120.2	26.8	28.6	93.4	102.4	95 % required
126	10/17/95	Station 7+00 E-Line	-0.0'	0.96/1.02	8"	118.1	27.0	29.6	91.0	99.7	95 % required
127	10/17/95	Station 7+00 F-Line	-0.0'	0.96/1.02	8"	116.0	29.5	34.0	86.6	95.0	95 % required
128	10/17/95	Station 7+00 G-Line	-0.0'	0.96/1.02	8"	115.7	28.6	32.8	87.1	95.5	95 % required
129	10/17/95	Station 6+00 B-Line	-0.0'	0.96/1.02	8"	115.7	28.6	32.8	87.2	95.5	95 % required
130	10/17/95	Station 6+00 C-Line	-0.0'	0.96/1.02	8"	117.0	28.6	32.3	88.4	96.9	95 % required
131	10/17/95	Station 6+00 D-Line	-0.0'	0.96/1.02	8"	119.1	27.5	30.1	91.6	100.4	95 % required
132	10/17/95	Station 6+00 E-Line	-0.0'	0.96/1.02	8"	117.1	28.3	31.9	88.8	97.3	95 % required
133	10/17/95	Station 6+00 G-Line	-0.0'	0.96/1.02	8"	117.1	27.3	30.3	90.1	98.7	95 % required

10-17-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

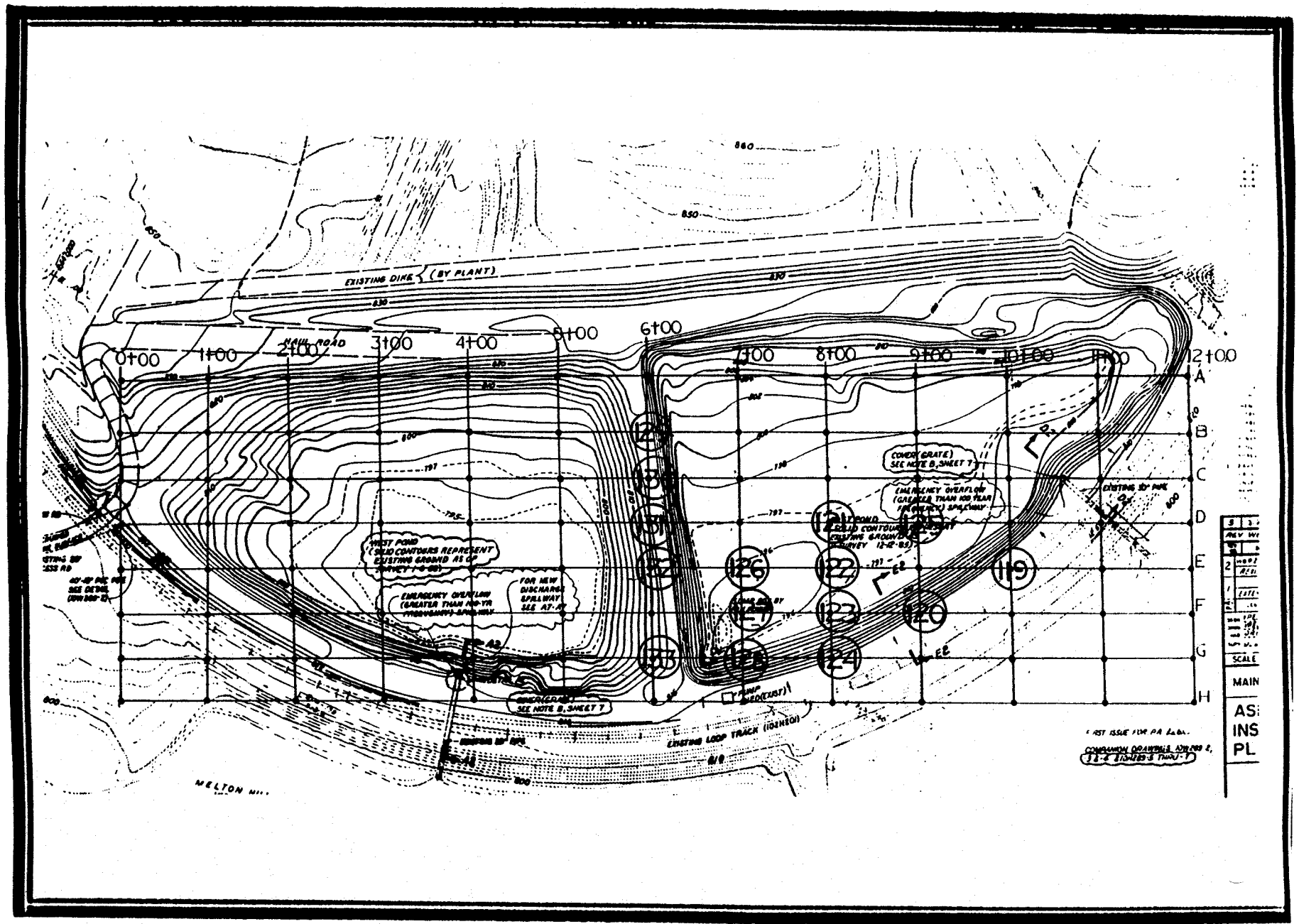
Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
	ASTM Designations D 698A & C
Date Tested	8/15/95
COMPACTION TEST (FAMILY OF CURVES)	

Tested by: TAL Reviewed by: [illegible]

Bull Run S.P. Ash Disposal Area Inside Railroad Loop Test Location Plan
10-17-95

Singleton Laboratories

The Critical Link.®



TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 10/19/95 Weather: Sunny

Location: East Ash Dike

==========

Observations: I departed Singleton Labs at 9:30 and arrived on site at 10:15. I met with Alan Myers to discuss area. Also Raul Gonzalez arrived on site to help me run sand cone densities and push shelby tubes. We conducted two sand densities in areas 10+00 D & E line. We also pushed 6 shelby tubes in the following stations A 2+00, A 4+00, E 6+00, F 6+00, G 6+00, B 11+00. To verify clay thickness and for permeability testing top soil is still being spread on East Ash dike today, and West Ash dike is complete it has already been seeded and strawed. Tubes are pushed by a track hoe and also pulled out with track hoe. I met with Alan Myers to discuss area and testing. I departed site at 3:30 and arrived back at Lab 4:15. Also station E 6+00 which was too wet to run density test on 10-17-95. They had already put down topsoil in this area. So I couldn't conduct test, but we did push a tube in this area, there was a wet spot in this area today, water and flyash was seeping up through topsoil.

Inspector: Allen E. Luttrell

EARTHFILL COMPACTION TEST - SAND CONE METHOD

Project: Bull Run Steam Plant Feature: Tested By: AEL
Date: 10/19/95 Station: 10+00 Offset: E-Line Sample Top Elevation:

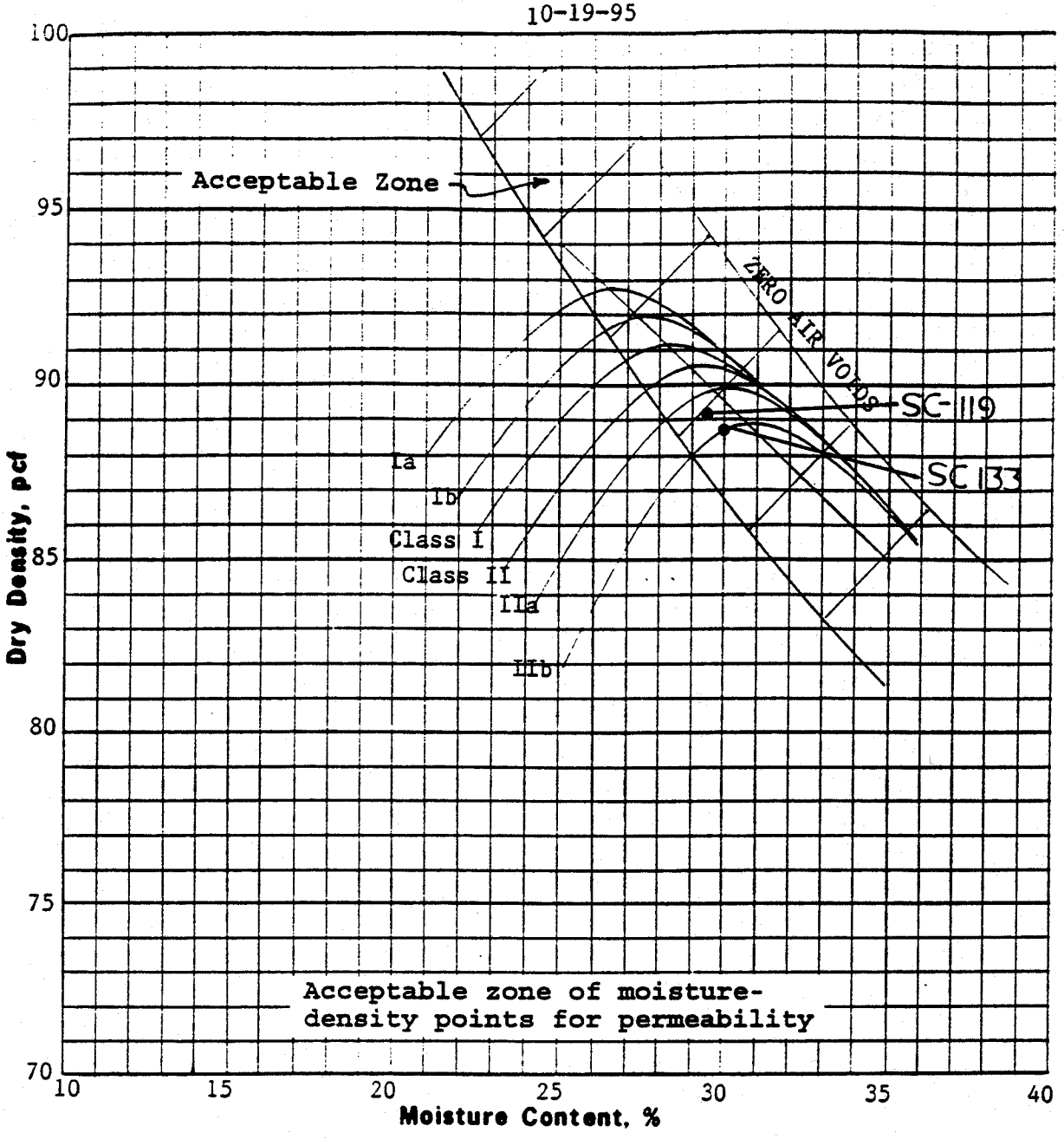
1. Test Number	-	SC-119	
2. Borrow Source	-		
3. Weight Sand & Cone Before Test SO/SC-3 7300	lb	16.09	
4. Weight Sand & Cone After Test	lb	8.33	
5. Weight Sand Used (3) - (4)	lb	7.76	
6. Cone Volume Weight Correction	lb	3.95	
7. Weight Sand in Test Hole (5)-(6)	lb	3.81	
8. Sand Calibration Factor	pcf	96.0	
9. Volume Test Hole (total sample) (7)/(8)	cf	.0397	
10. Weight Wet Total Sample & Tare	lb	5.04	
11. Weight Tare	lb	0.46	
12. Weight Wet Total Sample (10)-(11)	lb	4.58	
13. Weight Wet Plus 3/4 & Tare	lb	n/a	
14. Weight Dry Plus 3/4 & Tare	lb	n/a	
15. Weight Tare	lb	n/a	
16. Weight Wet Plus 3/4 (13)-(15)	lb	n/a	
17. Weight Dry Plus 3/4 (14)-(15)	lb	n/a	
18. Bulk Specific Gravity Plus #4 (SSD)	-	n/a	
19. Unit Weight Plus 3/4 (18)X 62.4	pcf	n/a	
20. Volume Plus 3/4 (16)/(19)	cf	n/a	
21. Weight Wet Minus 3/4 (12)-(16)	lb	4.58	
22. Volume Wet Minus 3/4 (9)-(20)	cf	.0397	
23. Wet Density Minus 3/4 (21)/(22)	pcf	115.4	
		Fill a 200	Mold b
24. Weight Wet Minus #4 and Tare	gm	382.6	382.6
25. Weight Dry Minus #4 and Tare	gm	318.1	318.1
26. Weight Tare	gm	99.6	99.6
27. Weight Water (24)-(25)	gm	64.5	64.5
28. Weight Dry Minus 3/4 (25)-(26)	gm	218.5	218.5
29. Moisture Content Minus 3/4 {(27)/(28)X100} W_f	%	29.5	29.5
30. Weight Total Dry Minus 3/4 (21)/{1+(29a)/100}	lb	3.54	-
31. Weight Total Dry Sample (17)+(30)	lb	3.54	-
32. Percentage Plus 3/4 {(17)/(31)} X 100	%	n/a	-
33. Dry Density Minus 3/4 (23)/{1+(29a)/100} Y_{df}	pcf	89.1	-
34. Weight 1/30 cf Compact Mold & Wet Minus	lb	-	8.5
35. Weight Compaction Mold	lb	-	4.46
36. Weight Wet Minus 3/4 (34)-(35)	lb	-	4.04
37. Wet Density (36) X 30	pcf	-	121.2
38. Dry Density (37)/{1+(29b)/100}	pcf	-	93.5
39. Soil Class {Control Curves with (29b) and (38b)}	-	II	-
40. Penetrometer Needle End Area	in^2	n/a	n/a
41. Average Needle Reading	lb	n/a	n/a
42. Penetration Resistance (41)-(40)	psi	n/a	n/a
43. Maximum Density (CONTROL CURVES) Y_{dL}	pcf	90.7	-
44. Optimum Moisture Content (CONTROL CURVES) W_o	%	29.0	-
45. (33)-(43) Y_{df}-Y_{dL}	pcf	-1.6	-
46. (29a)-(44) Required: - to + W_f-W_o	%	+0.5	-
47. Compaction Minus #4 {(33)/(43)} X 100	%	98.2	-
48. Required Compaction: Minimum - 95% Maximum -	%	-	-
Corrective Action: Compaction & Moisture content acceptable		*RETEST NO.*	

EARTHFILL COMPACTION TEST - SAND CONE METHOD

Project: Bull Run Steam Plant Feature: Tested By: AEL
Date: 10/19/95 Station: 6+00 Offset: G-Line Sample Top Elevation:

1. Test Number		-	SC-133	
2. Borrow Source		-		
3. Weight Sand & Cone Before Test	1	lb	17.81	
4. Weight Sand & Cone After Test		lb	10.16	
5. Weight Sand Used (3) - (4)		lb	7.65	
6. Cone Volume Weight Correction		lb	3.91	
7. Weight Sand in Test Hole (5)-(6)		lb	3.74	
8. Sand Calibration Factor		pcf	96.0	
9. Volume Test Hole (total sample) (7)/(8)		cf	.0390	
10. Weight Wet Total Sample & Tare		lb	5.56	
11. Weight Tare		lb	1.06	
12. Weight Wet Total Sample (10)-(11)		lb	4.50	
13. Weight Wet Plus 3/4 & Tare		lb	n/a	
14. Weight Dry Plus 3/4 & Tare		lb	n/a	
15. Weight Tare		lb	n/a	
16. Weight Wet Plus 3/4 (13)-(15)		lb	n/a	
17. Weight Dry Plus 3/4 (14)-(15)		lb	n/a	
18. Bulk Specific Gravity Plus #4 (SSD)		-	n/a	
19. Unit Weight Plus 3/4 (18)X 62.4		pcf	n/a	
20. Volume Plus 3/4 (16)/(19)		cf	n/a	
21. Weight Wet Minus 3/4 (12)-(16)		lb	4.50	
22. Volume Wet Minus 3/4 (9)-(20)		cf	.0390	
23. Wet Density Minus 3/4 (21)/(22)		pcf	115.4	
			Fill a 135	Mold b
24. Weight Wet Minus #4 and Tare		gm	345.8	345.8
25. Weight Dry Minus #4 and Tare		gm	288.2	288.2
26. Weight Tare		gm	96.1	96.1
27. Weight Water (24)-(25)		gm	57.6	57.6
28. Weight Dry Minus 3/4 (25)-(26)		gm	192.1	192.1
29. Moisture Content Minus 3/4 {(27)/(28)X100}	W_f	%	30.0	30.0
30. Weight Total Dry Minus 3/4 (21)/{1+(29a)/100}		lb	3.46	-
31. Weight Total Dry Sample (17)+(30)		lb	3.46	-
32. Percentage Plus 3/4 {(17)/(31)} X 100		%	n/a	-
33. Dry Density Minus 3/4 (23)/{1+(29a)/100}	Y_{df}	pcf	88.8	-
34. Weight 1/30 cf Compact Mold & Wet Minus		lb	-	8.4
35. Weight Compaction Mold		lb	-	4.46
36. Weight Wet Minus 3/4 (34)-(35)		lb	-	3.94
37. Wet Density (36) X 30		pcf	-	118.2
38. Dry Density (37)/{1+(29b)/100}		pcf	-	90.9
39. Soil Class {Control Curves with (29b) and (38b)}		-	II	-
40. Penetrometer Needle End Area		in^2	n/a	n/a
41. Average Needle Reading		lb	n/a	n/a
42. Penetration Resistance (41)-(40)		psi	n/a	n/a
43. Maximum Density (CONTROL CURVES)	Y_{dL}	pcf	90.7	-
44. Optimum Moisture Content (CONTROL CURVES)	W_o	%	29.0	-
45. (33)-(43)	Y_{df}-Y_{dL}	pcf	-1.9	-
46. (29a)-(44) Required: - to +	W_f-W_o	%	+1.0	-
47. Compaction Minus #4 {(33)/(43)} X 100		%	97.9	-
48. Required Compaction: Minimum - 95% Maximum -		%	-	-
Corrective Action: Compaction & Moisture content acceptable			*RETEST NO.*	

10-19-95



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95
COMPACTION TEST (FAMILY OF CURVES)	

Tested by: TAL Reviewed by: [signature]

Bull Run S.P. Ash Disposal Area Inst[illegible] Railroad Loop Test Location Plan

10-19-95

Singleton Laboratories

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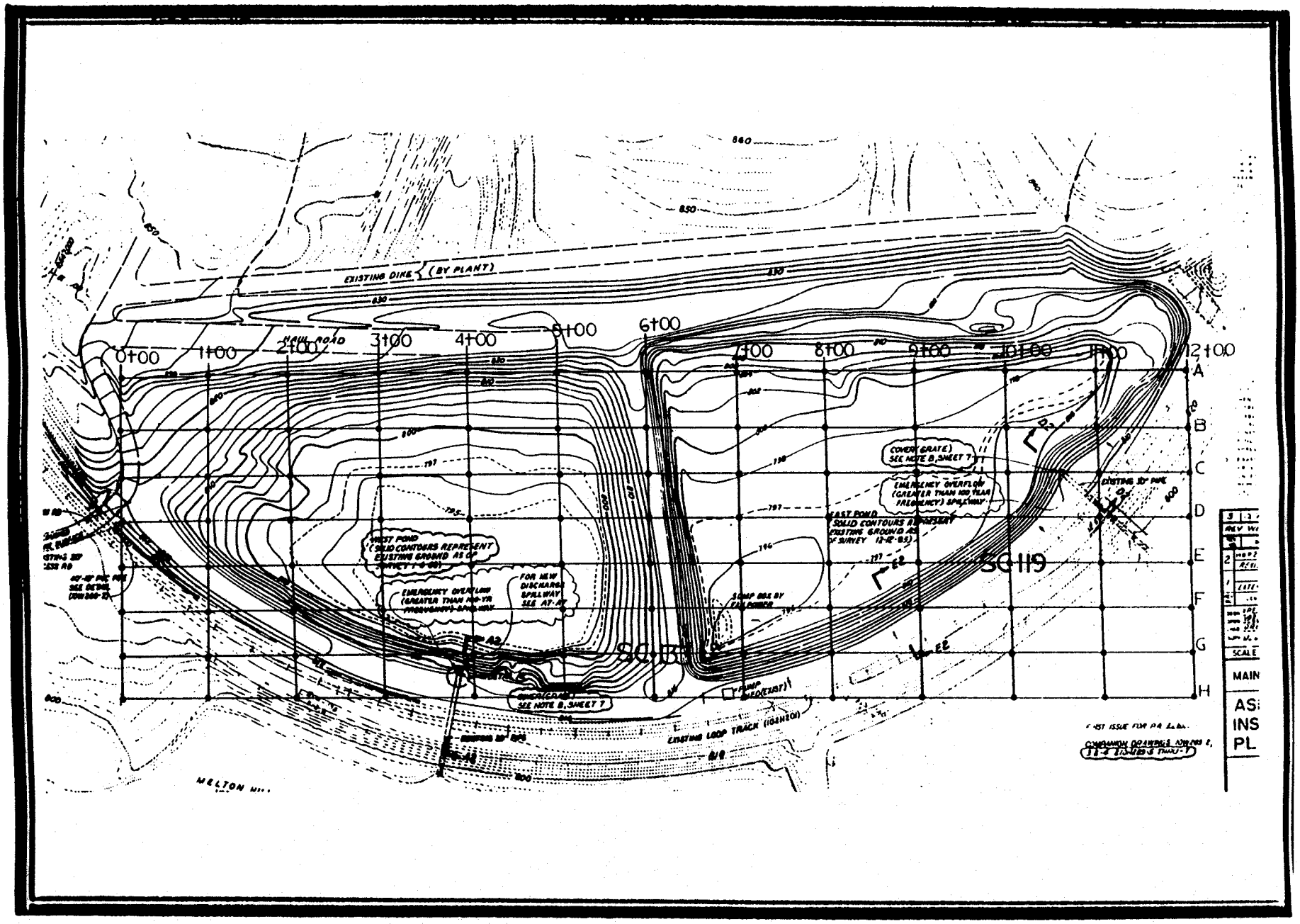

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

DAILY FIELD REPORT

Date: 10/23/95 Weather: Sunny

Location: East Ash Dike

==========

Observations: I departed Singleton Labs at 8:30 and arrived on site at 9:15. Jack Hilliard is also with me on site today. I met with Alan Myers to discuss area. Jack and I set up to survey East and West Ash dike for final topsoil elevation. We surveyed both East and West Ash dike. When we finished survey I met with Alan Myers to see if he had some equipment so we could push some more shelby tubes. He got operator to get track hoe to push tubes for us. We pushed 7 tubes in the East and West Ash dike for verifying clay depth and for permeability testing. We pushed tubes in the following stations E 2+00, E 3+00, D 9+00, B 6+00, B 11+00 E 7+00, C 5+00. I met with Alan Myers to discuss area. I departed site at 3:30 and arrived back at Lab at 4:15.

Inspector: Allen E. Luttrell

Bull Run S.P. Ash Disposal Area Ins. - Railroad Loop Test Location Plan

10-23-95

Singleton Laboratories

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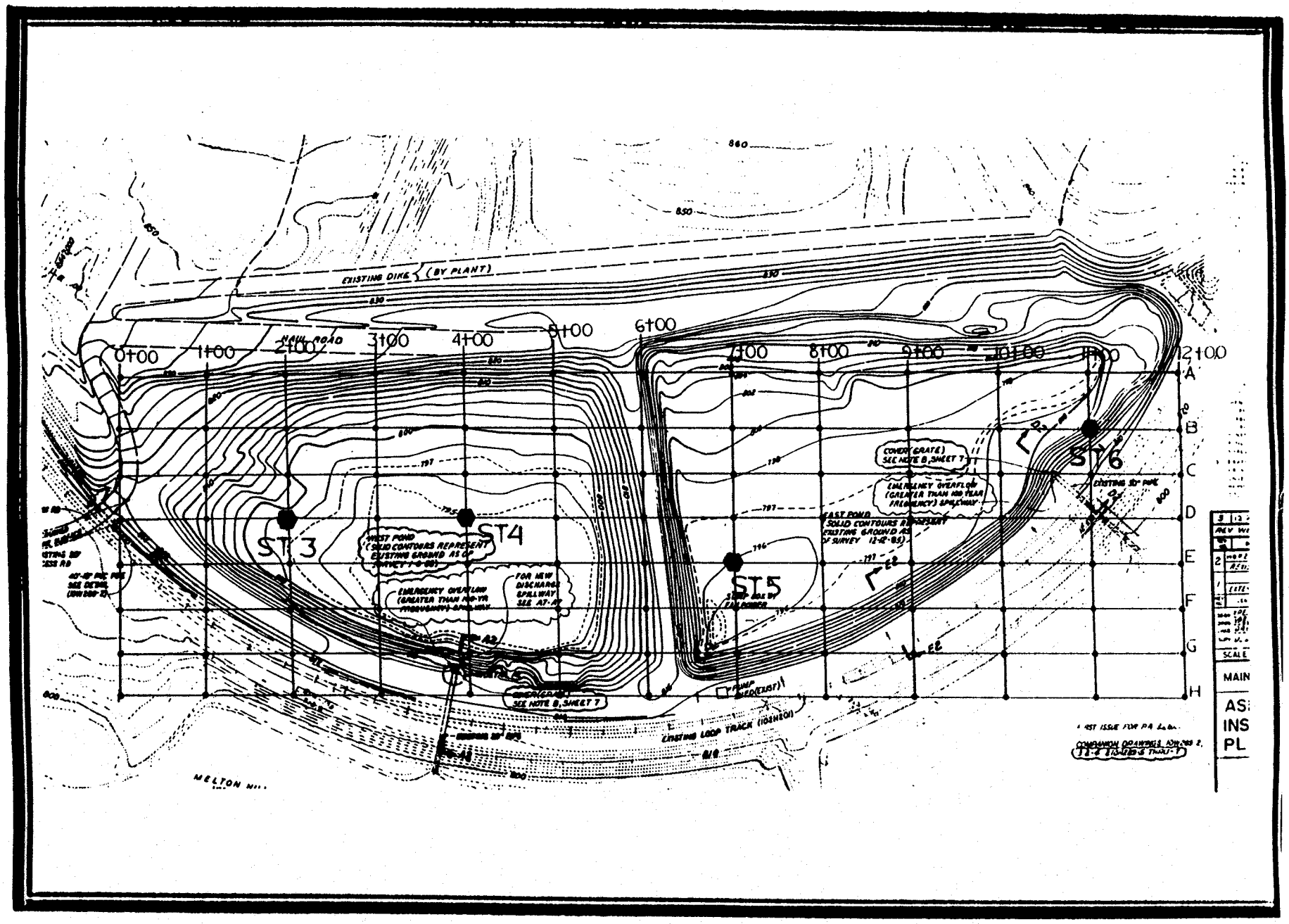

TVA BULL RUN FOSSIL PLANT
QA/QC TESTING OF ASH DISPOSAL AREA
INSIDE LOOP TRACK

Singleton Laboratories Report 209-078-001B

ATTACHMENT B

Laboratory Test Data for Permeability Verification

TABLE

BULL RUN STEAM PLANT
ASH DISPOSAL AREA

SUMMARY OF LABORATORY TEST DATA

Sample No.	Station	Range	Soil Symbol	Natural Moisture		Grain-Size Analysis					Atterberg Limits		Dry Density	% Compaction	Coefficient of Permeability	
				%	% Sat.	Gravel %	Sand %	Silt %	Clay %	D_{10} mm	Liquid Limit (%)	Plastic Index (%)	pcf		K_h cm/sec	K_v cm/sec
1	1+00	D-Line	CH			9	13	13	65	-	68	42				
2	3+00	B-Line	CH/MH			3	12	16	69	-	70	37				
3	1+00	B-Line	CH/MH			0	12	14	74	-	71	38				
4	4+00	C-Line	CH			0	3	23	74	-	78	45				
5	6+00	A-Line	CH			6	13	16	65	-	67	37				
ST-1	6+00	B-Line	CH	30.0		9	13	16	62	-	68	42	93.2	102.2		4.5×10^{-8}
ST-2	2+00	C-Line	CH	30.0		12	10	14	64	-	72	44	92.2	101		1.9×10^{-8}
ST-3	2+00	D-Line	MH	33.0		3	9	8	80	-	72	37	85.7	94.5		3.1×10^{-8}
ST-4	4+00	D-Line	MH	32.0		3	9	14	74	-	58	23	85.7	94.5		2.9×10^{-8}
ST-5	7+00	E-Line	CH	32.0		12	10	13	65	-	68	39	89.2	98.3		3.0×10^{-8}
ST-6	11+00	B-Line	MH/CH	30.0		12	4	6	78	-	64	31	92.9	101.9		3.0×10^{-8}

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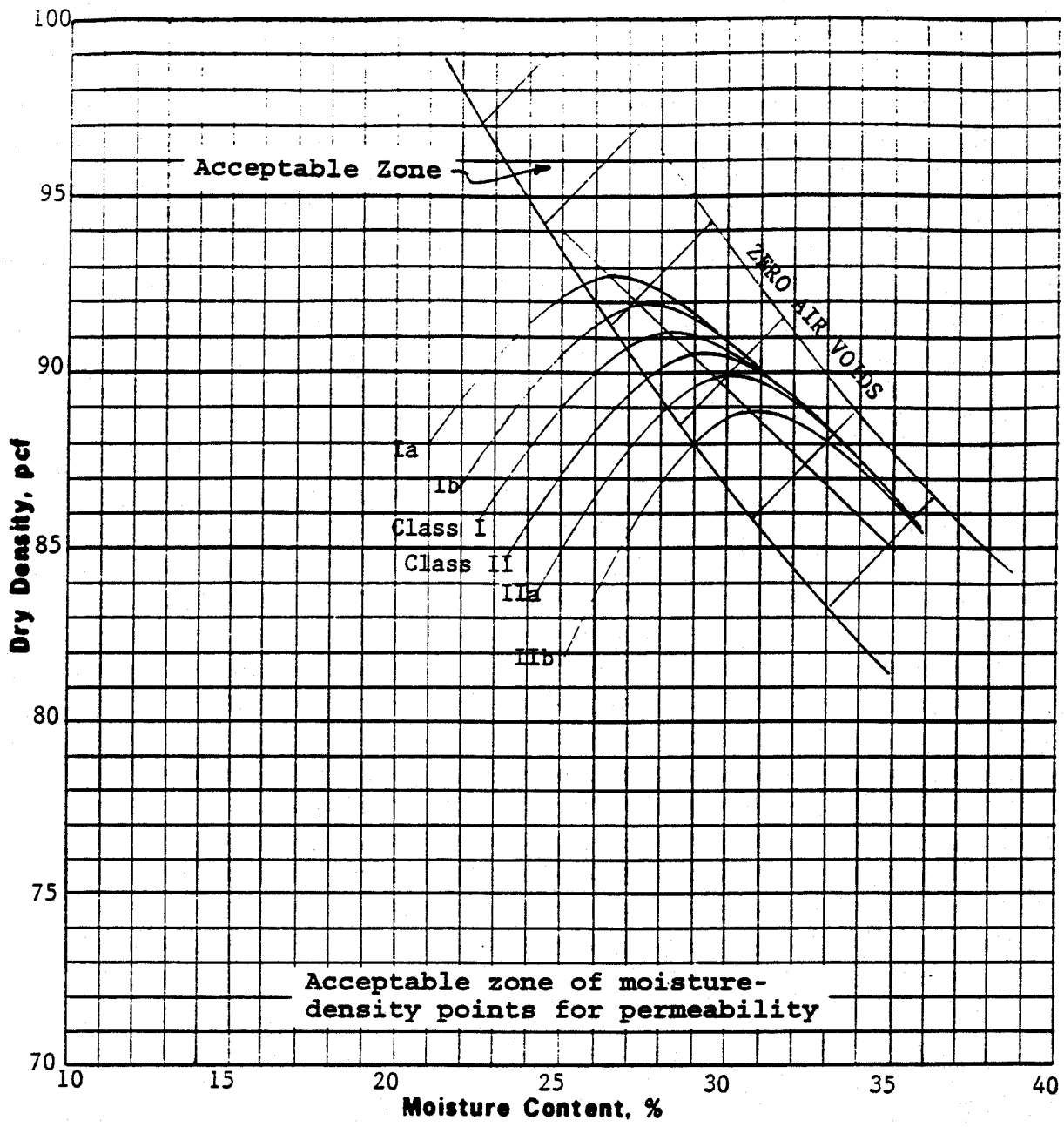


Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

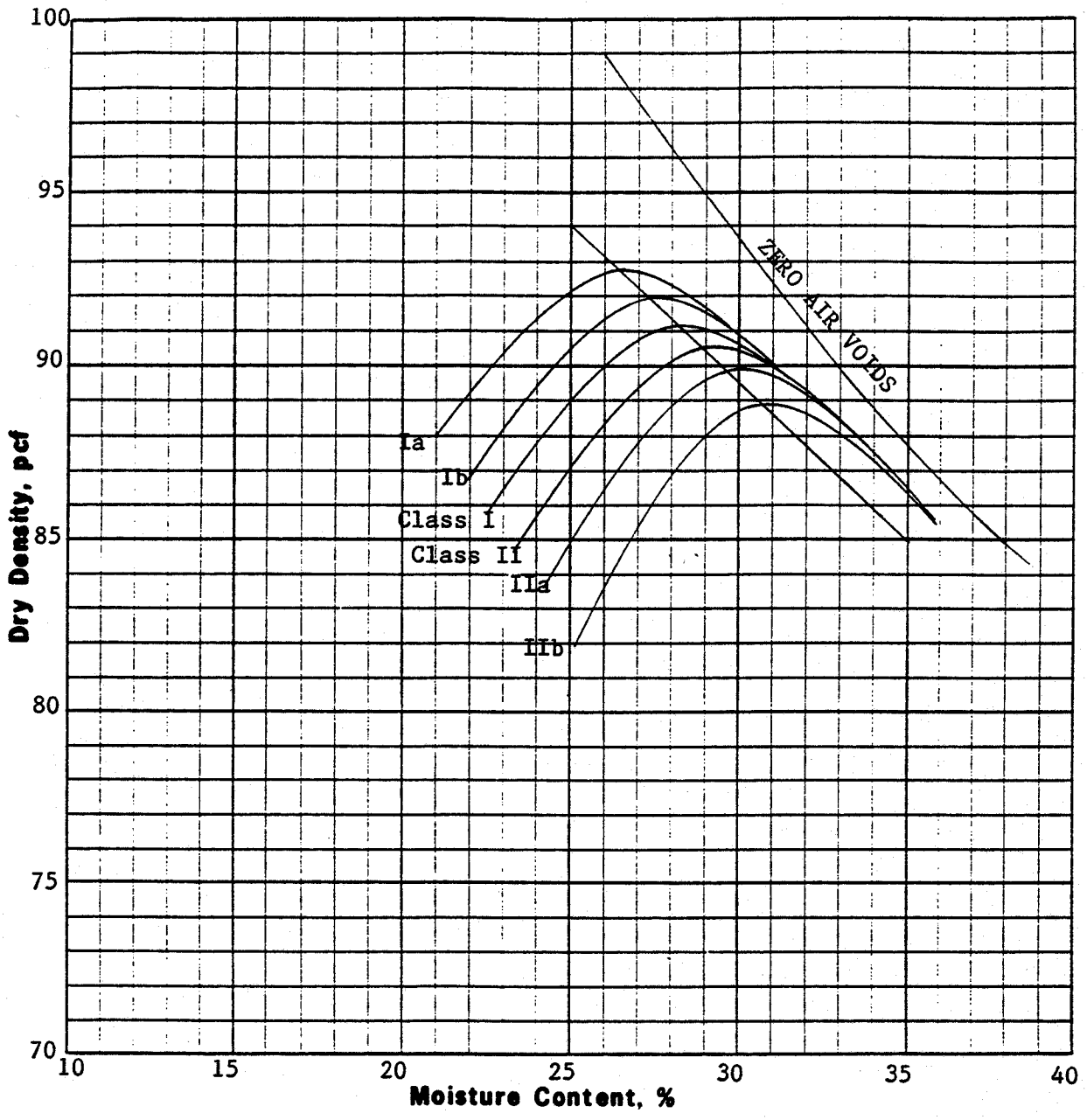
Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95

COMPACTION TEST (FAMILY OF CURVES)

Tested by: TAL Reviewed by:

SINGLETON LABORATORIES



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95

COMPACTION TEST (FAMILY OF CURVES)

Tested by: TAI Reviewed by: REG

*** PERMEABILITY ANALYSIS ***

PROJECT: Bull Run Steam Plant
FEATURE: Ash Disposal Area Upper Stack
TEST NO: ST-1

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	0.7134	0.3674	39.15	12.18	61200.0	165.60	156.56	0.000000069
2	14.0	0.7134	0.3674	39.15	12.18	28800.0	165.60	163.21	0.000000038
3	14.0	0.7134	0.3674	39.15	12.18	61200.0	165.60	162.51	0.000000023
4	14.0	0.7134	0.3674	39.15	12.18	21600.0	165.60	163.28	0.000000049
								Avg=	4.49435E-08

REMARKS:
STATION: 6+00 ELEVATION/DEPTH: 0.0'-1.0' RANGE: B-LINE

*** PERMEABILITY ANALYSIS ***

PROJECT: Bull Run Steam Plant
FEATURE: Ash Disposal Area Upper Stack
TEST NO: ST-2

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	0.7094	0.3860	39.30	14.02	61200.0	165.60	163.56	0.000000018
2	14.0	0.7094	0.3860	39.30	14.02	21600.0	165.60	164.48	0.000000028
3	14.0	0.7094	0.3860	39.30	14.02	75600.0	165.60	163.56	0.000000014
4	14.0	0.7094	0.3860	39.30	14.02	72000.0	165.60	163.72	0.000000014
								Avg=	1.87109E-08

REMARKS:
STATION: 2+00 ELEVATION/DEPTH: 0.0'-1.0' RANGE: C-LINE

*** PERMEABILITY ANALYSIS ***

PROJECT: Bull Run Steam Plant
FEATURE: Ash Disposal Area West Pond
TEST NO: ST-3

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	0.7174	0.3871	39.00	14.13	28800.0	165.60	163.35	0.000000043
2	14.0	0.7174	0.3871	39.30	14.13	61200.0	165.60	162.40	0.000000028
3	14.0	0.7174	0.3871	39.30	14.13	75600.0	165.60	162.03	0.000000026
4	14.0	0.7174	0.3871	39.30	14.13	72000.0	165.60	162.42	0.000000024
								Avg=	3.06207E-08

REMARKS:
STATION: 2+00 ELEVATION/DEPTH: 0.0'-1.0' RANGE: D-LINE

*** PERMEABILITY ANALYSIS ***

PROJECT: Bull Run Steam Plant
FEATURE: Ash Disposal Area West Pond
TEST NO: ST-4

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	19.8650	0.3040	39.58	13.92	90000.0	190.60	186.27	0.000000026
2	14.0	19.8650	0.3040	39.58	13.92	79200.0	190.10	186.61	0.000000024
3	14.0	19.8650	0.3040	39.58	13.92	82800.0	188.10	183.52	0.000000031
4	14.0	19.8650	0.3040	39.58	13.92	86400.0	187.80	182.67	0.000000033
								Avg=	2.91504E-08

REMARKS:
STATION: 4+00 ELEVATION/DEPTH: 0.0'-1.0' RANGE: D-LINE

*** PERMEABILITY ANALYSIS ***

PROJECT: Bull Run Steam Plant
FEATURE: Ash Disposal Area East Pond
TEST NO: ST-5

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	19.8650	0.3040	39.57	12.98	86400.0	191.60	186.50	0.000000030
2	14.0	19.8650	0.3040	39.57	12.98	82800.0	188.10	183.40	0.000000030
3	14.0	19.8650	0.3040	39.57	12.98	86400.0	187.80	183.00	0.000000029
4	14.0	19.8650	0.3040	39.57	12.98	97200.0	187.60	182.40	0.000000028
								Avg=	2.96286E-08

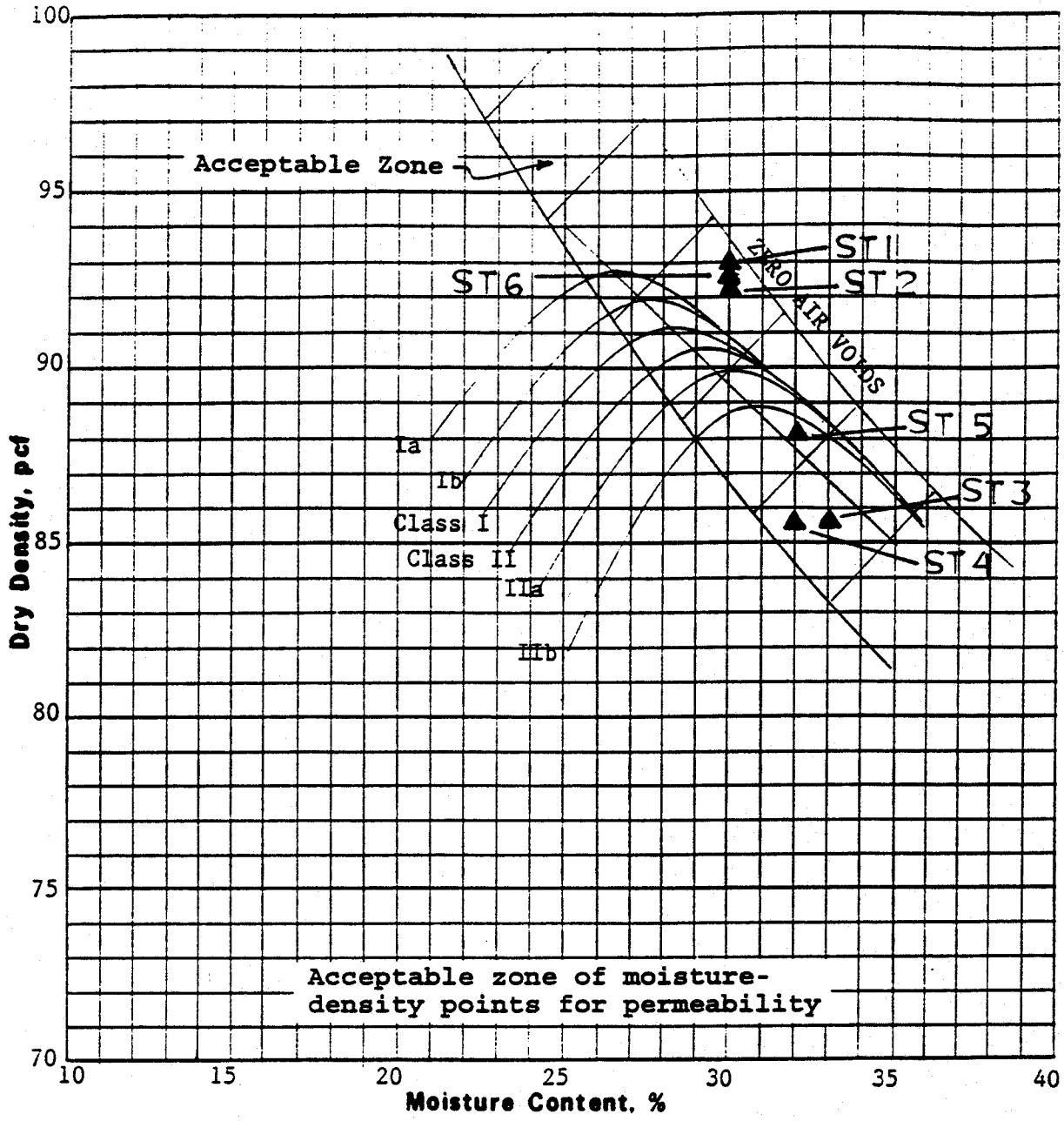
REMARKS:
STATION: 7+00 ELEVATION/DEPTH: 0.0'-1.0' RANGE: E-LINE

*** PERMEABILITY ANALYSIS ***

PROJECT: Bull Run Steam Plant
FEATURE: Ash Disposal Area East Pond
TEST NO: ST-6

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	FINAL CM	PERMEABILITY K CM/SEC
1	14.0	19.8650	0.3040	39.53	15.18	79200.0	190.10	186.30	0.000000029
2	14.0	19.8650	0.3040	39.53	15.18	82800.0	188.10	183.90	0.000000031
3	14.0	19.8650	0.3040	39.53	15.18	86400.0	187.80	183.60	0.000000030
4	14.0	19.8650	0.3040	39.53	15.18	97200.0	187.60	183.10	0.000000028
								Avg=	2.98802E-08

REMARKS:
STATION: 11+00 ELEVATION/DEPTH: 0.0'-1.0' RANGE: B-LINE



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

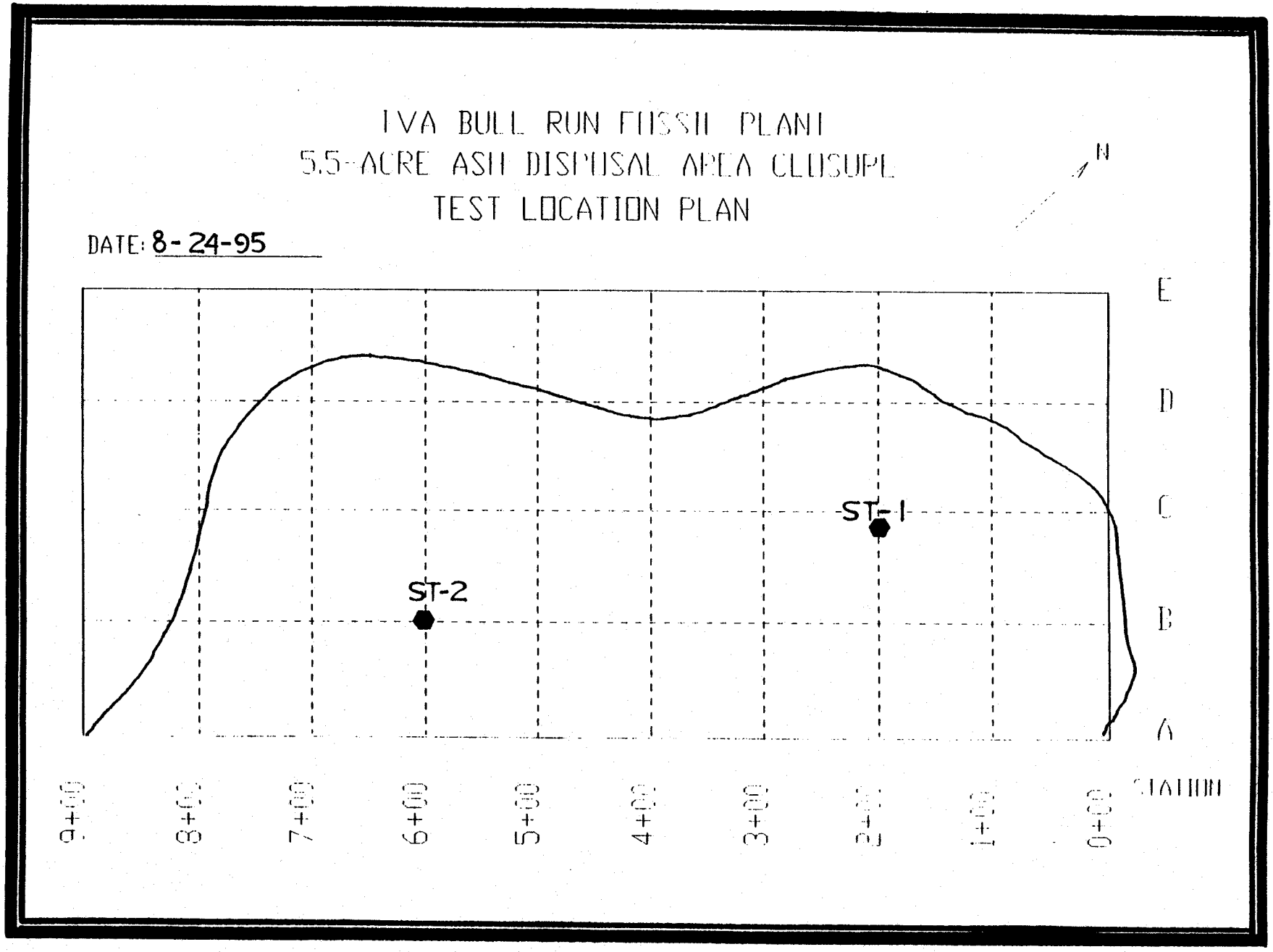
Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95
COMPACTION TEST (FAMILY OF CURVES)	

Tested by: TAL Reviewed by: [illegible]

Singleton Laboratories

The Critical Link.



Bull Run S.P. Ash Disposal Area Inside Railroad Loop Test Location Plan

10-23-95

Singleton Laboratories

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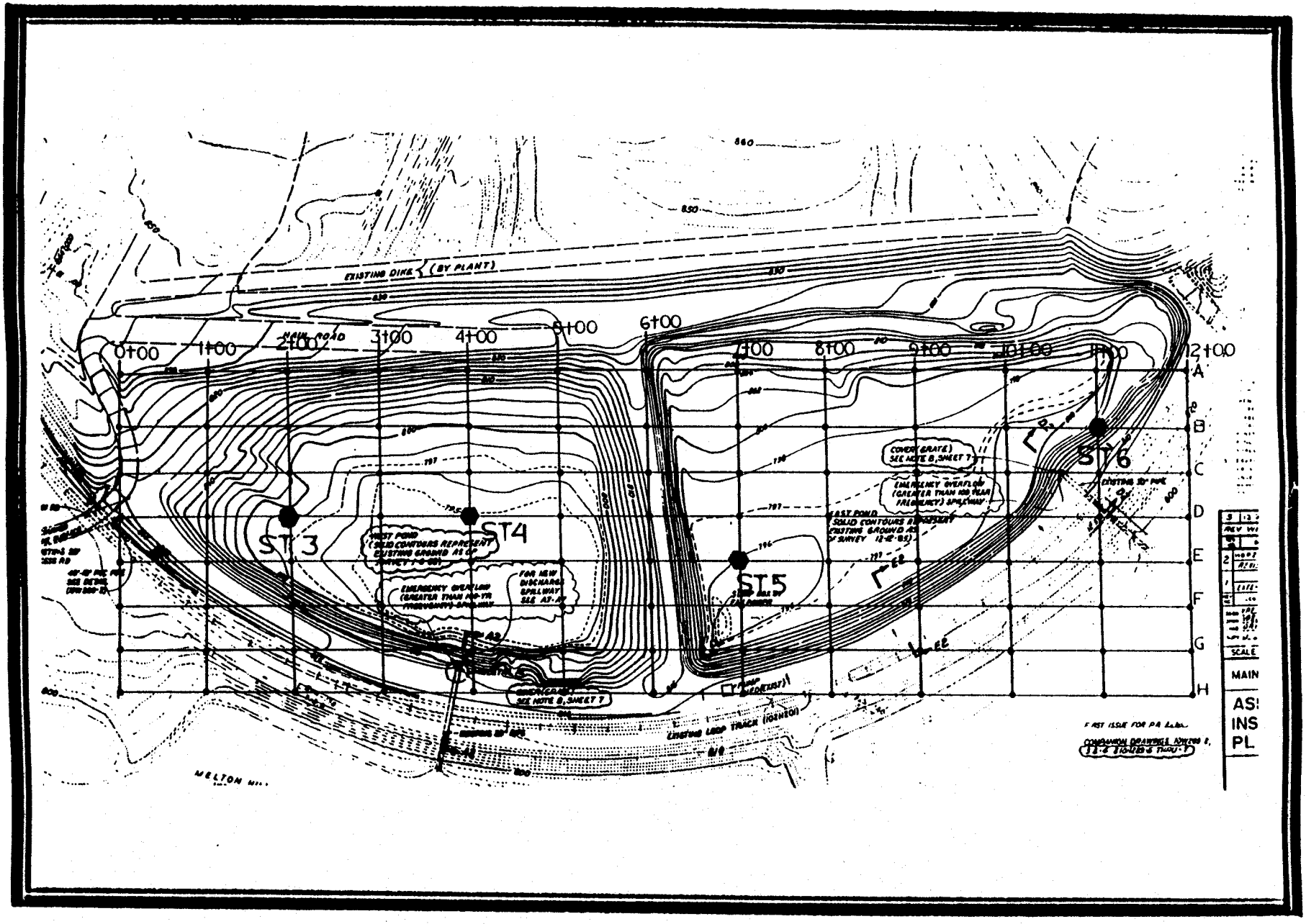
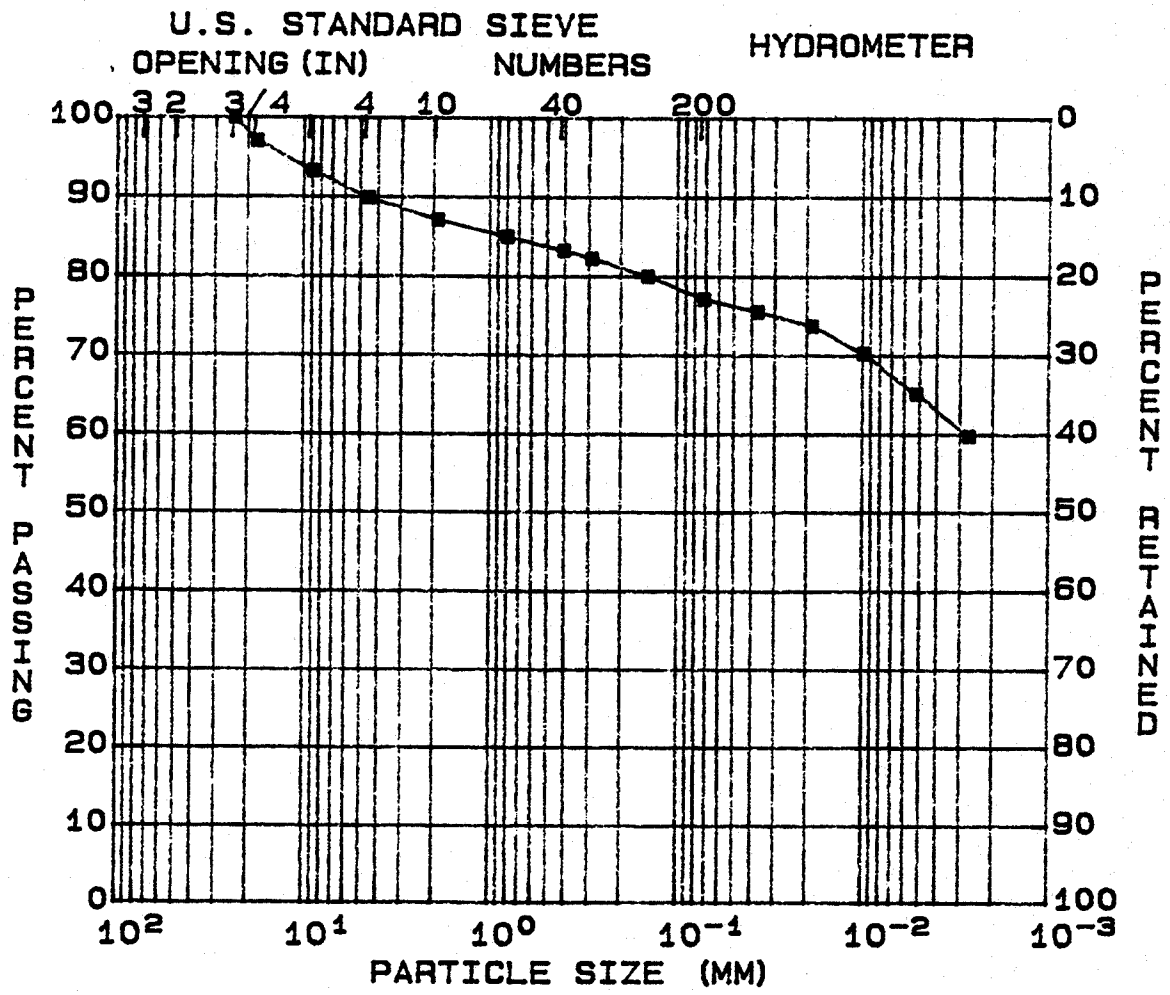


SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: Ash Disposal Area
STATION: 1+00
RANGE : D
PART :

BORING:
EL. : -0.0'
SAMPLE: 1
DATE : 10-12-95



GRAVEL (%)	= 9	D10 (MM)	= ---
SAND (%)	= 13	D30 (MM)	= ---
SILT (%)	= 13	D60 (MM)	= ---
CLAY (%)	= 65	COEF UNIF	= ---

SOIL SYMBOL	= CH	L.L. (%)	= 68	DENSITY (pcf)	= ---
MOISTURE (%)	= ---	P.I. (%)	= 42	SATURATION (%)	= ---
SP. GR.	= 2.65			VOID RATIO	= ---

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: Ash Disposal Area
Station: 1+00
Range : D
Boring :

El. : -0.0'
Sample: 1
Part :

FILE : 529
TESTED BY : TAL
Computed By:TRB
Checked By : REG
Report Date:10-12-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 625.90 Tare Wt(gm) = 95.50

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 67.60 Dry Wt.+Tare(gm)= 66.80
Tare Wt(gm) = 38.20 Moisture(%) = 2.80

Liquid Limit
Blows = 26.00
Wet Wt.(gm) = 17.30
Dry Wt.(gm) = 11.80
Tare Wt.(gm) = 3.70
Liquid Limit(%) = 68.22
Plasticity Index= 41.73

Plastic Limit
Wet Wt.(gm) = 16.30
Dry Wt.(gm) = 13.73
Tare Wt.(gm) = 4.03
Plastic Limit(%)= 26.49

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 530.4

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	10.3	98.1	19.0500
3/8 in.	30.7	94.2	9.5300
NO.4	49.2	90.7	4.7500
NO.10	63.9	88.0	2.0000
NO.20	1.2	85.8	0.8500
NO.40	2.2	84.0	0.4250
NO.50	2.8	82.9	0.3000
NO.100	4.1	80.5	0.1500
NO.200	5.7	77.6	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 48.64

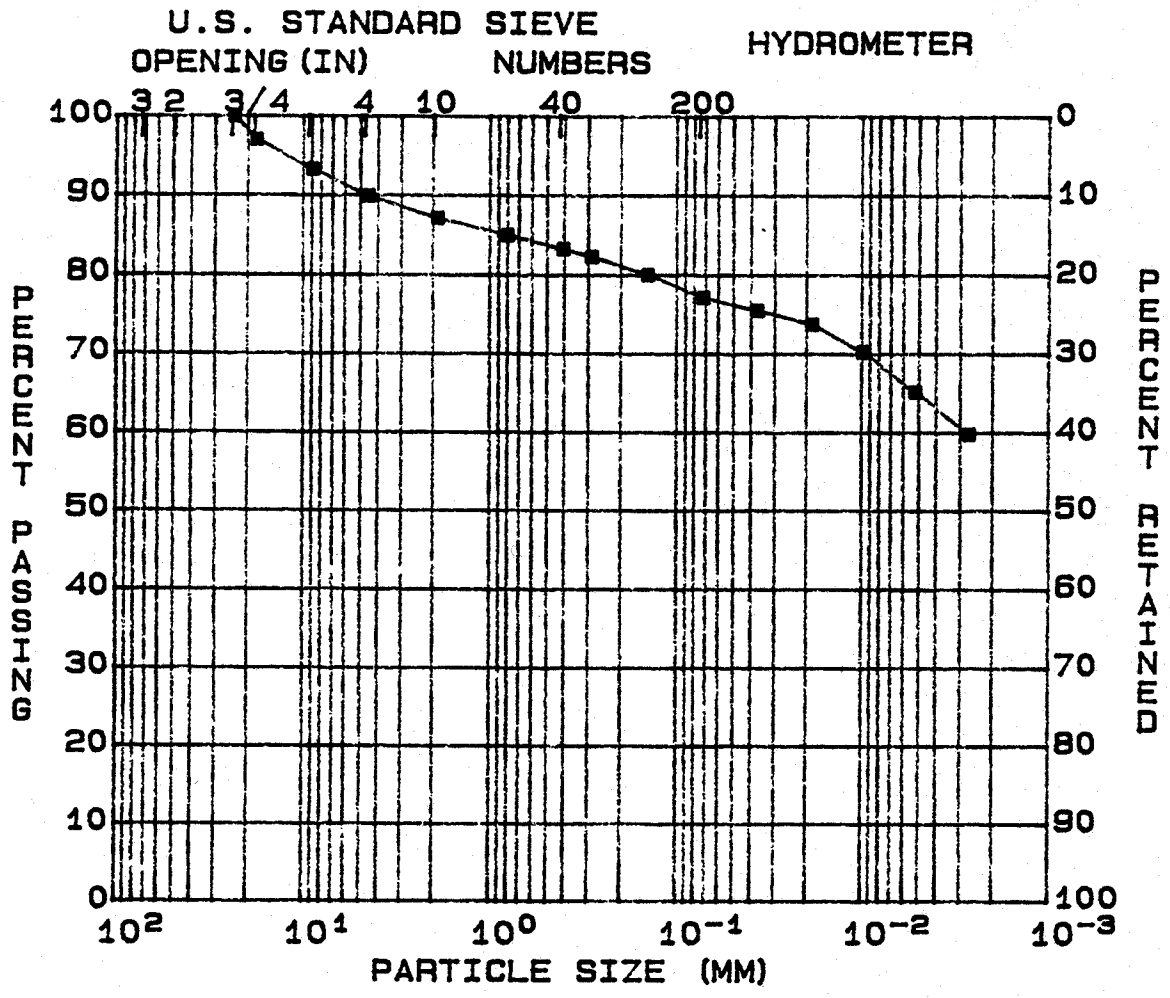
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	20.2	50.0	8.0	75.9	0.0383
4 min.	20.2	49.0	8.0	74.1	0.0193
15 min.	20.2	47.0	8.0	70.5	0.0102
1 hour	20.3	44.0	7.9	65.3	0.0052
4 hours	20.3	41.0	7.9	59.9	0.0027

Soil Symbol= CH (Inorganic clay of high plasticity)
Gravel(%)= 9 Sand(%)=13 Silt(%)= 13 Clay(%)= 65

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: Ash Disposal Area
STATION: 1+00
RANGE : D
PART :

BORING:
EL. : -0.0'
SAMPLE: 1
DATE : 10-12-95



GRAVEL (%)	= 9	D10 (MM)	= --
SAND (%)	= 13	D30 (MM)	= --
SILT (%)	= 13	D60 (MM)	= --
CLAY (%)	= 65	COEF UNIF	= --

SOIL SYMBOL	= CH	L.L. (%)	= 68	DENSITY (pcf)	= --
MOISTURE (%)	= --	P.I. (%)	= 42	SATURATION (%)	= --
SP. GR.	= 2.65			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: Ash Disposal Area
Station: 1+00
Range : D
Boring :

El. : -0.0'
Sample: 1
Part :

FILE : 530
TESTED BY : TAL
Computed By:TRB
Checked By : KEG
Report Date:10-12-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 625.90 Tare Wt(gm) = 95.50
Hygroscopic Moisture
Wet Wt.+Tare(gm)= 67.60 Dry Wt.+Tare(gm)= 66.80
Tare Wt(gm) = 38.20 Moisture(%) = 2.80

Liquid Limit
Blows = 26.00
Wet Wt.(gm) = 21.32
Dry Wt.(gm) = 14.21
Tare Wt.(gm) = 3.77
Liquid Limit(%) = 68.42
Plasticity Index= 41.93

Plastic Limit
Wet Wt.(gm) = 16.30
Dry Wt.(gm) = 13.73
Tare Wt.(gm) = 4.03
Plastic Limit(%)= 26.49

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 530.4

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	10.3	98.1	19.0500
3/8 in.	30.7	94.2	9.5300
NO.4	49.2	90.7	4.7500
NO.10	63.9	88.0	2.0000
NO.20	1.2	85.8	0.8500
NO.40	2.2	84.0	0.4250
NO.50	2.8	82.9	0.3000
NO.100	4.1	80.5	0.1500
NO.200	5.7	77.6	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 48.64

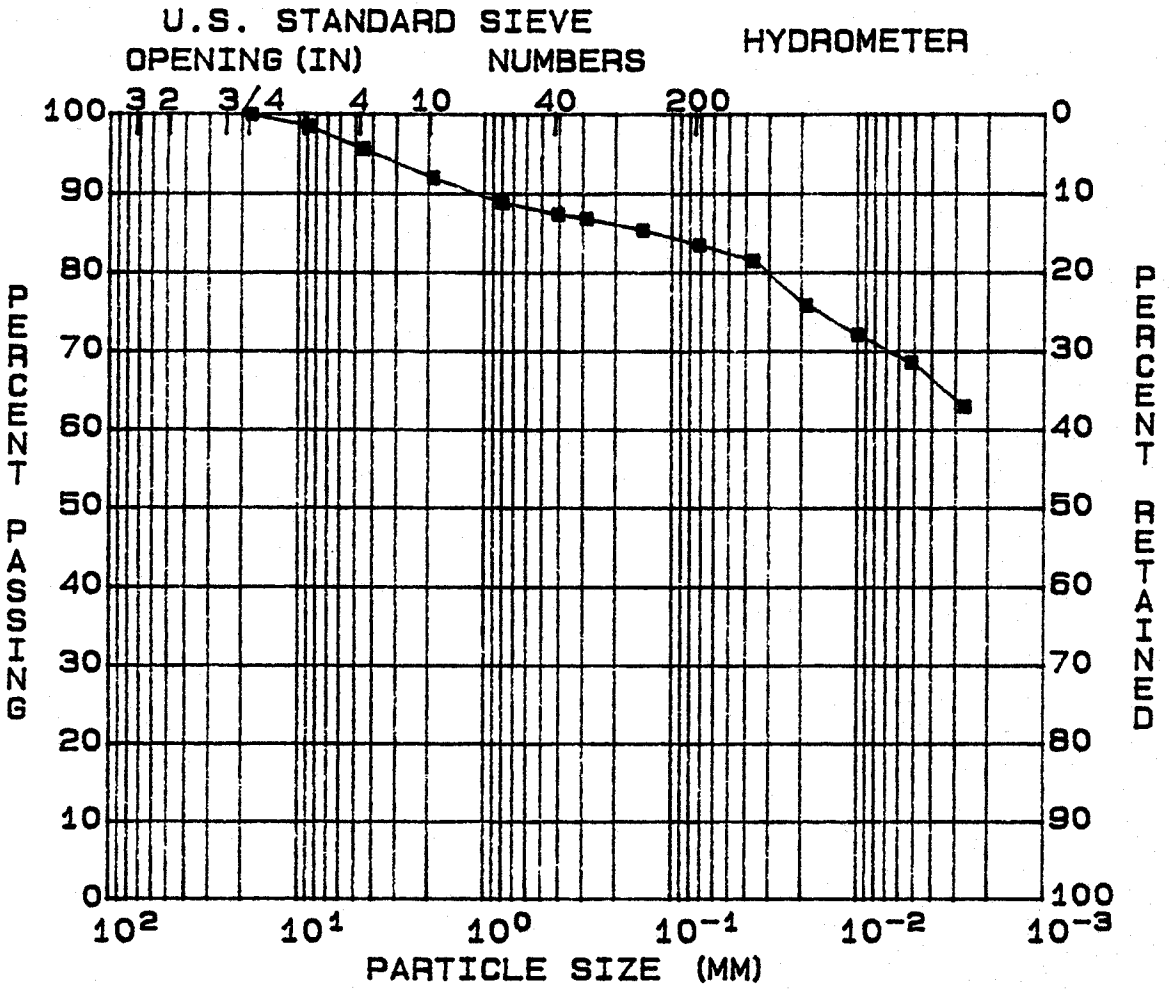
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	20.2	50.0	8.0	75.9	0.0383
4 min.	20.2	49.0	8.0	74.1	0.0193
15 min.	20.2	47.0	8.0	70.5	0.0102
1 hour	20.3	44.0	7.9	65.3	0.0052
4 hours	20.3	41.0	7.9	59.9	0.0027

Soil Symbol= CH (Inorganic clay of high plasticity)
Gravel(%)= 9 Sand(%)=13 Silt(%)= 13 Clay(%)= 65

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: Ash Disposal Area
STATION: 3+00
RANGE : B
PART :

BORING:
EL. : -0.0'
SAMPLE: 2
DATE : 10-12-95



GRAVEL (%)	= 3	D10 (MM)	= --
SAND (%)	= 12	D30 (MM)	= --
SILT (%)	= 16	D60 (MM)	= --
CLAY (%)	= 69	COEF UNIF	= --

SOIL SYMBOL	= CH/MH	L.L. (%)	= 70	DENSITY (pcf)	= --
MOISTURE (%)	= --	P.I. (%)	= 37	SATURATION (%)	= --
SP. GR.	= 2.65			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: Ash Disposal Area
Station: 3+00
Range : B
Boring :

El. : -0.0'
Sample: 2
Part :

FILE : 523
TESTED BY : TAL
Computed By:TRB
Checked By : RLG
Report Date:10-12-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 639.20 Tare Wt(gm) = 96.70
Hygroscopic Moisture
Wet Wt.+Tare(gm)= 80.30 Dry Wt.+Tare(gm)= 79.20
Tare Wt(gm) = 37.80 Moisture(%) = 2.66

Liquid Limit
Blows = 27.00
Wet Wt.(gm) = 23.31
Dry Wt.(gm) = 15.31
Tare Wt.(gm) = 3.79
Liquid Limit(%) = 70.09
Plasticity Index= 37.28

Plastic Limit
Wet Wt.(gm) = 14.88
Dry Wt.(gm) = 12.18
Tare Wt.(gm) = 3.95
Plastic Limit(%)= 32.81

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 542.5

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	2.8	99.5	9.5300
NO.4	18.4	96.6	4.7500
NO.10	38.6	92.9	2.0000
NO.20	1.7	89.6	0.8500
NO.40	2.5	88.1	0.4250
NO.50	2.8	87.5	0.3000
NO.100	3.6	86.0	0.1500
NO.200	4.6	84.1	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 48.71

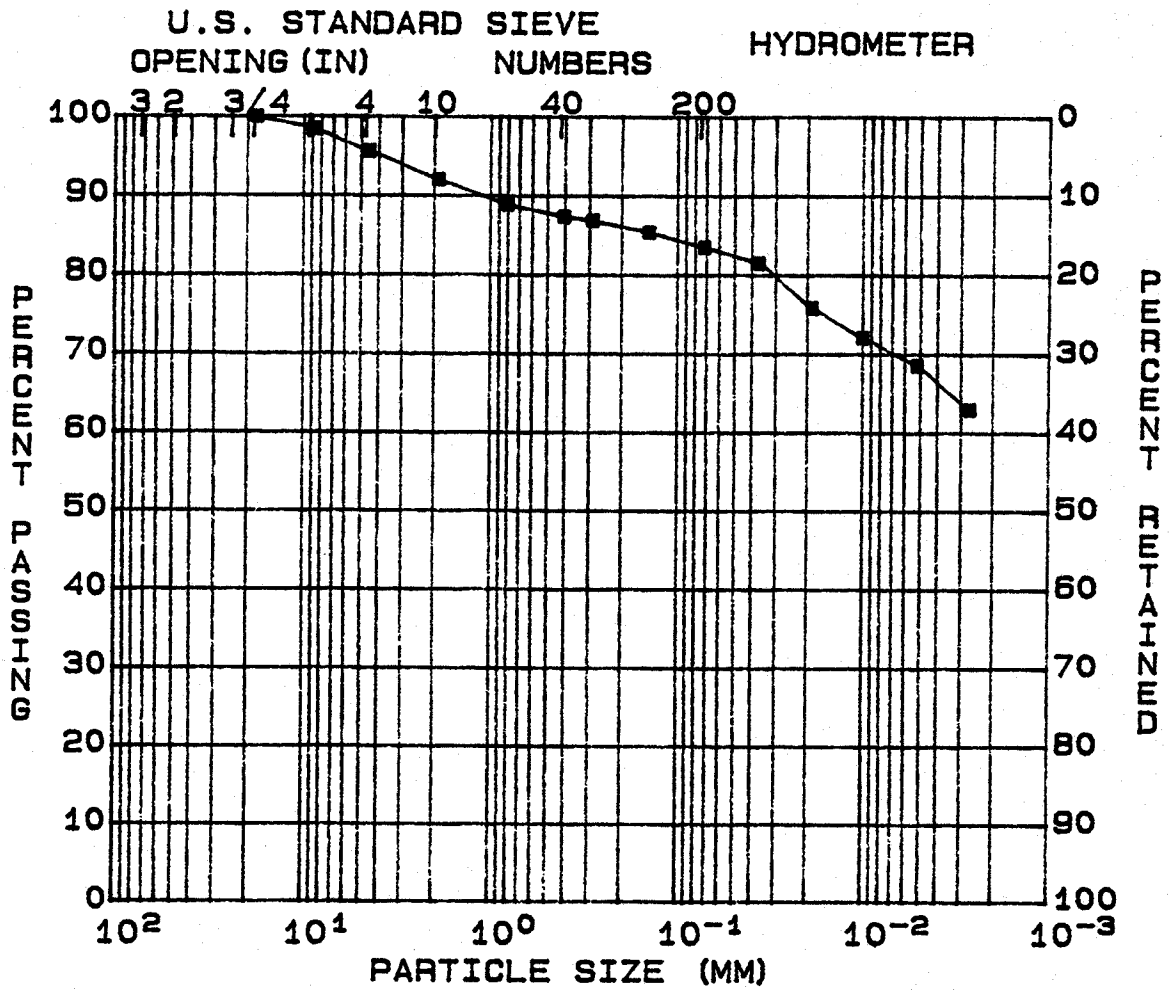
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	20.2	51.0	8.0	82.0	0.0379
4 min.	20.2	48.0	8.0	76.3	0.0195
15 min.	20.2	46.0	8.0	72.5	0.0103
1 hour	20.3	44.0	7.9	68.8	0.0052
4 hours	20.3	41.0	7.9	63.1	0.0027

Soil Symbol= CH/MH (Inorganic clayey silt of high plasticity)
Gravel(%)= 3 Sand(%)=12 Silt(%)= 16 Clay(%)= 69

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: Ash Disposal Area
STATION: 3+00
RANGE : B
PART :

BORING:
EL. : -0.0'
SAMPLE: 2
DATE : 10-12-95



GRAVEL (%)	= 3	D10 (MM)	= --
SAND (%)	= 12	D30 (MM)	= --
SILT (%)	= 16	D60 (MM)	= --
CLAY (%)	= 69	COEF UNIF	= --

SOIL SYMBOL	= CH/MH	L.L. (%)	= 70	DENSITY (pcf)	= --
MOISTURE (%)	= --	P.I. (%)	= 38	SATURATION (%)	= --
SP. GR.	= 2.65			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P. FILE : 524
Feature: Ash Disposal Area TESTED BY : TAL
Station: 3+00 El. : -0.0' Computed By:TRB
Range : B Sample: 2 Checked By : [illegible]
Boring : Part : Report Date:10-12-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 639.20 Tare Wt(gm) = 96.70
Hygroscopic Moisture
Wet Wt.+Tare(gm)= 80.30 Dry Wt.+Tare(gm)= 79.20
Tare Wt(gm) = 37.80 Moisture(%) = 2.66
Liquid Limit Plastic Limit
Blows = 27.00 Wet Wt.(gm) = 14.88
Wet Wt.(gm) = 23.06 Dry Wt.(gm) = 12.18
Dry Wt.(gm) = 15.16 Tare Wt.(gm) = 3.95
Tare Wt.(gm) = 3.82
Liquid Limit(%) = 70.31 Plastic Limit(%)= 32.81
Plasticity Index= 37.50

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 542.5

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	2.8	99.5	9.5300
NO.4	18.4	96.6	4.7500
NO.10	38.6	92.9	2.0000
NO.20	1.7	89.6	0.8500
NO.40	2.5	88.1	0.4250
NO.50	2.8	87.5	0.3000
NO.100	3.6	86.0	0.1500
NO.200	4.6	84.1	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 48.71

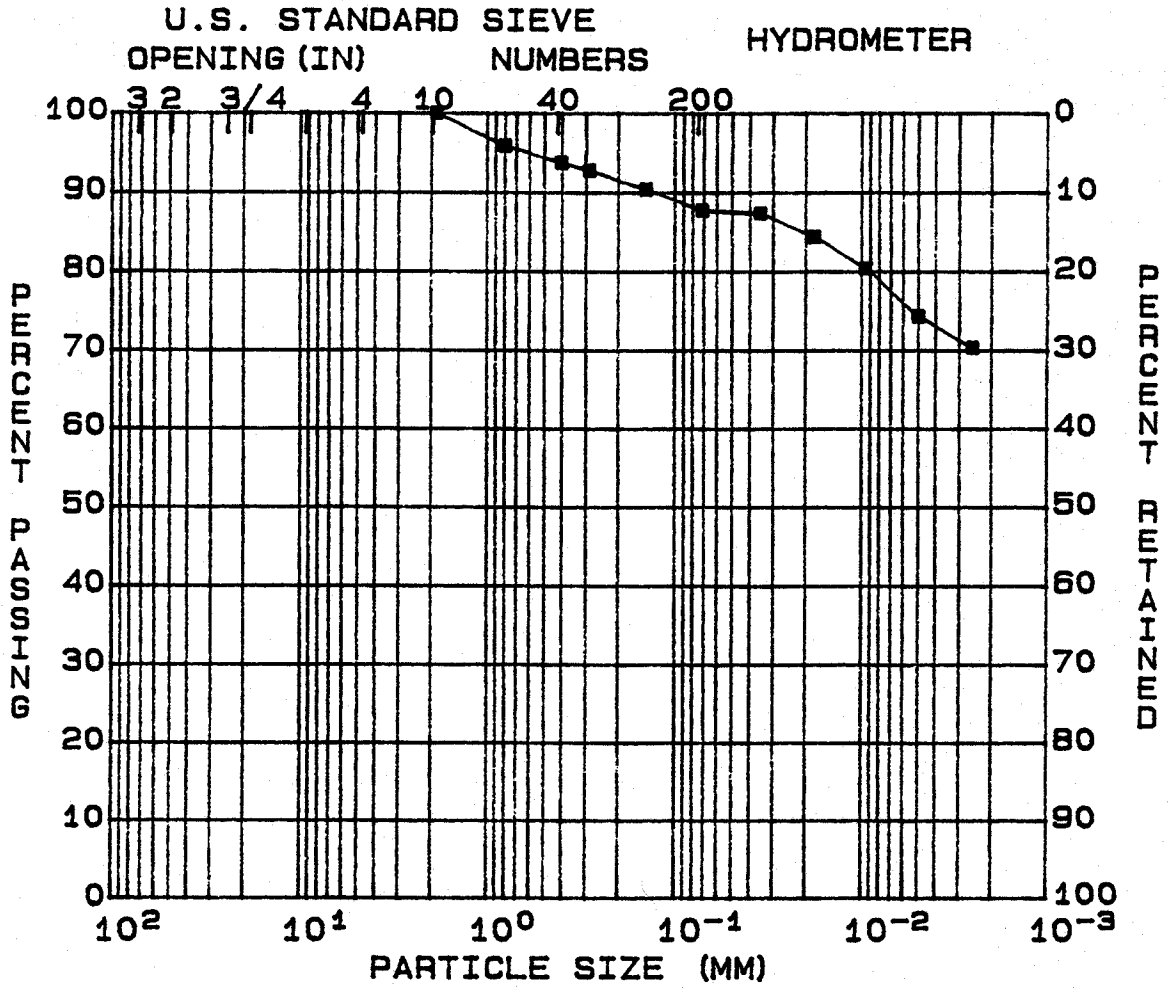
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	20.2	51.0	8.0	82.0	0.0379
4 min.	20.2	48.0	8.0	76.3	0.0195
15 min.	20.2	46.0	8.0	72.5	0.0103
1 hour	20.3	44.0	7.9	68.8	0.0052
4 hours	20.3	41.0	7.9	63.1	0.0027

Soil Symbol= CH/MH (Inorganic clayey silt of high plasticity)
Gravel(%)= 3 Sand(%)=12 Silt(%)= 16 Clay(%)= 69

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: West Ash Dike
STATION: 1+00
RANGE : B-Line
PART :

BORING:
EL. :
SAMPLE: 3
DATE : 10-11-95



GRAVEL (%)	= 0	D10 (MM)	= --
SAND (%)	= 12	D30 (MM)	= --
SILT (%)	= 14	D60 (MM)	= --
CLAY (%)	= 74	COEF UNIF	= --

SOIL SYMBOL	= CH/MH	L.L. (%)	= 71	DENSITY (pcf)	= --
MOISTURE (%)	= --	P.I. (%)	= 38	SATURATION (%)	= --
SP. GR.	= 2.65			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: West Ash Dike
Station: 1+00
Range : B-line
Boring :

El. :
Sample: 3
Part :

FILE : 519
TESTED BY : REG
Computed By:TRB
Checked By : TAL
Report Date:10-11-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 0.00 Tare Wt(gm) = 0.00
Hygroscopic Moisture
Wet Wt.+Tare(gm)= 119.40 Dry Wt.+Tare(gm)= 117.80
Tare Wt(gm) = 38.80 Moisture(%) = 2.03

Liquid Limit
Blows = 24.00
Wet Wt.(gm) = 24.03
Dry Wt.(gm) = 15.74
Tare Wt.(gm) = 4.06
Liquid Limit(%) = 70.63
Plasticity Index= 37.84

Plastic Limit
Wet Wt.(gm) = 14.00
Dry Wt.(gm) = 11.57
Tare Wt.(gm) = 4.16
Plastic Limit(%)= 32.79

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 0

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	15.6	100.0	9.5300
NO.4	28.0	100.0	4.7500
NO.10	45.2	100.0	2.0000
NO.20	1.7	96.5	0.8500
NO.40	2.8	94.3	0.4250
NO.50	3.3	93.3	0.3000
NO.100	4.5	90.8	0.1500
NO.200	5.8	88.2	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 49.01

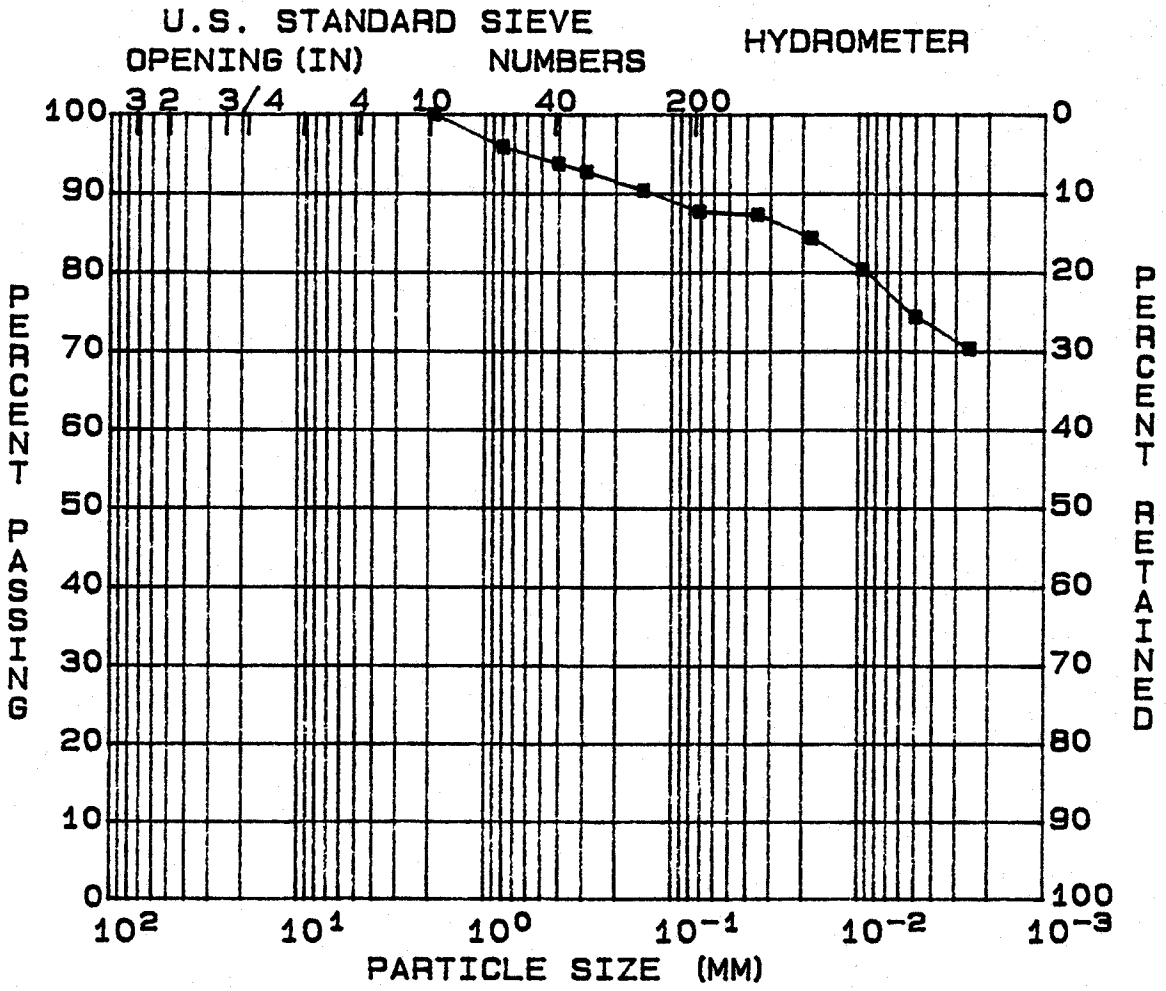
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	23.0	51.0	8.0	87.7	0.0367
4 min.	23.0	49.5	8.0	84.7	0.0186
15 min.	23.0	47.5	8.0	80.6	0.0098
1 hour	23.0	44.5	8.0	74.5	0.0050
4 hours	23.0	42.5	8.0	70.4	0.0026

Soil Symbol= CH/MH (Inorganic clayey silt of high plasticity)
Gravel(%)= 0 Sand(%)=12 Silt(%)= 14 Clay(%)= 74

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: West Ash Dike
STATION: 1+00
RANGE : B-Line
PART :

BORING:
EL. :
SAMPLE: 3
DATE : 10-11-95



GRAVEL (%)	= 0	D10 (MM)	= --
SAND (%)	= 12	D30 (MM)	= --
SILT (%)	= 14	D60 (MM)	= --
CLAY (%)	= 74	COEF UNIF	= --

SOIL SYMBOL	= CH	L.L. (%)	= 71	DENSITY (pcf)	= --
MOISTURE (%)	= --	P.I. (%)	= 38	SATURATION (%)	= --
SP. GR.	= 2.65			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: West Ash Dike
Station: 1+00
Range : B-Line
Boring :

El. :
Sample: 3
Part :

FILE : 520
TESTED BY : REG
Computed By:TRB
Checked By : TAL
Report Date:10-11-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 0.00 Tare Wt(gm) = 0.00

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 119.40 Dry Wt.+Tare(gm)= 117.80
Tare Wt(gm) = 38.80 Moisture(%) = 2.03

Liquid Limit
Blows = 26.00
Wet Wt.(gm) = 23.04
Dry Wt.(gm) = 15.19
Tare Wt.(gm) = 4.10
Liquid Limit(%) = 71.12
Plasticity Index= 38.32

Plastic Limit
Wet Wt.(gm) = 14.00
Dry Wt.(gm) = 11.57
Tare Wt.(gm) = 4.16
Plastic Limit(%)= 32.79

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 0

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	15.6	100.0	9.5300
NO.4	28.0	100.0	4.7500
NO.10	45.2	100.0	2.0000
NO.20	1.7	96.5	0.8500
NO.40	2.8	94.3	0.4250
NO.50	3.3	93.3	0.3000
NO.100	4.5	90.8	0.1500
NO.200	5.8	88.2	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 49.01

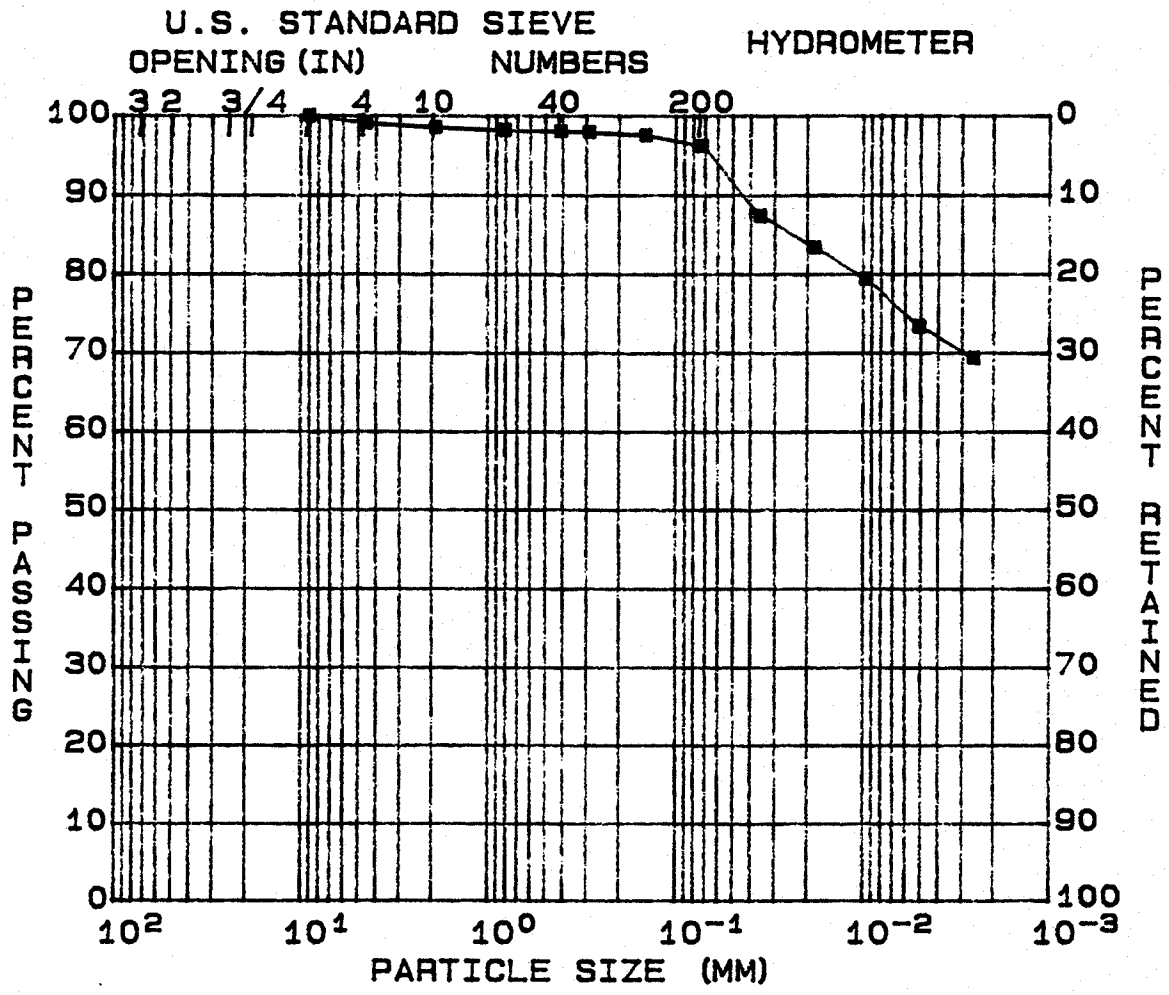
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	23.0	51.0	8.0	87.7	0.0367
4 min.	23.0	49.5	8.0	84.7	0.0186
15 min.	23.0	47.5	8.0	80.6	0.0098
1 hour	23.0	44.5	8.0	74.5	0.0050
4 hours	23.0	42.5	8.0	70.4	0.0026

Soil Symbol= CH (Inorganic clay of high plasticity)
Gravel(%)= 0 Sand(%)=12 Silt(%)= 14 Clay(%)= 74

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: West Ash Dike
STATION: 4+00
RANGE : C-Line
PART :

BORING:
EL. :
SAMPLE: 4
DATE : 10-19-95



GRAVEL (%)	= 0	D10 (MM)	= ---
SAND (%)	= 3	D30 (MM)	= ---
SILT (%)	= 23	D60 (MM)	= ---
CLAY (%)	= 74	COEF UNIF	= ---

SOIL SYMBOL= CH	L.L. (%) = 78	DENSITY (pcf) = ---
MOISTURE (%) = ---	P.I. (%) = 45	SATURATION (%) = ---
SP. GR. = 2.65		VOID RATIO = ---

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: West Ash Dike
Station: 4+00
Range : C-Line
Boring :

El. :
Sample: 4
Part :

FILE : 569
TESTED BY : REG
Computed By:TRB
Checked By : TAL
Report Date:10-19-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 475.20 Tare Wt(gm) = 102.70

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 125.70 Dry Wt.+Tare(gm)= 123.30
Tare Wt(gm) = 39.70 Moisture(%) = 2.87

Liquid Limit
Blows = 27.00
Wet Wt.(gm) = 20.21
Dry Wt.(gm) = 13.10
Tare Wt.(gm) = 3.92
Liquid Limit(%) = 78.17
Plasticity Index= 45.42

Plastic Limit
Wet Wt.(gm) = 13.99
Dry Wt.(gm) = 11.54
Tare Wt.(gm) = 4.06
Plastic Limit(%)= 32.75

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 372.5

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	0.0	100.0	9.5300
NO.4	1.0	99.7	4.7500
NO.10	3.0	99.2	2.0000
NO.20	0.2	98.8	0.8500
NO.40	0.3	98.6	0.4250
NO.50	0.4	98.4	0.3000
NO.100	0.6	98.0	0.1500
NO.200	1.3	96.5	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 48.60

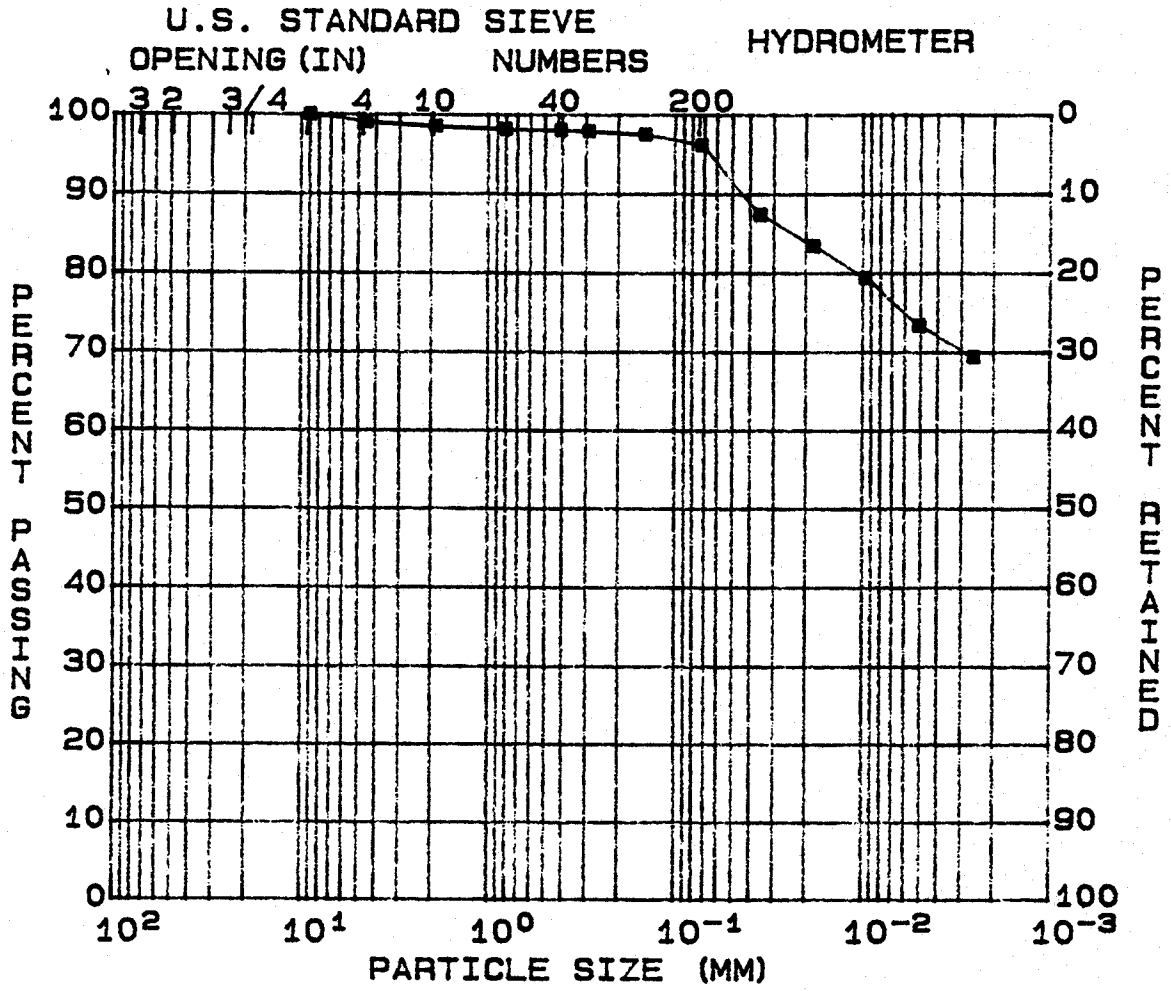
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	23.0	51.0	8.0	87.8	0.0367
4 min.	23.0	49.0	8.0	83.7	0.0187
15 min.	23.0	47.0	8.0	79.6	0.0099
1 hour	23.0	44.0	8.0	73.5	0.0051
4 hours	23.0	42.0	8.0	69.4	0.0026

Soil Symbol= CH (Inorganic clay of high plasticity)
Gravel(%)= 0 Sand(%)= 3 Silt(%)= 23 Clay(%)= 74

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: West Ash Dike
STATION: 4+00
RANGE : C-Line
PART :

BORING:
EL. :
SAMPLE: 4
DATE : 10-19-95



GRAVEL (%)	= 0	D10 (MM)	= --
SAND (%)	= 3	D30 (MM)	= --
SILT (%)	= 23	D60 (MM)	= --
CLAY (%)	= 74	COEF UNIF	= --

SOIL SYMBOL	= CH	L.L. (%)	= 78	DENSITY (pcf)	= --
MOISTURE (%)	= --	P.I. (%)	= 45	SATURATION (%)	= --
SP. GR.	= 2.65			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: West Ash Dike
Station: 4+00
Range : C-Line
Boring :
El. :
Sample: 4
Part :
FILE : 570
TESTED BY : REG
Computed By:TRB
Checked By : TAC
Report Date:10-19-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 475.20
Tare Wt(gm) = 102.70
Hygroscopic Moisture
Wet Wt.+Tare(gm)= 125.70
Dry Wt.+Tare(gm)= 123.30
Tare Wt(gm) = 39.70
Moisture(%) = 2.87

Liquid Limit
Blows = 26.00
Wet Wt.(gm) = 18.99
Dry Wt.(gm) = 12.43
Tare Wt.(gm) = 3.95
Liquid Limit(%) = 77.72
Plasticity Index= 44.97

Plastic Limit
Wet Wt.(gm) = 13.99
Dry Wt.(gm) = 11.54
Tare Wt.(gm) = 4.06
Plastic Limit(%)= 32.75

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 372.5

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	0.0	100.0	9.5300
NO.4	1.0	99.7	4.7500
NO.10	3.0	99.2	2.0000
NO.20	0.2	98.8	0.8500
NO.40	0.3	98.6	0.4250
NO.50	0.4	98.4	0.3000
NO.100	0.6	98.0	0.1500
NO.200	1.3	96.5	0.0750

Air Dry Weight(gm)= 50.00
Corrected Weight(gm)= 48.60

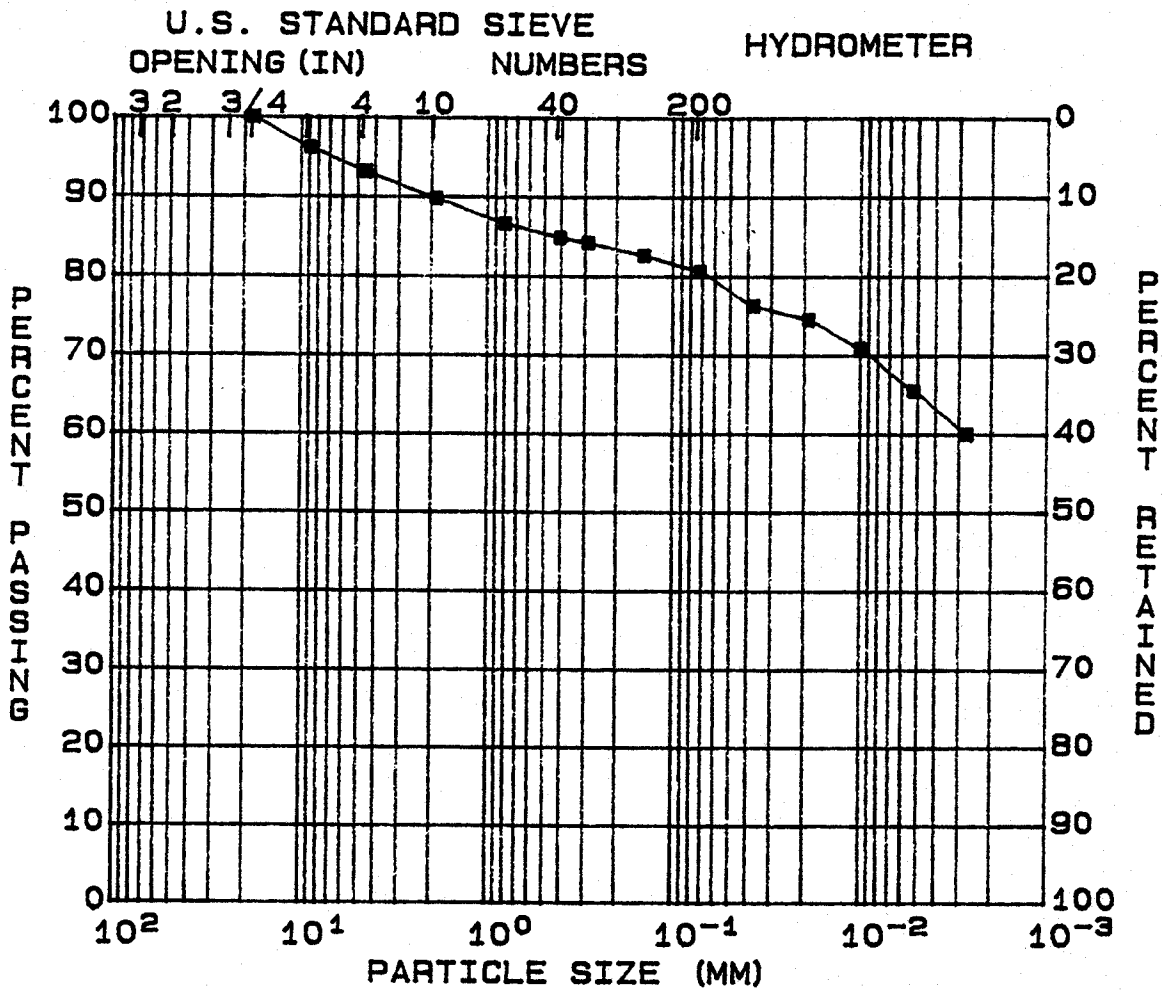
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	23.0	51.0	8.0	87.8	0.0367
4 min.	23.0	49.0	8.0	83.7	0.0187
15 min.	23.0	47.0	8.0	79.6	0.0099
1 hour	23.0	44.0	8.0	73.5	0.0051
4 hours	23.0	42.0	8.0	69.4	0.0026

Soil Symbol= CH (Inorganic clay of high plasticity)
Gravel(%)= 0 Sand(%)= 3 Silt(%)= 23 Clay(%)= 74

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run
FEATURE: Ash Disposal Area
STATION: 6+00
RANGE : A-Line
PART :

BORING:
EL. : -0.0'
SAMPLE: 5
DATE : 10-11-95



GRAVEL (%)	= 6	D10 (MM)	= --
SAND (%)	= 13	D30 (MM)	= --
SILT (%)	= 16	D60 (MM)	= --
CLAY (%)	= 65	COEF UNIF	= --

SOIL SYMBOL	= CH	L.L. (%)	= 67	DENSITY (pcf)	= --
MOISTURE (%)	= --	P.I. (%)	= 37	SATURATION (%)	= --
SP. GR.	= 2.65			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run
Feature: Ash Disposal Area
Station: 6+00
Range : A-Line
Boring :

El. : -0.0'
Sample: 5
Part :

FILE : 521
TESTED BY : REG
Computed By:TRB
Checked By : TAL
Report Date:10-11-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 574.00 Tare Wt(gm) = 95.20
Hygroscopic Moisture
Wet Wt.+Tare(gm)= 73.40 Dry Wt.+Tare(gm)= 72.30
Tare Wt(gm) = 38.10 Moisture(%) = 3.22
Liquid Limit Plastic Limit
Blows = 28.00 Wet Wt.(gm) = 17.01
Wet Wt.(gm) = 22.04 Dry Wt.(gm) = 14.00
Dry Wt.(gm) = 14.84 Tare Wt.(gm) = 4.11
Tare Wt.(gm) = 4.01
Liquid Limit(%) = 67.39 Plastic Limit(%)= 30.43
Plasticity Index= 36.96
Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 478.8

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	14.3	97.0	9.5300
NO.4	28.9	94.0	4.7500
NO.10	45.2	90.6	2.0000
NO.20	1.7	87.4	0.8500
NO.40	2.7	85.5	0.4250
NO.50	3.1	84.8	0.3000
NO.100	4.0	83.1	0.1500
NO.200	5.1	81.0	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 48.44

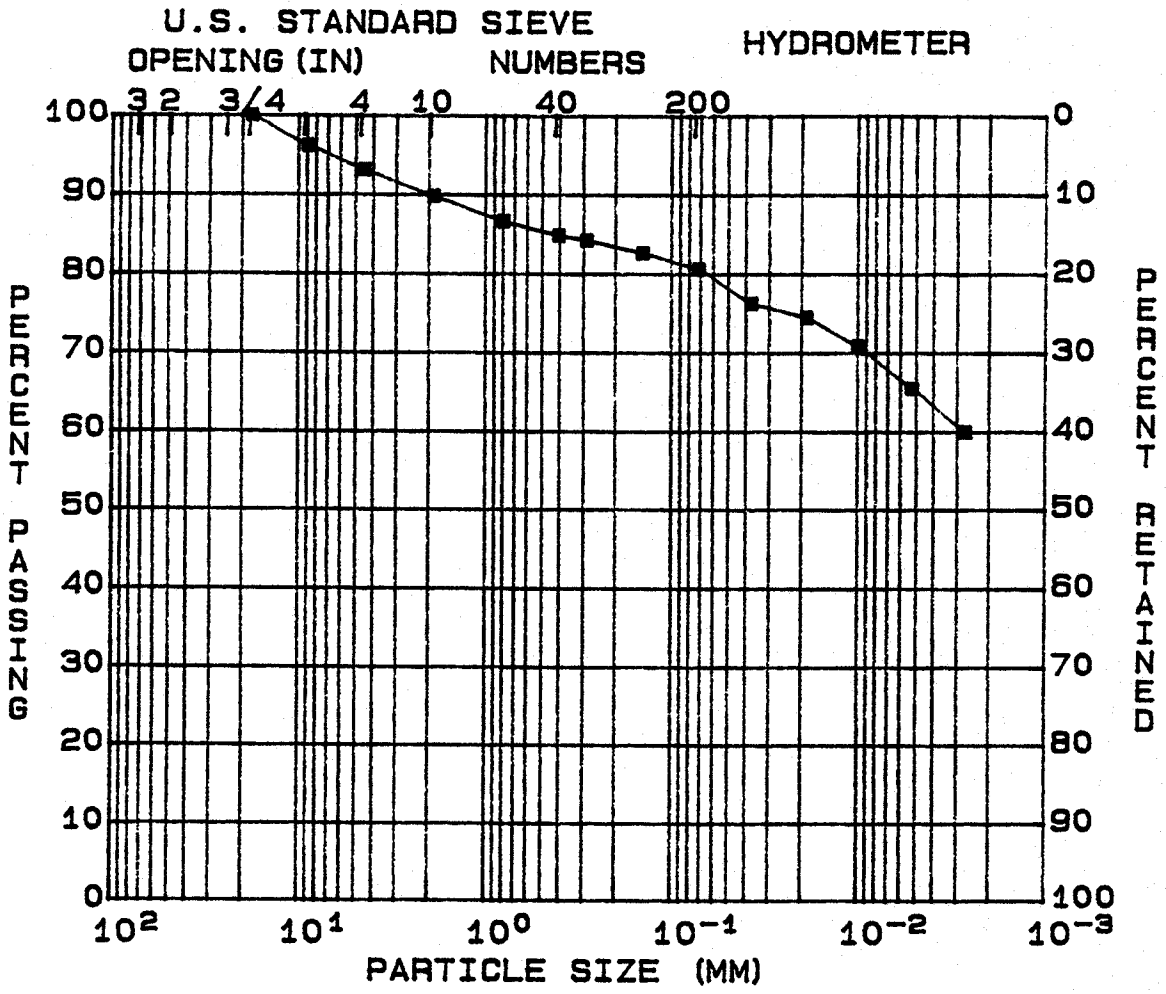
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	20.2	49.0	8.0	76.6	0.0387
4 min.	20.2	48.0	8.0	74.8	0.0195
15 min.	20.2	46.0	8.0	71.0	0.0103
1 hour	20.3	43.0	7.9	65.6	0.0053
4 hours	20.3	40.0	7.9	60.0	0.0027

Soil Symbol= CH (Inorganic clay of high plasticity)
Gravel(%)= 6 Sand(%)=13 Silt(%)= 16 Clay(%)= 65

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: Ash Disposal Area
STATION: 6+00
RANGE : A-Line
PART :

BORING:
EL. : -0.0'
SAMPLE: 5
DATE : 10-11-95



GRAVEL (%)	= 6	D10 (MM)	= --
SAND (%)	= 13	D30 (MM)	= --
SILT (%)	= 16	D60 (MM)	= --
CLAY (%)	= 65	COEF UNIF	= --

SOIL SYMBOL	= CH	L.L. (%)	= 68	DENSITY (pcf)	= --
MOISTURE (%)	= --	P.I. (%)	= 37	SATURATION (%)	= --
SP. GR.	= 2.65			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: Ash Disposal Area
Station: 6+00
Range : A-Line
Boring :

El. : -0.0'
Sample: 5
Part :

FILE : 522
TESTED BY : REG
Computed By:TRB
Checked By : TAL
Report Date:10-11-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 574.00 Tare Wt(gm) = 95.20
Hygroscopic Moisture
Wet Wt.+Tare(gm)= 73.40 Dry Wt.+Tare(gm)= 72.30
Tare Wt(gm) = 38.10 Moisture(%) = 3.22

Liquid Limit
Blows = 28.00
Wet Wt.(gm) = 23.67
Dry Wt.(gm) = 15.86
Tare Wt.(gm) = 4.15
Liquid Limit(%) = 67.61
Plasticity Index= 37.17

Plastic Limit
Wet Wt.(gm) = 17.01
Dry Wt.(gm) = 14.00
Tare Wt.(gm) = 4.11
Plastic Limit(%)= 30.43

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 478.8

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	14.3	97.0	9.5300
NO.4	28.9	94.0	4.7500
NO.10	45.2	90.6	2.0000
NO.20	1.7	87.4	0.8500
NO.40	2.7	85.5	0.4250
NO.50	3.1	84.8	0.3000
NO.100	4.0	83.1	0.1500
NO.200	5.1	81.0	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 48.44

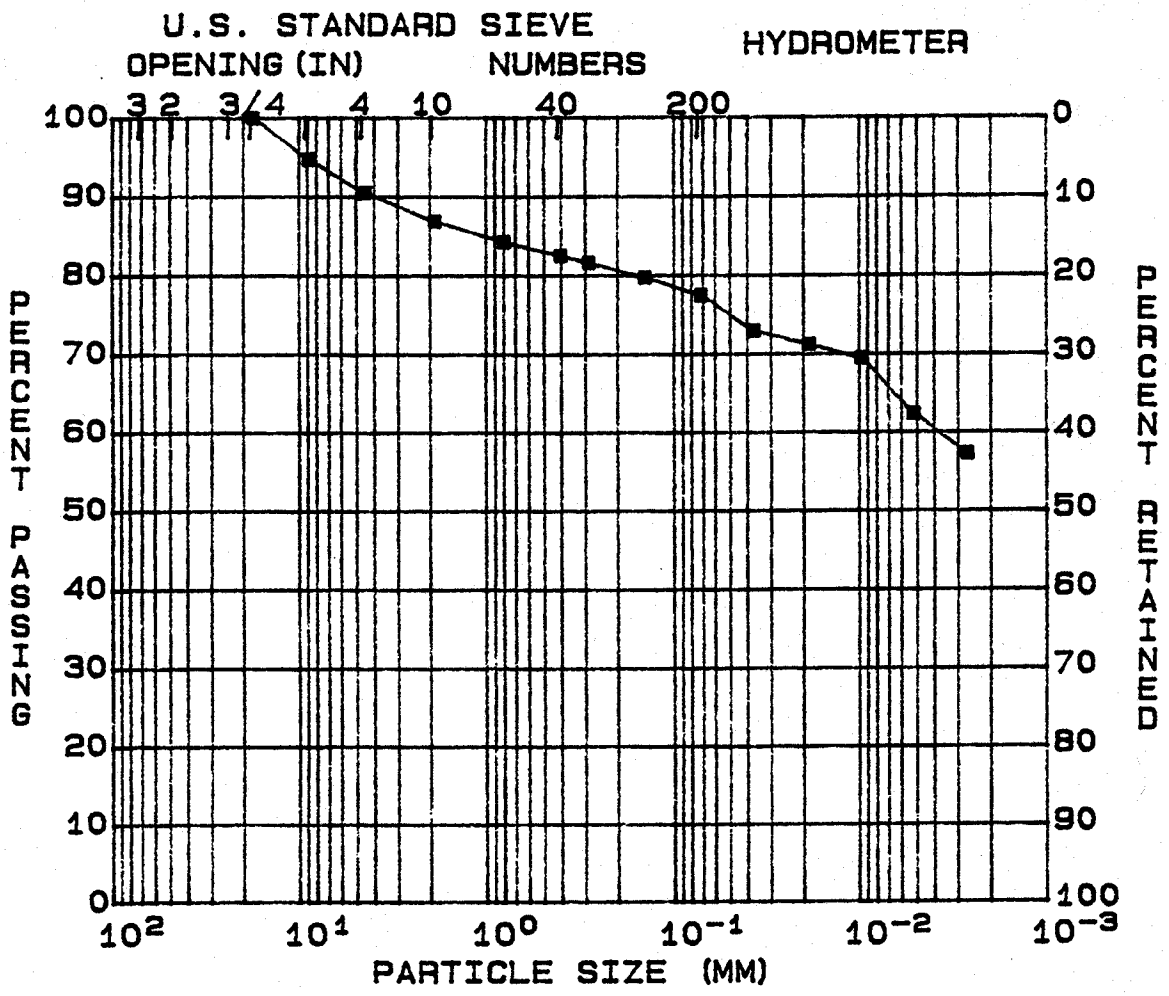
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	20.2	49.0	8.0	76.6	0.0387
4 min.	20.2	48.0	8.0	74.8	0.0195
15 min.	20.2	46.0	8.0	71.0	0.0103
1 hour	20.3	43.0	7.9	65.6	0.0053
4 hours	20.3	40.0	7.9	60.0	0.0027

Soil Symbol= CH (Inorganic clay of high plasticity)
Gravel(%)= 6 Sand(%)=13 Silt(%)= 16 Clay(%)= 65

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: Ash Disposal Area
STATION: 6+00
RANGE : B-Line
PART :

BORING:
EL. : 0.0'-1.0'
SAMPLE: ST-1
DATE : 10-12-95



GRAVEL (%)	= 9	D10 (MM)	= ---
SAND (%)	= 13	D30 (MM)	= ---
SILT (%)	= 16	D60 (MM)	= ---
CLAY (%)	= 62	COEF UNIF	= ---

SOIL SYMBOL	= CH	L.L. (%)	= 68	DENSITY (pcf)	= ---
MOISTURE (%)	= ---	P.I. (%)	= 42	SATURATION (%)	= ---
SP. GR.	= 2.65			VOID RATIO	= ---

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: Ash Disposal Area
Station: 6+00
Range : B-Line
Boring :

El. : 0.0'-1.0'
Sample: ST-1
Part :

FILE : 525
TESTED BY : TAL
Computed By:TRB
Checked By : REG
Report Date:10-12-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 431.90 Tare Wt(gm) = 95.10

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 72.10 Dry Wt.+Tare(gm)= 71.40
Tare Wt(gm) = 38.70 Moisture(%) = 2.14

Liquid Limit
Blows = 27.00
Wet Wt.(gm) = 16.60
Dry Wt.(gm) = 11.50
Tare Wt.(gm) = 3.93
Liquid Limit(%) = 68.00
Plasticity Index= 42.36

Plastic Limit
Wet Wt.(gm) = 12.19
Dry Wt.(gm) = 10.48
Tare Wt.(gm) = 3.81
Plastic Limit(%)= 25.64

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 336.8

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	15.8	95.3	9.5300
NO.4	30.2	91.0	4.7500
NO.10	42.7	87.3	2.0000
NO.20	1.5	84.6	0.8500
NO.40	2.5	82.9	0.4250
NO.50	3.0	82.0	0.3000
NO.100	4.1	80.0	0.1500
NO.200	5.4	77.7	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 48.95

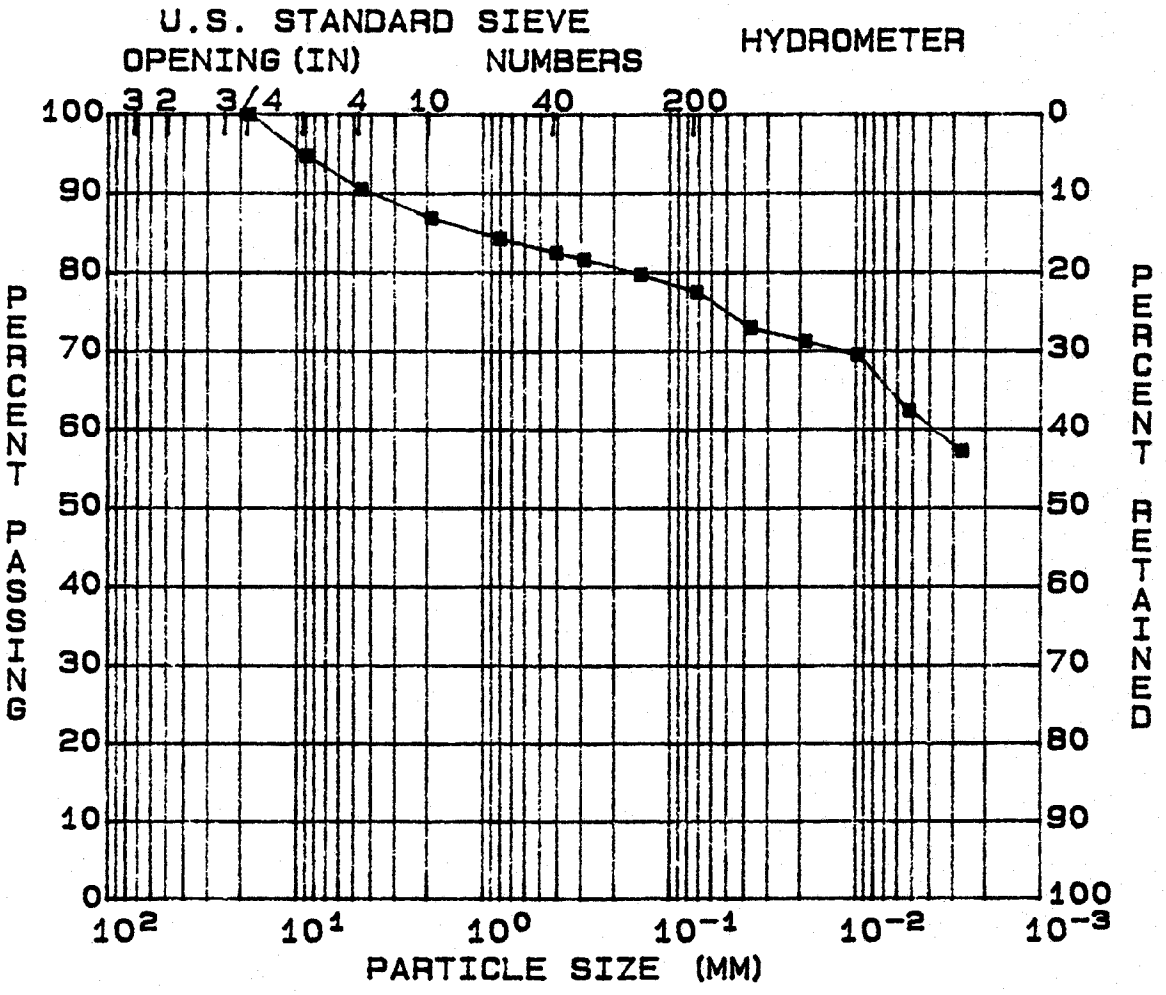
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	21.2	49.0	8.0	73.1	0.0382
4 min.	21.2	48.0	8.0	71.4	0.0193
15 min.	21.2	47.0	8.0	69.6	0.0101
1 hour	21.2	43.0	8.0	62.4	0.0052
4 hours	21.2	40.0	7.9	57.3	0.0027

Soil Symbol= CH (Inorganic clay of high plasticity)
Gravel(%)= 9 Sand(%)=13 Silt(%)= 16 Clay(%)= 62

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: Ash Disposal Area
STATION: 6+00
RANGE : B-Line
PART :

BORING:
EL. : 0.0'-1.0'
SAMPLE: ST-1
DATE : 10-12-95



GRAVEL (%)	= 9	D10 (MM)	= ---
SAND (%)	= 13	D30 (MM)	= ---
SILT (%)	= 16	D60 (MM)	= ---
CLAY (%)	= 62	COEF UNIF	= ---

SOIL SYMBOL	= CH	L.L. (%)	= 67	DENSITY (pcf)	= ---
MOISTURE (%)	= ---	P.I. (%)	= 42	SATURATION (%)	= ---
SP. GR.	= 2.65			VOID RATIO	= ---

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: Ash Disposal Area
Station: 6+00
Range : B-Line
Boring :

El. : 0.0'-1.0'
Sample: ST-1
Part :

FILE : 526
TESTED BY : TAL
Computed By:TRB
Checked By : REG
Report Date:10-12-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 431.90 Tare Wt(gm) = 95.10
Hygroscopic Moisture
Wet Wt.+Tare(gm)= 72.10 Dry Wt.+Tare(gm)= 71.40
Tare Wt(gm) = 38.70 Moisture(%) = 2.14

Liquid Limit
Blows = 27.00
Wet Wt.(gm) = 16.70
Dry Wt.(gm) = 11.54
Tare Wt.(gm) = 3.80
Liquid Limit(%) = 67.29
Plasticity Index= 41.65

Plastic Limit
Wet Wt.(gm) = 12.19
Dry Wt.(gm) = 10.48
Tare Wt.(gm) = 3.81
Plastic Limit(%)= 25.64

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 336.8

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	15.8	95.3	9.5300
NO.4	30.2	91.0	4.7500
NO.10	42.7	87.3	2.0000
NO.20	1.5	84.6	0.8500
NO.40	2.5	82.9	0.4250
NO.50	3.0	82.0	0.3000
NO.100	4.1	80.0	0.1500
NO.200	5.4	77.7	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 48.95

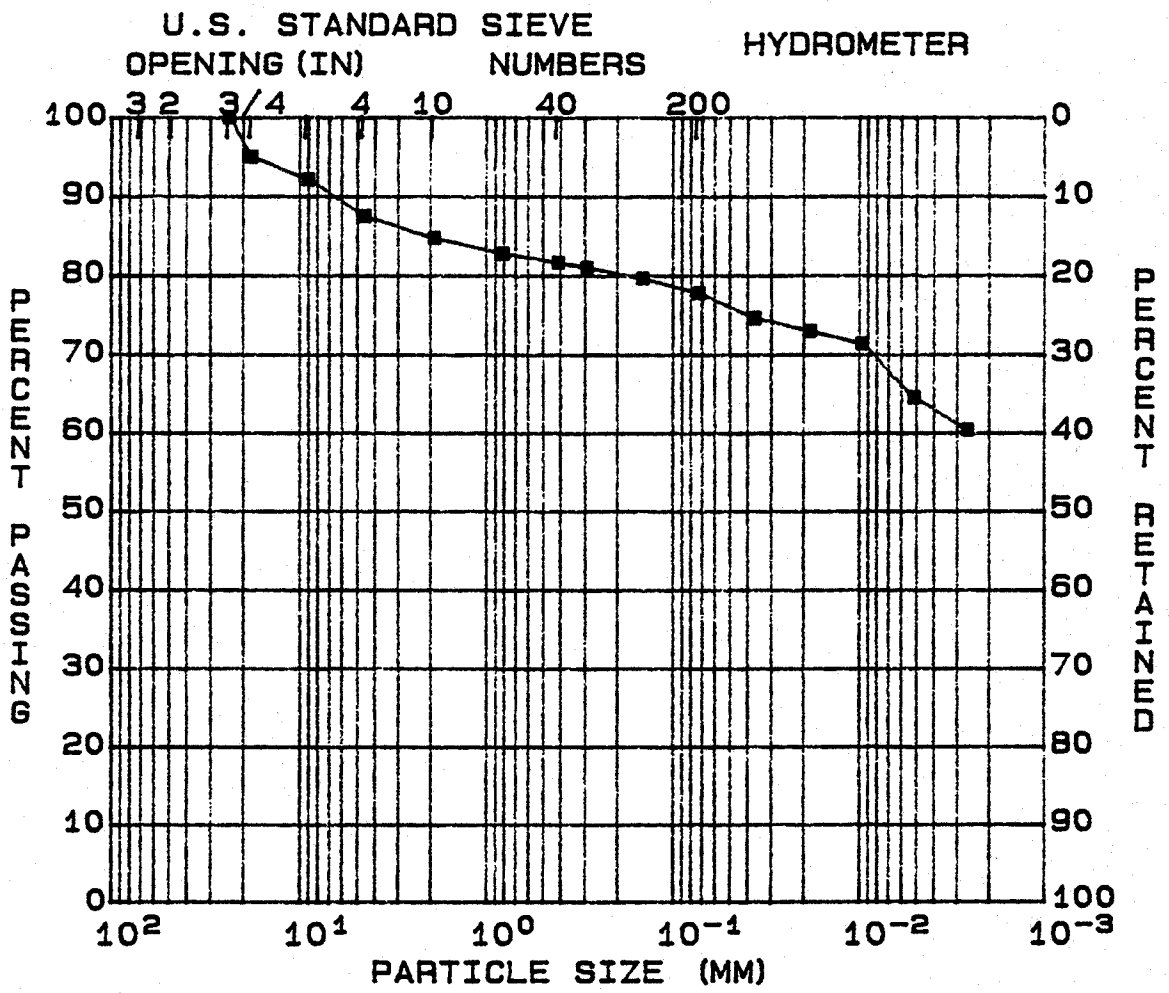
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	21.2	49.0	8.0	73.1	0.0382
4 min.	21.2	48.0	8.0	71.4	0.0193
15 min.	21.2	47.0	8.0	69.6	0.0101
1 hour	21.2	43.0	8.0	62.4	0.0052
4 hours	21.2	40.0	7.9	57.3	0.0027

Soil Symbol= CH (Inorganic clay of high plasticity)
Gravel(%)= 9 Sand(%)=13 Silt(%)= 16 Clay(%)= 62

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: Ash Disposal Area
STATION: 2+00
RANGE : C-Line
PART :

BORING:
EL. : 0.0'-1.0'
SAMPLE: ST-2
DATE : 10-12-95



GRAVEL (%)	= 12	D10 (MM)	= --
SAND (%)	= 10	D30 (MM)	= --
SILT (%)	= 14	D60 (MM)	= --
CLAY (%)	= 64	COEF UNIF	= --

SOIL SYMBOL	= CH	L.L. (%)	= 72	DENSITY (pcf)	= --
MOISTURE (%)	= --	P.I. (%)	= 44	SATURATION (%)	= --
SP. GR.	= 2.65			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: Ash Disposal Area
Station: 2+00
Range : C-Line
Boring :

El. : 0.0'-1.0'
Sample: ST-2
Part :

FILE : 527
TESTED BY : TAL
Computed By:TRB
Checked By : REG
Report Date:10-12-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 736.70 Tare Wt(gm) = 97.30
Hygroscopic Moisture
Wet Wt.+Tare(gm)= 79.60 Dry Wt.+Tare(gm)= 78.80
Tare Wt(gm) = 39.00 Moisture(%) = 2.01

Liquid Limit
Blows = 29.00
Wet Wt.(gm) = 23.75
Dry Wt.(gm) = 15.58
Tare Wt.(gm) = 4.07
Liquid Limit(%) = 72.26
Plasticity Index= 44.16

Plastic Limit
Wet Wt.(gm) = 14.09
Dry Wt.(gm) = 11.87
Tare Wt.(gm) = 3.97
Plastic Limit(%)= 28.10

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 639.4

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	26.2	95.9	19.0500
3/8 in.	44.7	93.0	9.5300
NO.4	74.3	88.4	4.7500
NO.10	92.4	85.5	2.0000
NO.20	1.2	83.5	0.8500
NO.40	1.9	82.2	0.4250
NO.50	2.3	81.5	0.3000
NO.100	3.1	80.1	0.1500
NO.200	4.2	78.2	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 49.01

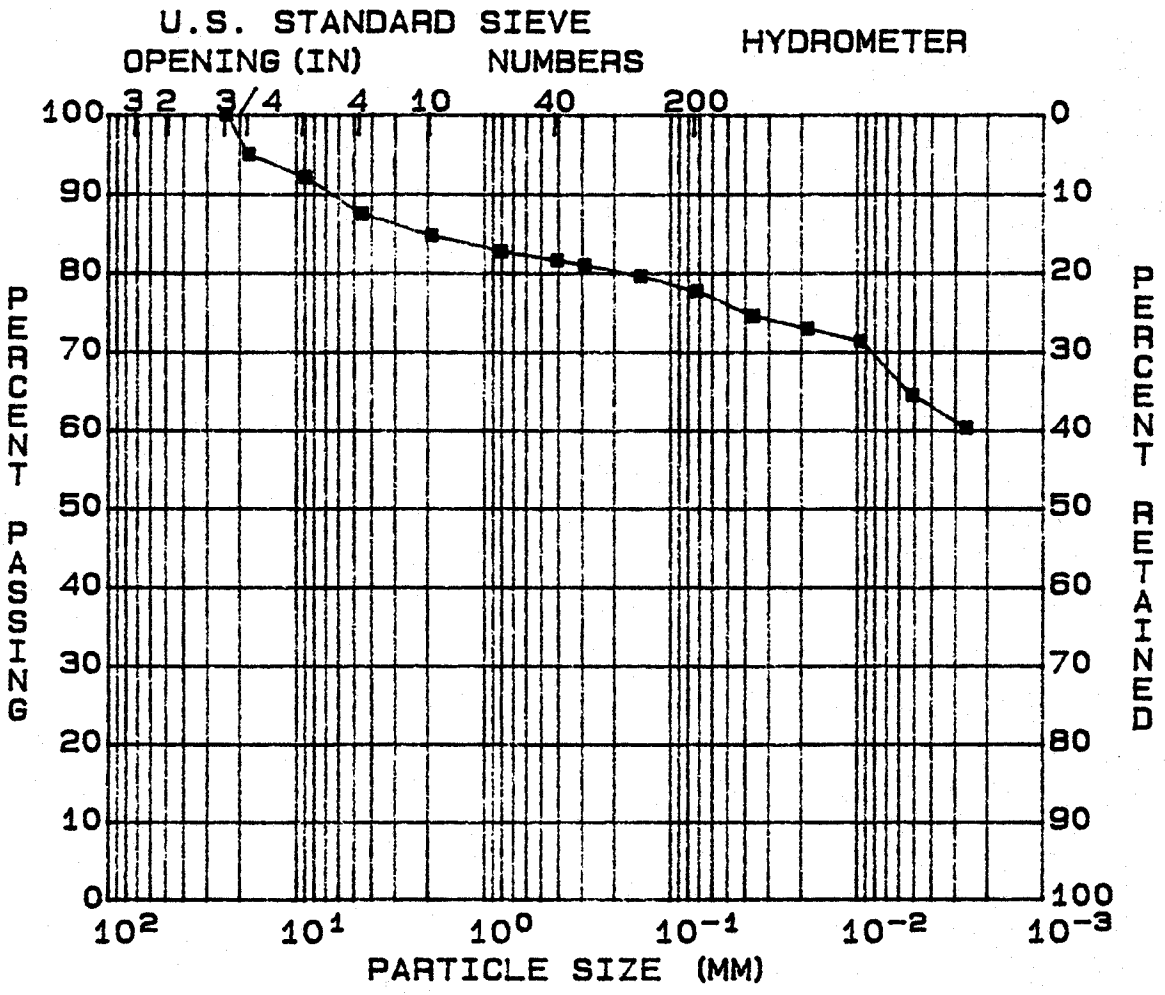
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	21.2	51.0	8.0	75.1	0.0374
4 min.	21.2	50.0	8.0	73.3	0.0189
15 min.	21.2	49.0	8.0	71.6	0.0099
1 hour	21.2	45.0	8.0	64.6	0.0051
4 hours	21.2	42.5	7.9	60.4	0.0026

Soil Symbol= CH (Inorganic clay of high plasticity)
Gravel(%)=12 Sand(%)=10 Silt(%)= 14 Clay(%)= 64

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: Ash Disposal Area
STATION: 2+00
RANGE : C-Line
PART :

BORING:
EL. : 0.0'-1.0'
SAMPLE: ST-2
DATE : 10-12-95



GRAVEL (%)	= 12	D10 (MM)	= --
SAND (%)	= 10	D30 (MM)	= --
SILT (%)	= 14	D60 (MM)	= --
CLAY (%)	= 64	COEF UNIF	= --

SOIL SYMBOL	= CH	L.L. (%)	= 72	DENSITY (pcf)	= --
MOISTURE (%)	= --	P.I. (%)	= 44	SATURATION (%)	= --
SP. GR.	= 2.65			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: Ash Disposal Area
Station: 2+00
Range : C-Line
Boring :

El. : 0.0'-1.0'
Sample: ST-2
Part :

FILE : 528
TESTED BY : TAL
Computed By:TRB
Checked By : REG
Report Date:10-12-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 736.70 Tare Wt(gm) = 97.30

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 79.60 Dry Wt.+Tare(gm)= 78.80
Tare Wt(gm) = 39.00 Moisture(%) = 2.01

Liquid Limit
Blows = 29.00
Wet Wt.(gm) = 21.89
Dry Wt.(gm) = 14.52
Tare Wt.(gm) = 4.13
Liquid Limit(%) = 72.21
Plasticity Index= 44.11

Plastic Limit
Wet Wt.(gm) = 14.09
Dry Wt.(gm) = 11.87
Tare Wt.(gm) = 3.97
Plastic Limit(%)= 28.10

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 639.4

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	26.2	95.9	19.0500
3/8 in.	44.7	93.0	9.5300
NO.4	74.3	88.4	4.7500
NO.10	92.4	85.5	2.0000
NO.20	1.2	83.5	0.8500
NO.40	1.9	82.2	0.4250
NO.50	2.3	81.5	0.3000
NO.100	3.1	80.1	0.1500
NO.200	4.2	78.2	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 49.01

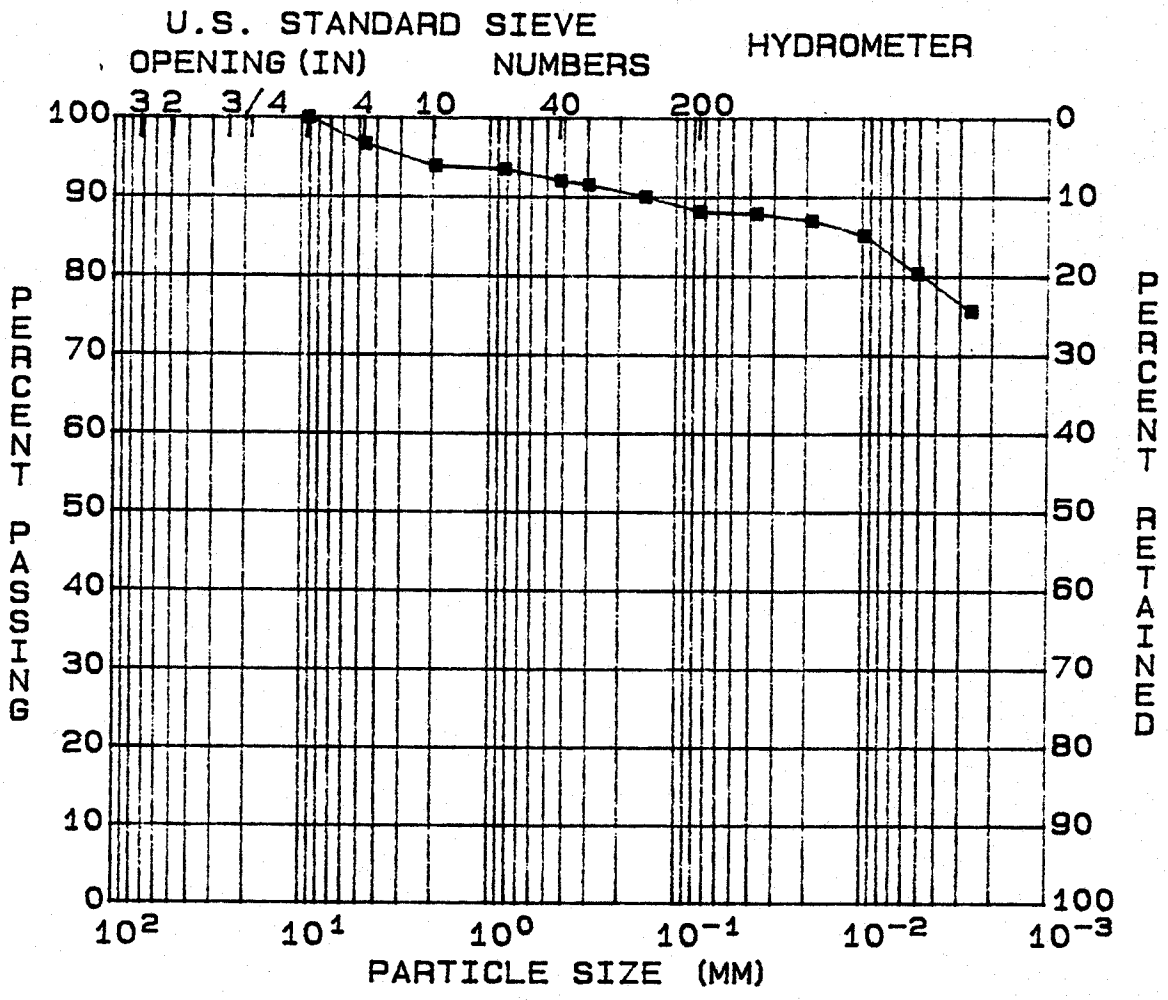
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	21.2	51.0	8.0	75.1	0.0374
4 min.	21.2	50.0	8.0	73.3	0.0189
15 min.	21.2	49.0	8.0	71.6	0.0099
1 hour	21.2	45.0	8.0	64.6	0.0051
4 hours	21.2	42.5	7.9	60.4	0.0026

Soil Symbol= CH (Inorganic clay of high plasticity)
Gravel(%)=12 Sand(%)=10 Silt(%)= 14 Clay(%)= 64

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: West Ash Dike
STATION: 2+00
RANGE : D-Line
PART :

BORING:
EL. :
SAMPLE: ST-3
DATE : 10-19-95



GRAVEL (%)	= 3	D10 (MM)	= --
SAND (%)	= 9	D30 (MM)	= --
SILT (%)	= 8	D60 (MM)	= --
CLAY (%)	= 80	COEF UNIF	= --

SOIL SYMBOL= MH	L.L. (%) = 72	DENSITY (pcf) = --
MOISTURE (%) = --	P.I. (%) = 37	SATURATION (%) = --
SP. GR. = 2.65		VOID RATIO = --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: West Ash Dike
Station: 2+00
Range : D-Line
Boring :

El. :
Sample: ST-3
Part :

FILE : 561
TESTED BY : REG
Computed By:TRB
Checked By : CBE
Report Date:10-19-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 426.30 Tare Wt(gm) = 104.50
Hygroscopic Moisture
Wet Wt.+Tare(gm)= 99.20 Dry Wt.+Tare(gm)= 97.70
Tare Wt(gm) = 39.90 Moisture(%) = 2.60

Liquid Limit
Blows = 28.00
Wet Wt.(gm) = 23.35
Dry Wt.(gm) = 15.33
Tare Wt.(gm) = 4.01
Liquid Limit(%) = 71.82
Plasticity Index= 36.63

Plastic Limit
Wet Wt.(gm) = 14.68
Dry Wt.(gm) = 11.90
Tare Wt.(gm) = 4.00
Plastic Limit(%)= 35.19

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 321.8

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	0.0	100.0	9.5300
NO.4	8.4	97.4	4.7500
NO.10	17.6	94.5	2.0000
NO.20	0.2	94.1	0.8500
NO.40	1.0	92.6	0.4250
NO.50	1.3	92.0	0.3000
NO.100	2.1	90.5	0.1500
NO.200	3.1	88.5	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 48.74

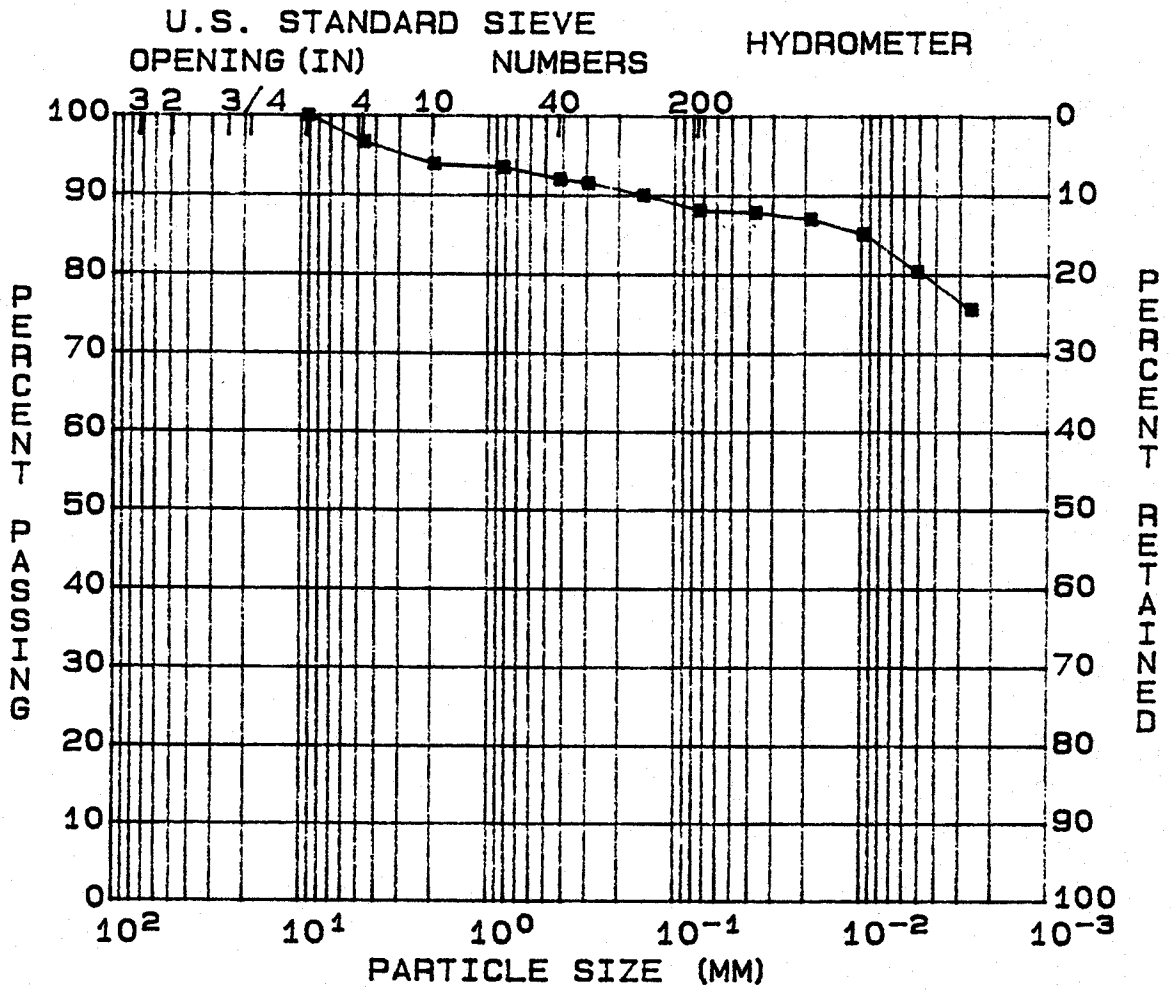
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	20.9	51.5	6.0	88.3	0.0374
4 min.	20.9	51.0	6.0	87.3	0.0188
15 min.	20.9	50.0	6.0	85.3	0.0098
1 hour	20.9	47.5	6.0	80.5	0.0050
4 hours	20.9	45.0	6.0	75.6	0.0026

Soil Symbol= MH (Inorganic silt of high plasticity)
Gravel(%)= 3 Sand(%)= 9 Silt(%)= 8 Clay(%)= 80

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: West Ash Dike
STATION: 2+00
RANGE : D-Line
PART :

BORING:
EL. :
SAMPLE: ST-3
DATE : 10-19-95



GRAVEL (%)	= 3	D10 (MM)	= --
SAND (%)	= 9	D30 (MM)	= --
SILT (%)	= 8	D60 (MM)	= --
CLAY (%)	= 80	COEF UNIF	= --

SOIL SYMBOL	= MH	L.L. (%)	= 72	DENSITY (pcf)	= --
MOISTURE (%)	= --	P.I. (%)	= 37	SATURATION (%)	= --
SP. GR.	= 2.65			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: West Ash Dike
Station: 2+00
Range : D-Line
Boring :

El. :
Sample: ST-3
Part :

FILE : 562
TESTED BY : REG
Computed By:TRB
Checked By : UBG
Report Date:10-19-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 426.30 Tare Wt(gm) = 104.50

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 99.20 Dry Wt.+Tare(gm)= 97.70
Tare Wt(gm) = 39.90 Moisture(%) = 2.60

Liquid Limit
Blows = 29.00
Wet Wt.(gm) = 23.92
Dry Wt.(gm) = 15.70
Tare Wt.(gm) = 4.14
Liquid Limit(%) = 72.39
Plasticity Index= 37.20

Plastic Limit
Wet Wt.(gm) = 14.68
Dry Wt.(gm) = 11.90
Tare Wt.(gm) = 4.00
Plastic Limit(%)= 35.19

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 321.8

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	0.0	100.0	9.5300
NO.4	8.4	97.4	4.7500
NO.10	17.6	94.5	2.0000
NO.20	0.2	94.1	0.8500
NO.40	1.0	92.6	0.4250
NO.50	1.3	92.0	0.3000
NO.100	2.1	90.5	0.1500
NO.200	3.1	88.5	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 48.74

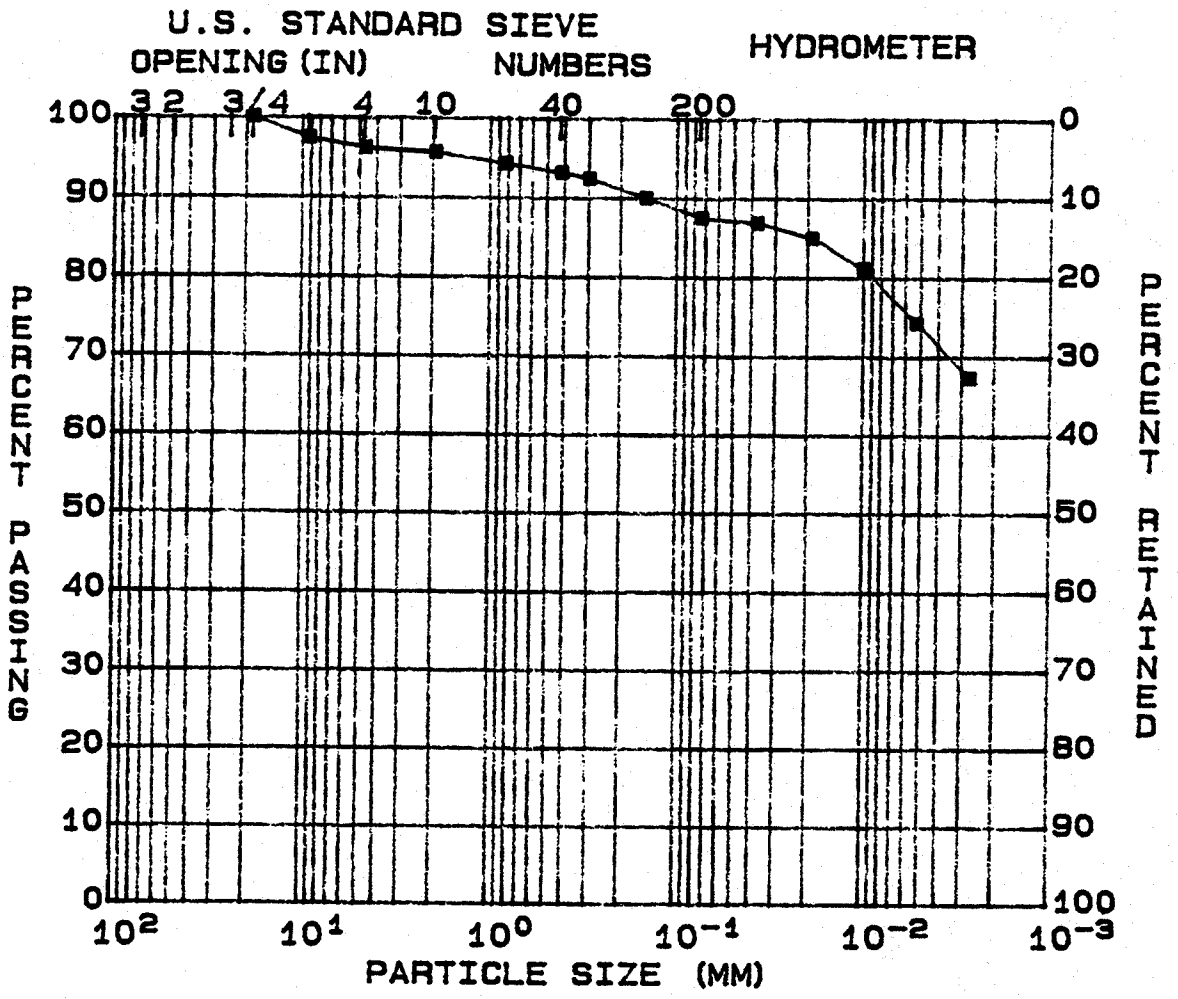
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	20.9	51.5	6.0	88.3	0.0374
4 min.	20.9	51.0	6.0	87.3	0.0188
15 min.	20.9	50.0	6.0	85.3	0.0098
1 hour	20.9	47.5	6.0	80.5	0.0050
4 hours	20.9	45.0	6.0	75.6	0.0026

Soil Symbol= MH (Inorganic silt of high plasticity)
Gravel(%)= 3 Sand(%)= 9 Silt(%)= 8 Clay(%)= 80

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: West Ash Dike
STATION: 4+00
RANGE : D-Line
PART :

BORING:
EL. :
SAMPLE: ST-4
DATE : 10-18-95



GRAVEL (%)	= 3	D10 (MM)	= ---
SAND (%)	= 9	D30 (MM)	= ---
SILT (%)	= 14	D60 (MM)	= ---
CLAY (%)	= 74	COEF UNIF	= ---

SOIL SYMBOL	= MH	L.L. (%)	= 58	DENSITY (pcf)	= ---
MOISTURE (%)	= ---	P.I. (%)	= 23	SATURATION (%)	= ---
SP. GR.	= 2.65			VOID RATIO	= ---

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: West Ash Dike
Station: 4+00
Range : D-Line
Boring :

El. :
Sample: ST-4
Part :

FILE : 536
TESTED BY : REG
Computed By:TRB
Checked By : CBG
Report Date:10-18-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 427.40 Tare Wt(gm) = 102.40

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 99.40 Dry Wt.+Tare(gm)= 97.70
Tare Wt(gm) = 39.80 Moisture(%) = 2.94

Liquid Limit
Blows = 23.00
Wet Wt.(gm) = 23.24
Dry Wt.(gm) = 16.12
Tare Wt.(gm) = 3.98
Liquid Limit(%) = 58.07
Plasticity Index= 23.47

Plastic Limit
Wet Wt.(gm) = 12.18
Dry Wt.(gm) = 10.08
Tare Wt.(gm) = 4.01
Plastic Limit(%)= 34.60

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 325

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	5.7	98.2	9.5300
NO.4	9.8	97.0	4.7500
NO.10	11.7	96.4	2.0000
NO.20	0.7	95.0	0.8500
NO.40	1.3	93.8	0.4250
NO.50	1.7	93.0	0.3000
NO.100	2.9	90.6	0.1500
NO.200	4.2	88.1	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 48.57

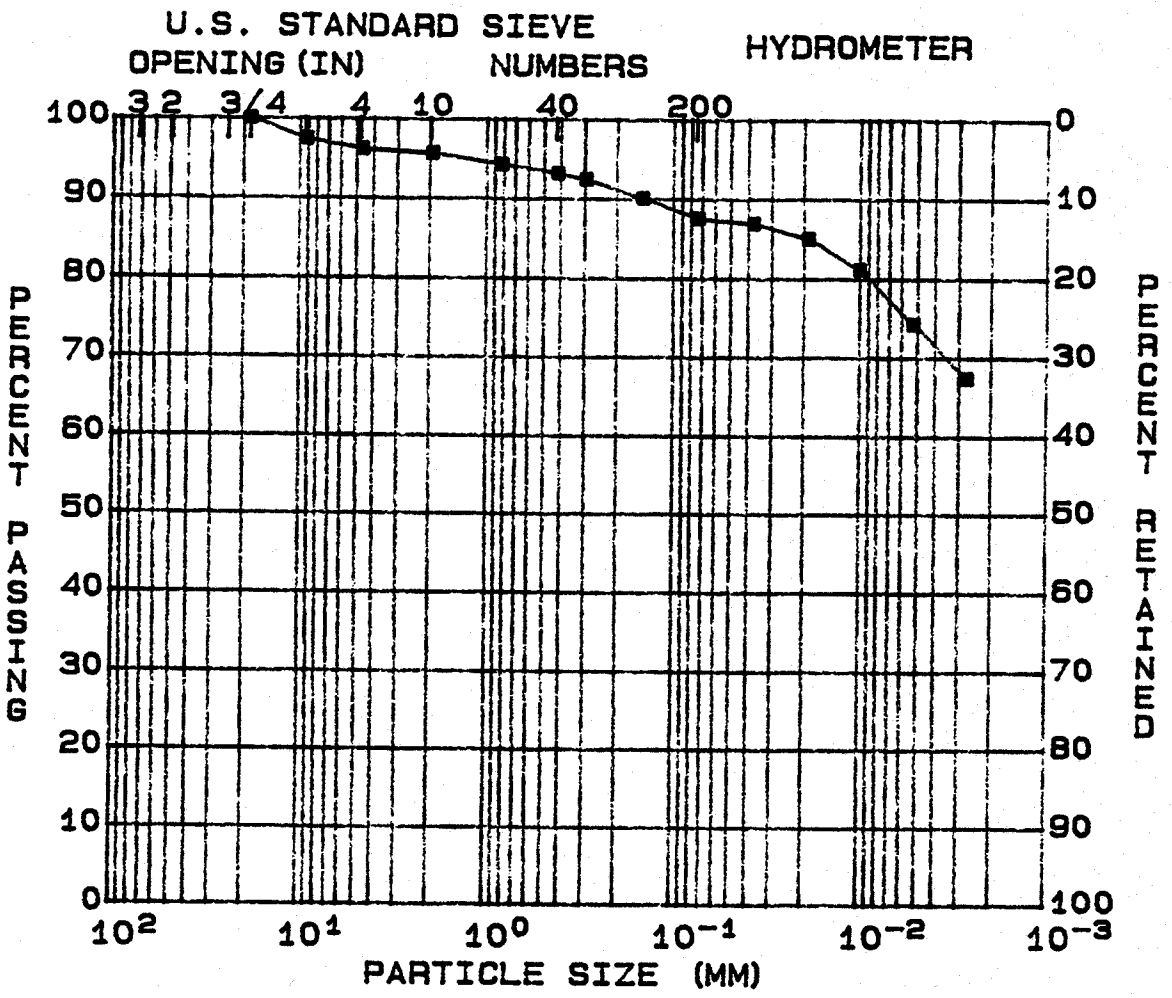
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	20.9	50.0	6.0	87.3	0.0380
4 min.	20.9	49.0	6.0	85.3	0.0192
15 min.	20.9	47.0	6.0	81.4	0.0101
1 hour	20.9	43.5	6.0	74.4	0.0052
4 hours	20.9	40.0	6.0	67.5	0.0027

Soil Symbol= MH (Inorganic silt of high plasticity)
Gravel(%)= 3 Sand(%)= 9 Silt(%)= 14 Clay(%)= 74

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: West Ash Dike
STATION: 4+00
RANGE : D-Line
PART :

BORING:
EL. :
SAMPLE: ST-4
DATE : 10-18-95



GRAVEL (%)	= 3	D10 (MM)	= ---
SAND (%)	= 9	D30 (MM)	= ---
SILT (%)	= 14	D60 (MM)	= ---
CLAY (%)	= 74	COEF UNIF	= ---

SOIL SYMBOL	= MH	L.L. (%)	= 58	DENSITY (pcf)	= ---
MOISTURE (%)	= ---	P.I. (%)	= 24	SATURATION (%)	= ---
SP. GR.	= 2.65			VOID RATIO	= ---

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: West Ash Dike
Station: 4+00
Range : D-Line
Boring :

El. :
Sample: ST-4
Part :

FILE : 537
TESTED BY : REG
Computed By:TRB
Checked By : CBC
Report Date:10-18-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 427.40 Tare Wt(gm) = 102.40

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 99.40 Dry Wt.+Tare(gm)= 97.70
Tare Wt(gm) = 39.80 Moisture(%) = 2.94

Liquid Limit
Blows = 23.00
Wet Wt.(gm) = 23.15
Dry Wt.(gm) = 16.06
Tare Wt.(gm) = 3.99
Liquid Limit(%) = 58.16
Plasticity Index= 23.56

Plastic Limit
Wet Wt.(gm) = 12.18
Dry Wt.(gm) = 10.08
Tare Wt.(gm) = 4.01
Plastic Limit(%)= 34.60

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 325

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	5.7	98.2	9.5300
NO.4	9.8	97.0	4.7500
NO.10	11.7	96.4	2.0000
NO.20	0.7	95.0	0.8500
NO.40	1.3	93.8	0.4250
NO.50	1.7	93.0	0.3000
NO.100	2.9	90.6	0.1500
NO.200	4.2	88.1	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 48.57

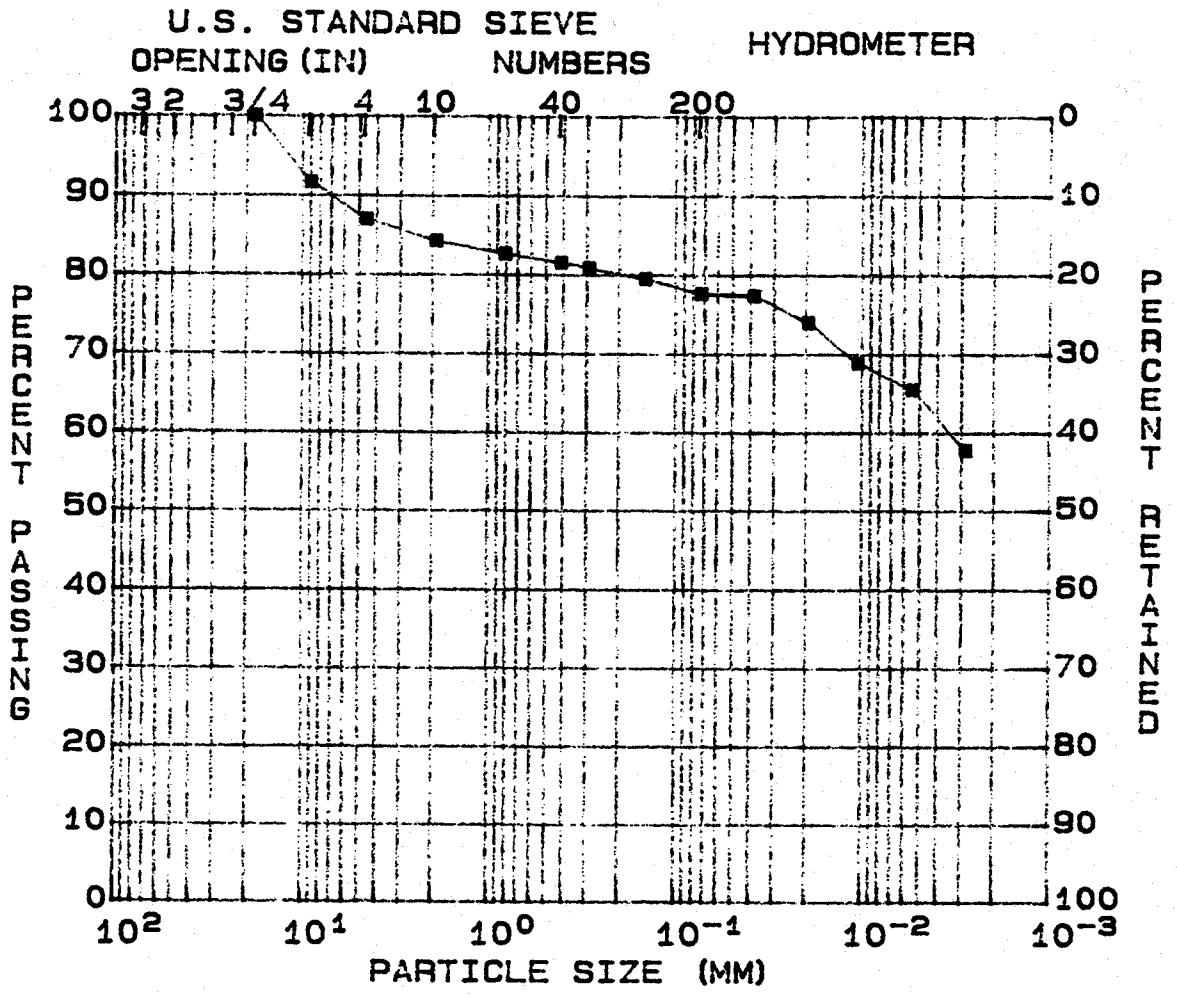
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	20.9	50.0	6.0	87.3	0.0380
4 min.	20.9	49.0	6.0	85.3	0.0192
15 min.	20.9	47.0	6.0	81.4	0.0101
1 hour	20.9	43.5	6.0	74.4	0.0052
4 hours	20.9	40.0	6.0	67.5	0.0027

Soil Symbol= MH (Inorganic silt of high plasticity)
Gravel(%)= 3 Sand(%)= 9 Silt(%)= 14 Clay(%)= 74

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run Steam Plant
FEATURE: Ash Pond - East
STATION: 7+00
RANGE : E-Line
PART :

BORING:
EL. :
SAMPLE: ST-5
DATE : 11-27-95



GRAVEL (%)	= 12	D10 (MM)	= --
SAND (%)	= 10	D30 (MM)	= --
SILT (%)	= 13	D60 (MM)	= --
CLAY (%)	= 65	COEF UNIF	= --

SOIL SYMBOL	= CH	L.L. (%)	= 68	DENSITY (pcf)	= --
MOISTURE (%)	= --	P.I. (%)	= 39	SATURATION (%)	= --
SP. GR.	= 2.65			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run Steam Plant
Feature: Ash Pond - East
Station: 7+00
Range : E-Line
Boring :

El. :
Sample: ST-5
Part :

FILE : 647
TESTED BY : REG
Computed By:TRB
Checked By : TA
Report Date:11-27-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 494.40
Tare Wt(gm) = 103.80

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 68.20
Tare Wt(gm) = 38.20
Dry Wt.+Tare(gm)= 67.70
Moisture(%) = 1.69

Liquid Limit
Blows = 22.00
Wet Wt.(gm) = 26.20
Dry Wt.(gm) = 17.17
Tare Wt.(gm) = 4.00
Liquid Limit(%) = 67.52
Plasticity Index= 39.02

Plastic Limit
Wet Wt.(gm) = 12.32
Dry Wt.(gm) = 10.49
Tare Wt.(gm) = 4.07
Plastic Limit(%)= 28.50

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 390.6

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	30.4	92.2	9.5300
NO.4	48.5	87.6	4.7500
NO.10	59.4	84.8	2.0000
NO.20	1.0	83.1	0.8500
NO.40	1.7	81.9	0.4250
NO.50	2.1	81.2	0.3000
NO.100	2.9	79.8	0.1500
NO.200	4.0	77.9	0.0750

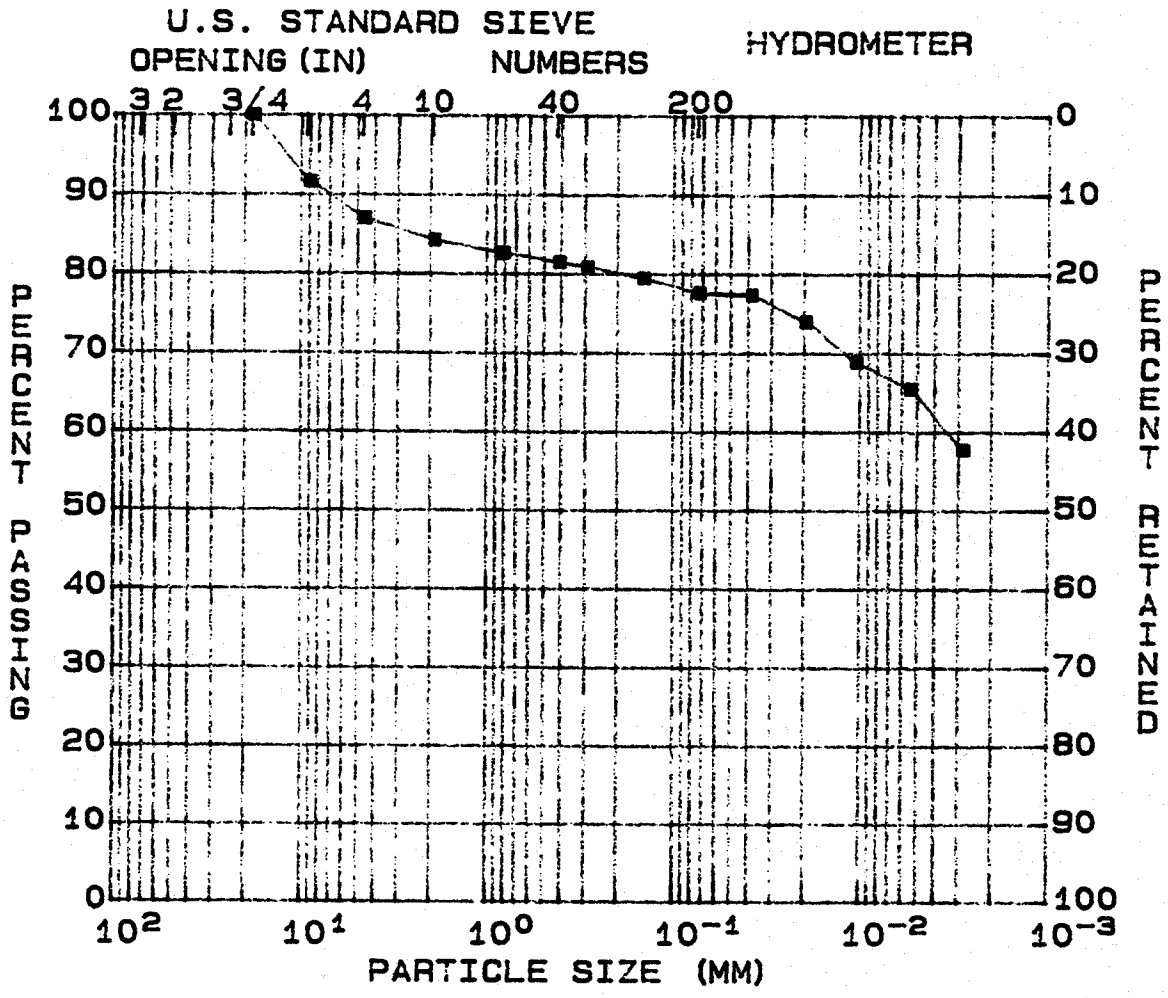
Air Dry Weight(gm)= 50.00
Corrected Weight(gm)= 49.17

Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	15.7	53.0	8.0	77.6	0.0393
4 min.	15.7	51.0	8.0	74.2	0.0201
15 min.	15.7	48.0	8.0	69.0	0.0107
1 hour	15.7	46.0	8.0	65.5	0.0054
4 hours	15.8	41.5	8.0	57.8	0.0028

Soil Symbol= CH (Inorganic gravelly clay of high plasticity)
Gravel(%)=12 Sand(%)=10 Silt(%)= 13 Clay(%)= 65

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run Steam Plant BORING:
FEATURE: Ash Pond - East EL. :
STATION: 7+00 SAMPLE: ST-5
RANGE : E-Line DATE : 11-27-95
PART :



GRAVEL (%)	= 12	D10 (MM)	= ---
SAND (%)	= 10	D30 (MM)	= ---
SILT (%)	= 13	D60 (MM)	= ---
CLAY (%)	= 65	COEF UNIF	= ---

SOIL SYMBOL	= CH	L.L. (%)	= 68	DENSITY (pcf)	= ---
MOISTURE (%)	= ---	P.I. (%)	= 39	SATURATION (%)	= ---
SP. GR.	= 2.65			VOID RATIO	= ---

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run Steam Plant
Feature: Ash Pond - East
Station: 7+00
Range : E-Line
Boring :

El. :
Sample: ST-5
Part :

FILE : 648
TESTED BY : REG
Computed By:TRB
Checked By : TAL
Report Date:11-27-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 494.40 Tare Wt(gm) = 103.80

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 68.20 Dry Wt.+Tare(gm)= 67.70
Tare Wt(gm) = 38.20 Moisture(%) = 1.69

Liquid Limit
Blows = 22.00
Wet Wt.(gm) = 24.43
Dry Wt.(gm) = 16.16
Tare Wt.(gm) = 4.12
Liquid Limit(%) = 67.64
Plasticity Index= 39.14

Plastic Limit
Wet Wt.(gm) = 12.32
Dry Wt.(gm) = 10.49
Tare Wt.(gm) = 4.07
Plastic Limit(%)= 28.50

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 390.6

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	30.4	92.2	9.5300
NO.4	48.5	87.6	4.7500
NO.10	59.4	84.8	2.0000
NO.20	1.0	83.1	0.8500
NO.40	1.7	81.9	0.4250
NO.50	2.1	81.2	0.3000
NO.100	2.9	79.8	0.1500
NO.200	4.0	77.9	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 49.17

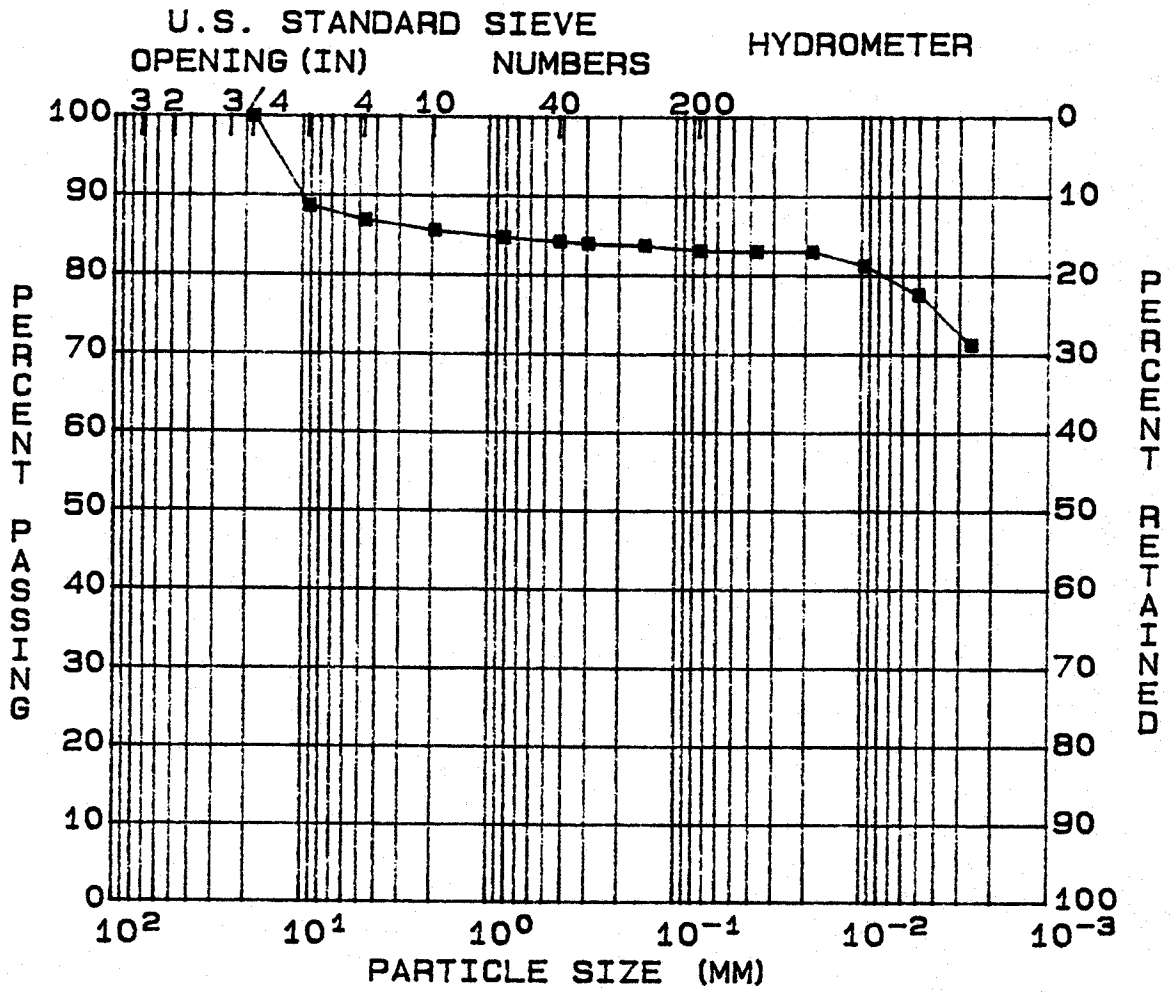
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	15.7	53.0	8.0	77.6	0.0393
4 min.	15.7	51.0	8.0	74.2	0.0201
15 min.	15.7	48.0	8.0	69.0	0.0107
1 hour	15.7	46.0	8.0	65.5	0.0054
4 hours	15.8	41.5	8.0	57.8	0.0028

Soil Symbol= CH (Inorganic gravelly clay of high plasticity)
Gravel(%)=12 Sand(%)=10 Silt(%)= 13 Clay(%)= 65

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: East Ash Dike
STATION: 11+00
RANGE : B-Line
PART :

BORING:
EL. :
SAMPLE: ST-6
DATE : 10-19-95



GRAVEL (%)	= 12	D10 (MM)	= --
SAND (%)	= 4	D30 (MM)	= --
SILT (%)	= 6	D60 (MM)	= --
CLAY (%)	= 78	COEF UNIF	= --

SOIL SYMBOL	= MH/CH	L.L. (%)	= 64	DENSITY (pcf)	= --
MOISTURE (%)	= --	P.I. (%)	= 31	SATURATION (%)	= --
SP. GR.	= 2.65			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: East Ash Dike
Station: 11+00
Range : B-Line
Boring :

El. :
Sample: ST-6
Part :

FILE : 563
TESTED BY : REG
Computed By:TRB
Checked By : CBH
Report Date:10-19-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 372.80 Tare Wt(gm) = 72.30

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 94.70 Dry Wt.+Tare(gm)= 90.90
Tare Wt(gm) = 37.60 Moisture(%) = 7.13

Liquid Limit
Blows = 23.00
Wet Wt.(gm) = 23.15
Dry Wt.(gm) = 15.53
Tare Wt.(gm) = 3.79
Liquid Limit(%) = 64.26
Plasticity Index= 31.35

Plastic Limit
Wet Wt.(gm) = 14.26
Dry Wt.(gm) = 11.68
Tare Wt.(gm) = 3.84
Plastic Limit(%)= 32.91

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 300.5

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	31.1	89.7	9.5300
NO.4	36.7	87.8	4.7500
NO.10	40.5	86.5	2.0000
NO.20	0.5	85.6	0.8500
NO.40	0.8	85.0	0.4250
NO.50	1.0	84.7	0.3000
NO.100	1.2	84.3	0.1500
NO.200	1.6	83.6	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 46.67

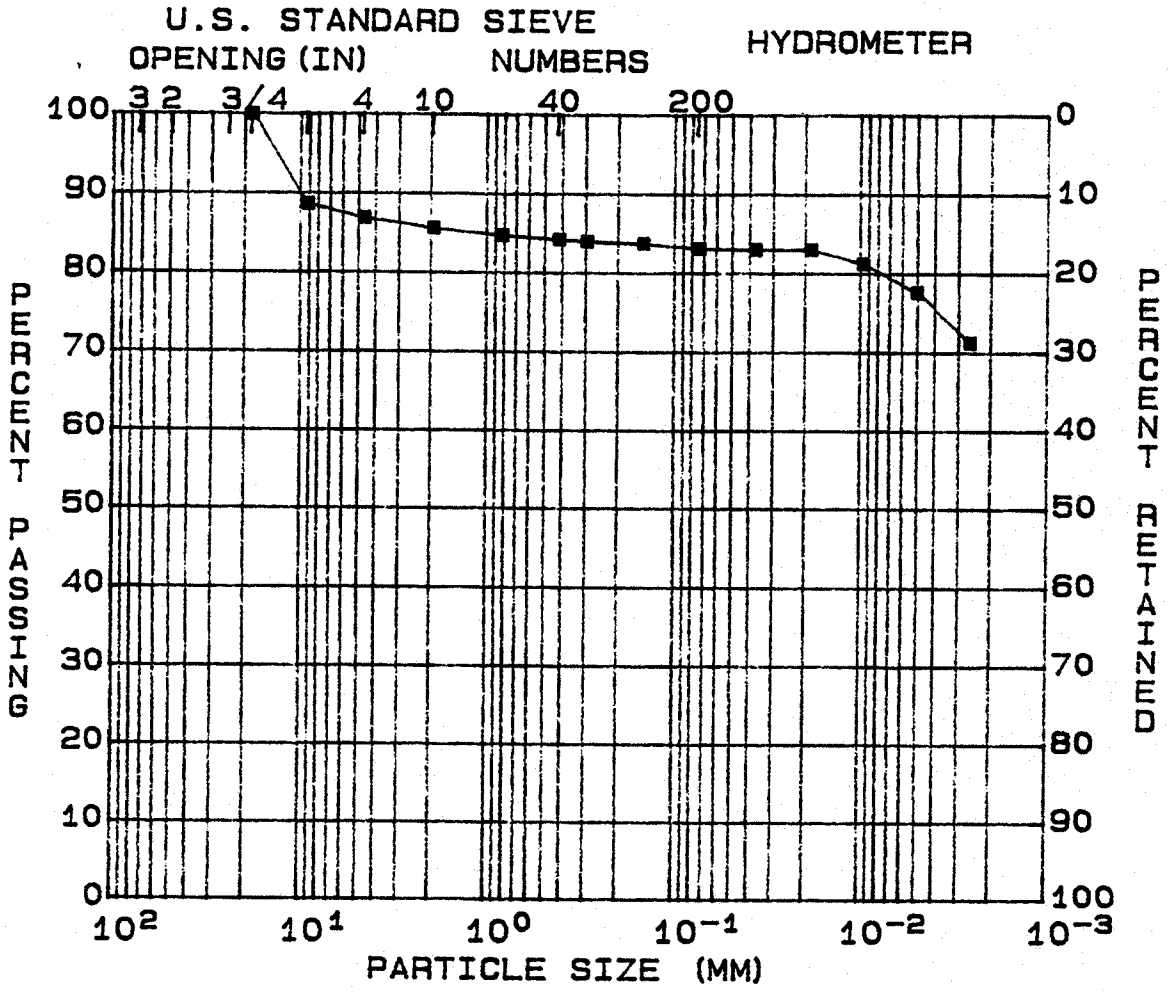
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	20.9	51.0	6.0	83.4	0.0376
4 min.	20.9	51.0	6.0	83.4	0.0188
15 min.	20.9	50.0	6.0	81.6	0.0098
1 hour	20.9	48.0	6.0	77.9	0.0050
4 hours	20.9	44.5	6.0	71.4	0.0026

Soil Symbol= MH/CH (Inorganic clayey silt of high plasticity)
Gravel(%)=12 Sand(%)= 4 Silt(%)= 6 Clay(%)= 78

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: Bull Run S.P.
FEATURE: East Ash Dike
STATION: 11+00
RANGE : B-Line
PART :

BORING:
EL. :
SAMPLE: ST-6
DATE : 10-19-95



GRAVEL (%)	= 12	D10 (MM)	= --
SAND (%)	= 4	D30 (MM)	= --
SILT (%)	= 6	D60 (MM)	= --
CLAY (%)	= 78	COEF UNIF	= --

SOIL SYMBOL	= MH/CH	L.L. (%)	= 64	DENSITY (pcf)	= --
MOISTURE (%)	= --	P.I. (%)	= 31	SATURATION (%)	= --
SP. GR.	= 2.65			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: Bull Run S.P.
Feature: East Ash Dike
Station: 11+00
Range : B-Line
Boring :

El. :
Sample: ST-6
Part :

FILE : 564
TESTED BY : REG
Computed By:TRB
Checked By : CBL
Report Date:10-19-95

Specific Gravity =2.650(Assumed)

Moisture Determination
Dry Wt.+Tare(gm)= 372.80 Tare Wt(gm) = 72.30

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 94.70 Dry Wt.+Tare(gm)= 90.90
Tare Wt(gm) = 37.60 Moisture(%) = 7.13

Liquid Limit
Blows = 23.00
Wet Wt.(gm) = 22.49
Dry Wt.(gm) = 15.13
Tare Wt.(gm) = 3.81
Liquid Limit(%) = 64.37
Plasticity Index= 31.46

Plastic Limit
Wet Wt.(gm) = 14.26
Dry Wt.(gm) = 11.68
Tare Wt.(gm) = 3.84
Plastic Limit(%)= 32.91

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 300.5

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	31.1	89.7	9.5300
NO.4	36.7	87.8	4.7500
NO.10	40.5	86.5	2.0000
NO.20	0.5	85.6	0.8500
NO.40	0.8	85.0	0.4250
NO.50	1.0	84.7	0.3000
NO.100	1.2	84.3	0.1500
NO.200	1.6	83.6	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 46.67

Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	20.9	51.0	6.0	83.4	0.0376
4 min.	20.9	51.0	6.0	83.4	0.0188
15 min.	20.9	50.0	6.0	81.6	0.0098
1 hour	20.9	48.0	6.0	77.9	0.0050
4 hours	20.9	44.5	6.0	71.4	0.0026

Soil Symbol= MH/CH (Inorganic clayey silt of high plasticity)
Gravel(%)=12 Sand(%)= 4 Silt(%)= 6 Clay(%)= 78

ATTACHMENT C

Purchase Receipts

E-10-601

PURCHASE REQUEST

REQ. NO. BRF-5062-220

DATE 9-18-95

- RUN FOSSIL PLANT

NAME OF EQUIPMENT: PERMIT / CLOSE DREDGE CELLS

NUMBER OF EQUIPMENT:

AGE

UMBER

W.O., OR ACCOUNT NUMBER: SEE BELOW

PRINT NUMBER:

ESTIMATED COST: 12,205.80

DELIVERY: RUN

SHIP VIA: VENDOR DELIVER

ED BY: ND CORDER

APPROVED BY: GLC

AUTHORIZED BY: JAB/GLC

DATE WANTED: 9/22/95

ARTICLES OR SERVICES (GIVE COMPLETE DESCRIPTION, CAT. NO., ETC.)	QUANTITY	UNIT	UNIT PRICE	AMOUNT	PRESENT STOCK	MINIMUM STOCK
STRAW,	1890	BALES	3.75	7087.50		
FERTILIZER, 34-0-0	3.3	TONS	$220	$726.00		
FERTILIZER, 15-15-15	6.6	TONS	$205	$1353.00		
GRASS SEED, KENTUCKY 31	2000 ~~1980~~	LBS	72¢	1440 ~~1426.68~~		
GRASS SEED, WHITE CLOVER	500 ~~495~~	LBS	1.90	950 ~~940.50~~		
GRASS SEED, PERENNIAL RYE	650 ~~643.50~~	LBS	0.82	559.50 ~~537.70~~		
GRASS SEED, WHEAT	17.00 ~~16.83~~	BUSHEL	$8.00	136.00 ~~134.68~~		
LIME (5 TONS EACH)	~~8~~ 5	EA	150	750.00		
				~~1290.80~~		
				12,905.00		

SUGGESTED SOURCES

75% TO 000 WQZJ = 3051.45

75% TO 000 WMMJ = 9154.35

TOTAL ACRES: 33

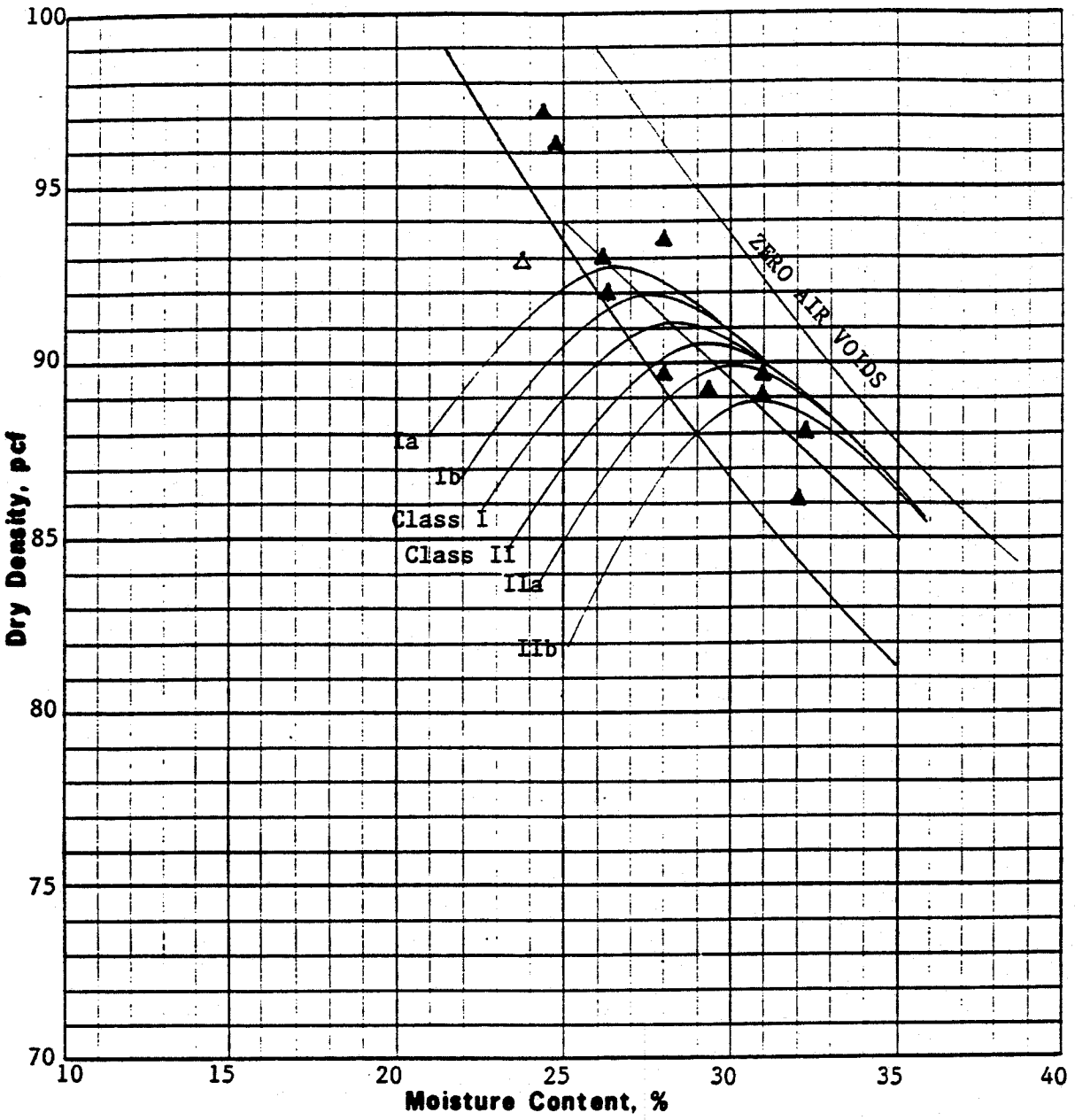
BUFFER - 8
DREDGE 25

95P3G - 154824
(ANDERSON COOP)

APPENDIX A

Compaction Curves and Laboratory Test Data

SINGLETON LABORATORIES



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-1	12	10	12	66	2.71	72	39	28.1	91.2
CH/MH-2	4	15	16	65	2.74	64	33	29.0	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Project	Bull Run FP
	Rogers Group
Feature	Off-Site Borrow Area
ASTM Designations D 698A & C	
Date Tested	8/15/95

COMPACTION TEST (FAMILY OF CURVES)

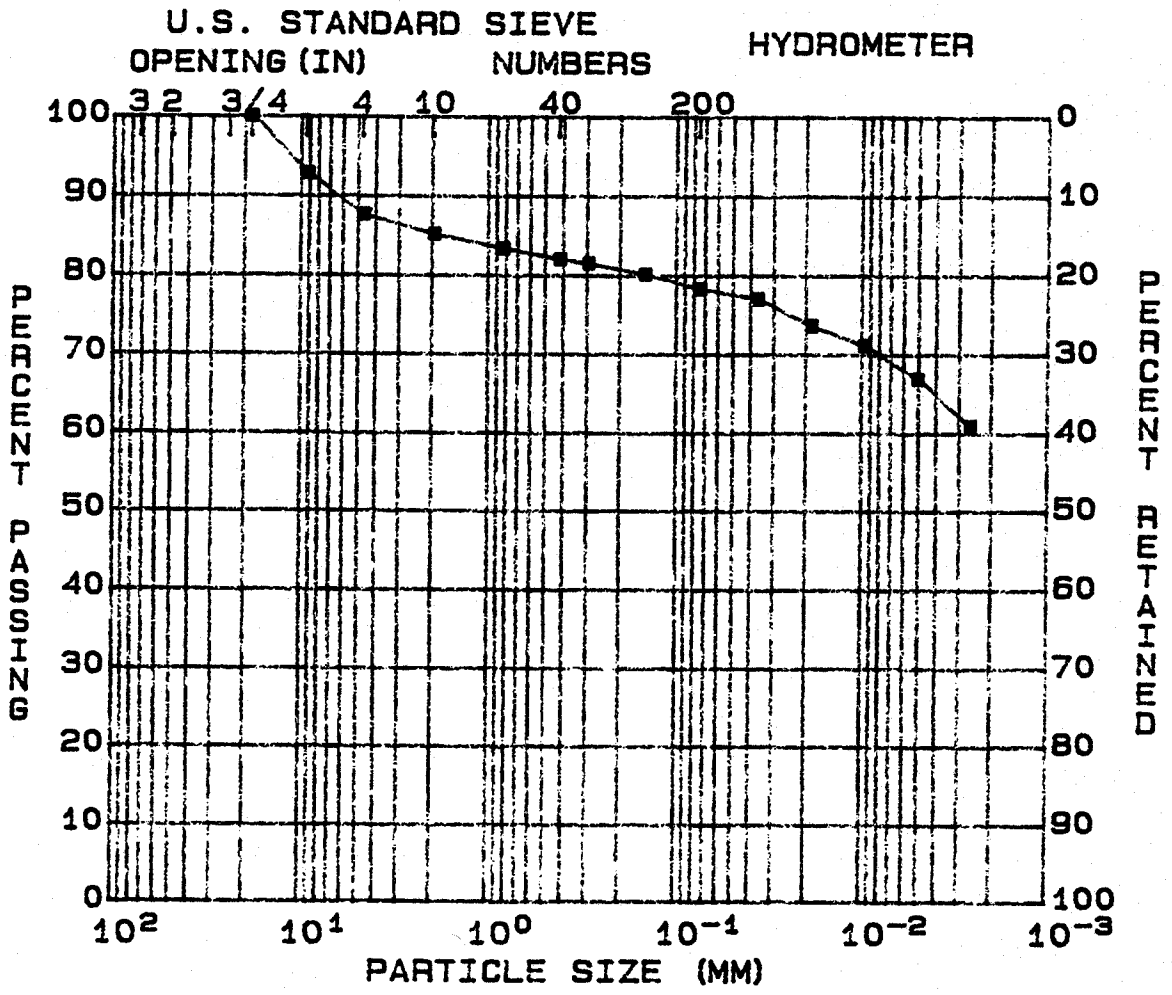
Table 3
SUMMARY OF LABORATORY TEST DATA

Sample	Location	Natural Moisture %	Dry Density pcf	Coefficient of Permeability K_v cm/sec
DC-1	8+50 H-Line	31.0	89.7	4.7×10^{-8}
DC-2	6+00 G-Line	32.0	86.1	4.8×10^{-8}
DC-3	8+00 A-Line	28.1	93.5	6.4×10^{-8}
DC-4	5+00 A-Line	31.0	89.1	3.4×10^{-8}
DC-5	7+00 A-Line	32.4	88.0	2.7×10^{-8}
DC-6	7+00 F-Line	26.5	92.1	1.1×10^{-7}
DC-7	4+00 G-Line	29.4	89.2	4.7×10^{-8}
DC-8	1+00 H-Line	24.5	97.3	2.0×10^{-8}
DC-9	2+50 D-Line	24.9	96.2	2.9×10^{-8}
DC-10	1+00 B-Line	26.2	93.0	3.2×10^{-8}
DC-11	3+00 F-Line	28.1	89.6	9.7×10^{-8}
DC-12	8+50 F-Line	23.9	92.9	5.4×10^{-7}

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: BULL RUN FP
FEATURE: STAGE 2
STATION: DRY FLY ASH STACK
RANGE :
PART :

BORING:
EL. :
SAMPLE: CLASS I
DATE : 11-15-94



GRAVEL (%)	= 12	D10 (MM)	= ---
SAND (%)	= 10	D30 (MM)	= ---
SILT (%)	= 12	D60 (MM)	= ---
CLAY (%)	= 66	COEF UNIF	= ---

SOIL SYMBOL	= CH	L.L. (%)	= 72	DENSITY (pcf)	= ---
MOISTURE (%)	= 23.2	P.I. (%)	= 39	SATURATION (%)	= ---
SP. GR.	= 2.71			VOID RATIO	= ---

REMARKS:

Singleton Laboratories
General Classification Tests

Project: BULL RUN FP
Feature: STAGE 2
Station: DRY FLY ASH STACK
Range :
Boring :

El. :
Sample: CLASS I
Part :

FILE : 96
TESTED BY : CBE
Computed By:MHD
Checked By : TAL
Report Date:11-15-94

Specific Gravity = 2.708
Flask No. = 22.00
Soil Wt.(gm) = 50.00
Temp.(deg.c.) = 23.50
Total Wt.(gm) =708.17

Moisture Determination
Dry Wt.+Tare(gm)= 540.80
Tare Wt(gm) = 105.10

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 70.10
Tare Wt(gm) = 40.10
Dry Wt.+Tare(gm)= 69.30
Moisture(%) = 2.74

Liquid Limit
Blows = 27.00
Wet Wt.(gm) = 10.60
Dry Wt.(gm) = 7.89
Tare Wt.(gm) = 4.09
Liquid Limit(%) = 71.98
Plasticity Index= 39.18

Plastic Limit
Wet Wt.(gm) = 16.60
Dry Wt.(gm) = 13.52
Tare Wt.(gm) = 4.13
Plastic Limit(%)= 32.80

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 435.7

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	28.4	93.5	9.5300
NO.4	51.0	88.3	4.7500
NO.10	61.9	85.8	2.0000
NO.20	1.0	84.0	0.8500
NO.40	1.8	82.6	0.4250
NO.50	2.1	82.1	0.3000
NO.100	2.9	80.7	0.1500
NO.200	4.0	78.7	0.0750

Air Dry Weight(gm)= 50.00
Corrected Weight(gm)= 48.67

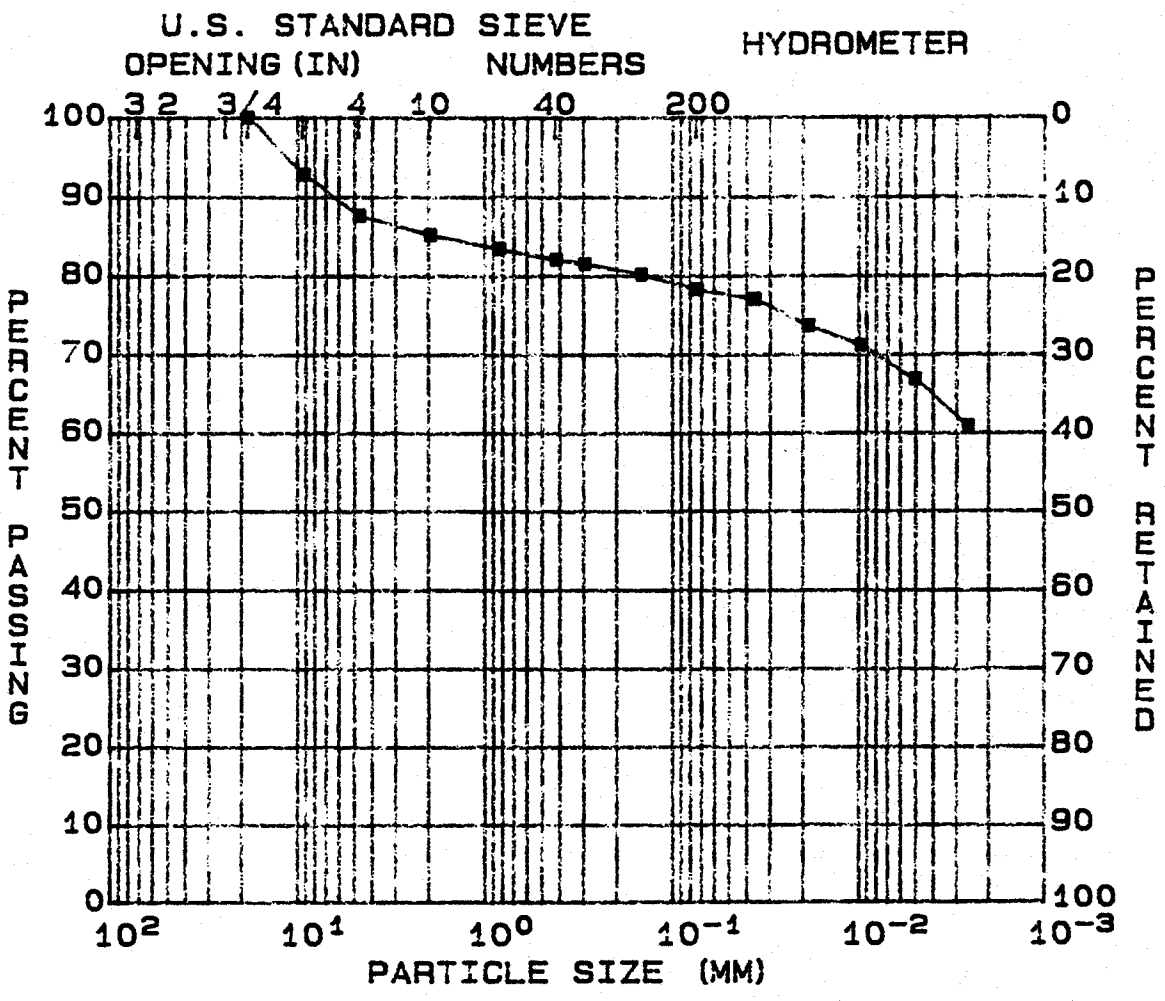
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	21.3	51.5	7.0	77.4	0.0366
4 min.	21.3	49.5	7.0	74.0	0.0187
15 min.	21.3	48.0	7.0	71.4	0.0098
1 hour	21.3	45.5	7.0	67.0	0.0050
4 hours	21.3	42.0	7.0	60.9	0.0026

Soil Symbol= CH (Inorganic clay of high plasticity)
Gravel(%)=12 Sand(%)=10 Silt(%)= 12 Clay(%)= 66

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: BULL RUN FP
FEATURE: STAGE 2
STATION: DRY FLY ASH STACK
RANGE :
PART :

BORING:
EL. :
SAMPLE: CLASS I
DATE : 11-15-94



GRAVEL (%)	= 12	D10 (MM)	= --
SAND (%)	= 10	D30 (MM)	= --
SILT (%)	= 12	D60 (MM)	= --
CLAY (%)	= 66	COEF UNIF	= --

SOIL SYMBOL	= CH	L.L. (%)	= 72	DENSITY (pcf)	= --
MOISTURE (%)	= 23.2	P.I. (%)	= 39	SATURATION (%)	= --
SP. GR.	= 2.71			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: BULL RUN FP
Feature: STAGE 2
Station: DRY FLY ASH STACK
Range :
Boring :

El. :
Sample: CLASS I
Part :

FILE : 97
TESTED BY : CBE
Computed By:MHD
Checked By : TAC
Report Date:11-15-94

Specific Gravity = 2.708
Flask No. = 22.00
Soil Wt.(gm) = 50.00
Temp.(deg.c.) = 23.50
Total Wt.(gm) =708.17

Moisture Determination
Dry Wt.+Tare(gm)= 540.80
Tare Wt(gm) = 105.10

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 70.10
Tare Wt(gm) = 40.10
Dry Wt.+Tare(gm)= 69.30
Moisture(%) = 2.74

Liquid Limit
Blows = 27.00
Wet Wt.(gm) = 9.86
Dry Wt.(gm) = 7.44
Tare Wt.(gm) = 4.03
Liquid Limit(%) = 71.63
Plasticity Index= 38.83

Plastic Limit
Wet Wt.(gm) = 16.60
Dry Wt.(gm) = 13.52
Tare Wt.(gm) = 4.13

Plastic Limit(%)= 32.80

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 435.7

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	28.4	93.5	9.5300
NO.4	51.0	88.3	4.7500
NO.10	61.9	85.8	2.0000
NO.20	1.0	84.0	0.8500
NO.40	1.8	82.6	0.4250
NO.50	2.1	82.1	0.3000
NO.100	2.9	80.7	0.1500
NO.200	4.0	78.7	0.0750

Air Dry Weight(gm)= 50.00 Corrected Weight(gm)= 48.67

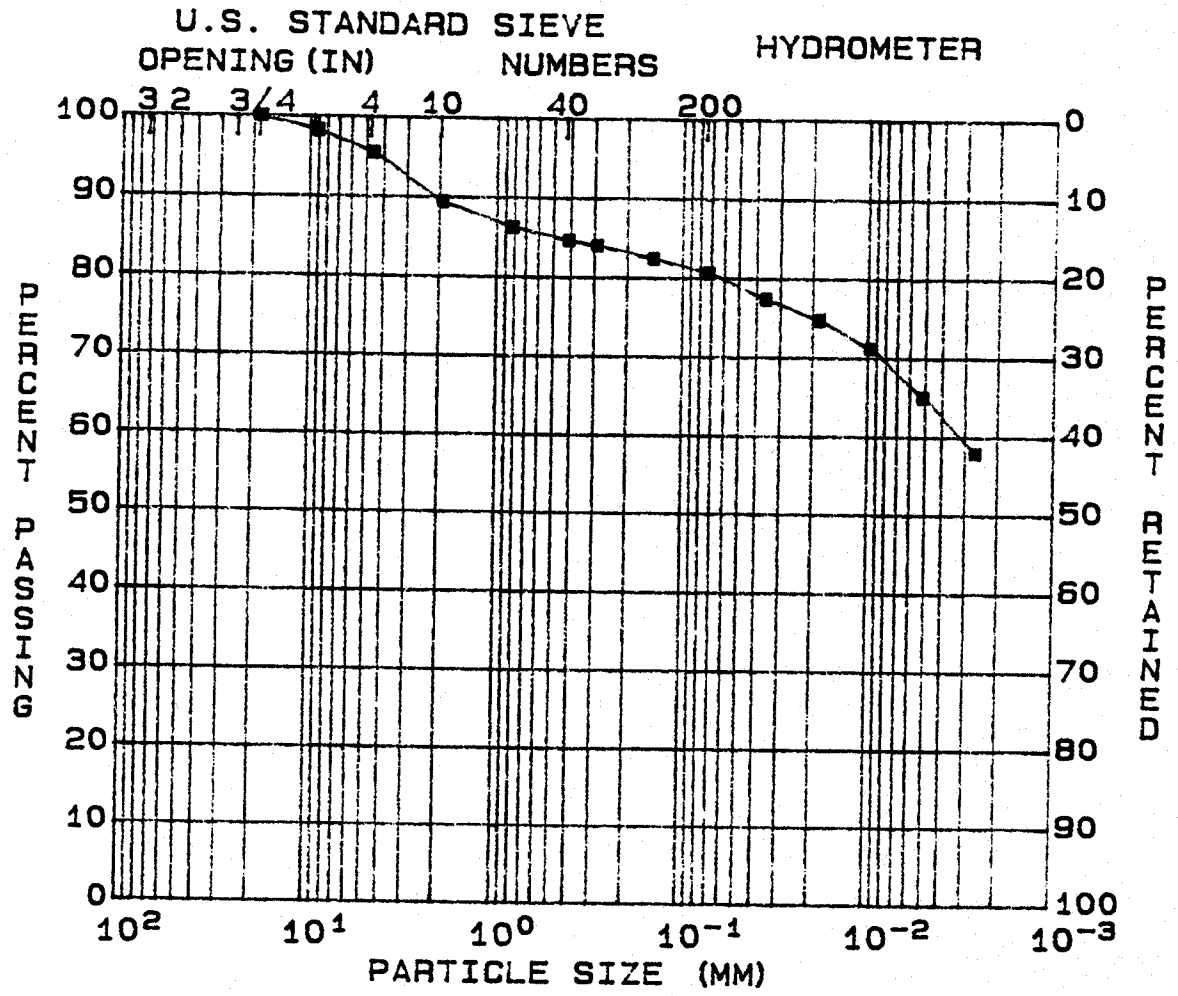
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	21.3	51.5	7.0	77.4	0.0366
4 min.	21.3	49.5	7.0	74.0	0.0187
15 min.	21.3	48.0	7.0	71.4	0.0098
1 hour	21.3	45.5	7.0	67.0	0.0050
4 hours	21.3	42.0	7.0	60.9	0.0026

Soil Symbol= CH (Inorganic clay of high plasticity)
Gravel(%)=12 Sand(%)=10 Silt(%)= 12 Clay(%)= 66

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: BULL RUN FP
FEATURE: STAGE 2
STATION: DRY FLY ASH STACK
RANGE :
PART :

BORING:
EL. :
SAMPLE: CLASS II
DATE : 11-15-94



GRAVEL (%)	= 4	D10 (MM)	= --
SAND (%)	= 15	D30 (MM)	= --
SILT (%)	= 16	D60 (MM)	= --
CLAY (%)	= 65	COEF UNIF	= --

SOIL SYMBOL	= CH/MH	L.L. (%)	= 64	DENSITY (pcf)	= --
MOISTURE (%)	= 20.4	P.I. (%)	= 33	SATURATION (%)	= --
SP. GR.	= 2.74			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: BULL RUN FP
Feature: STAGE 2
Station: DRY FLY ASH STACK
Range :
Boring :

El. :
Sample: CLASS II
Part :

FILE : 98
TESTED BY : CBE
Computed By:MHD
Checked By : TA
Report Date:11-15-94

Specific Gravity = 2.744
Flask No. = 24.00
Soil Wt.(gm) = 50.00
Temp.(deg.c.) = 23.50
Total Wt.(gm) =707.45

Moisture Determination
Dry Wt.+Tare(gm)= 557.20
Tare Wt(gm) = 103.30

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 67.90
Tare Wt(gm) = 37.90
Dry Wt.+Tare(gm)= 67.20
Moisture(%) = 2.39

Liquid Limit
Blows = 30.00
Wet Wt.(gm) = 10.16
Dry Wt.(gm) = 7.86
Tare Wt.(gm) = 4.21
Liquid Limit(%) = 64.41
Plasticity Index= 32.73

Plastic Limit
Wet Wt.(gm) = 15.77
Dry Wt.(gm) = 12.97
Tare Wt.(gm) = 4.13
Plastic Limit(%)= 31.67

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 453.9

Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	3.8	99.2	9.5300
NO.4	16.7	96.3	4.7500
NO.10	44.6	90.2	2.0000
NO.20	1.7	87.0	0.8500
NO.40	2.6	85.4	0.4250
NO.50	3.0	84.6	0.3000
NO.100	3.9	83.0	0.1500
NO.200	4.9	81.1	0.0750

Air Dry Weight(gm)= 50.00
Corrected Weight(gm)= 48.83

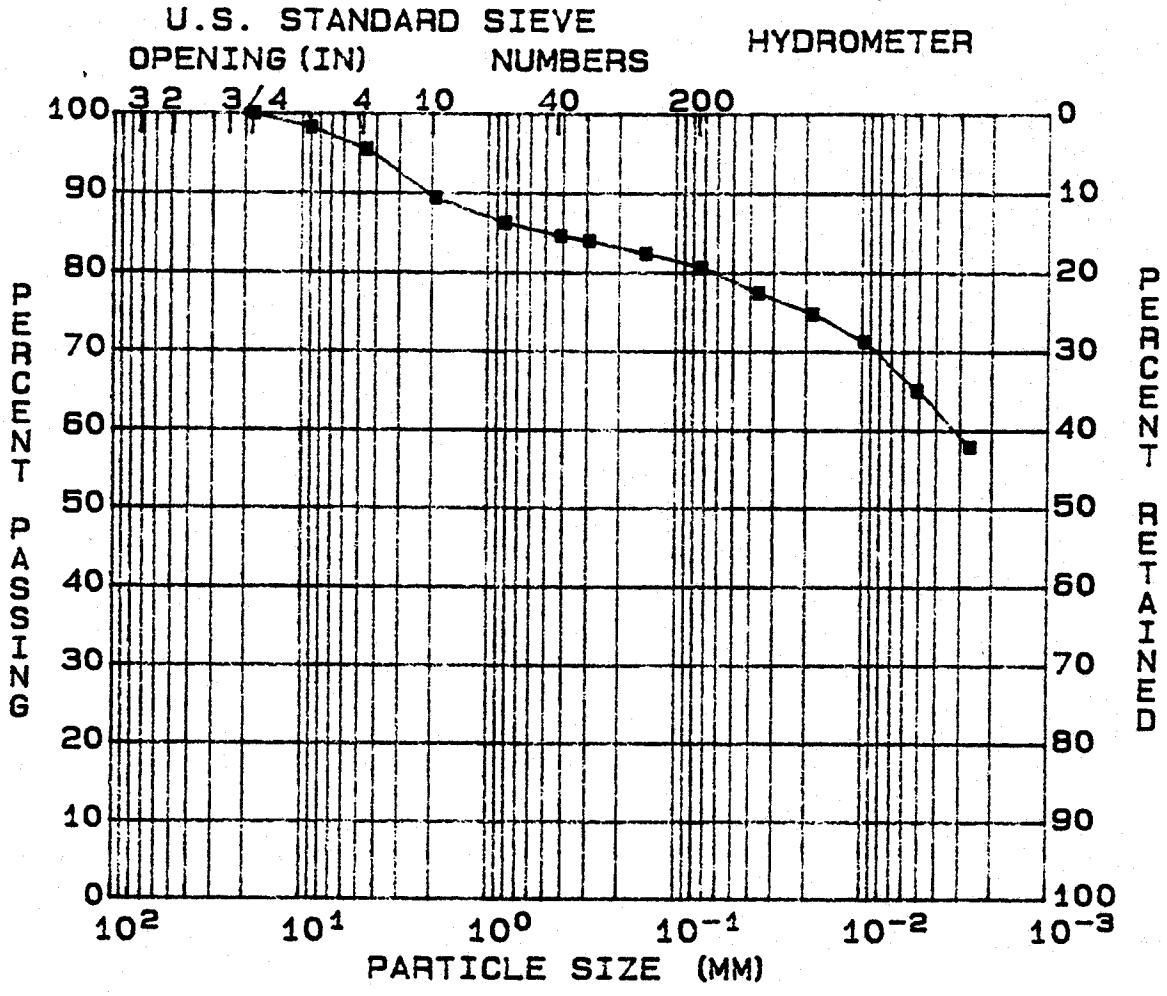
Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	21.3	50.0	7.0	77.8	0.0368
4 min.	21.3	48.5	7.0	75.1	0.0187
15 min.	21.3	46.5	7.0	71.5	0.0098
1 hour	21.3	43.0	7.0	65.1	0.0051
4 hours	21.3	39.0	7.0	57.9	0.0026

Soil Symbol= CH/MH (Inorganic clayey silt of high plasticity)
Gravel(%)= 4 Sand(%)=15 Silt(%)= 16 Clay(%)= 65

SINGLETON LABORATORIES
PARTICLE SIZE ANALYSIS

PROJECT: BULL RUN FP
FEATURE: STAGE 2
STATION: DRY FLY ASH STACK
RANGE :
PART :

BORING:
EL. :
SAMPLE: CLASS II
DATE : 11-15-94



GRAVEL (%)	= 4	D10 (MM)	= --
SAND (%)	= 15	D30 (MM)	= --
SILT (%)	= 16	D60 (MM)	= --
CLAY (%)	= 65	COEF UNIF	= --

SOIL SYMBOL	= CH/MH	L.L. (%)	= 64	DENSITY (pcf)	= --
MOISTURE (%)	= 20.4	P.I. (%)	= 32	SATURATION (%)	= --
SP. GR.	= 2.74			VOID RATIO	= --

REMARKS:

Singleton Laboratories
General Classification Tests

Project: BULL RUN FP
Feature: STAGE 2
Station: DRY FLY ASH STACK
Range :
Boring :

El. :
Sample: CLASS II
Part :

FILE : 99
TESTED BY : CBE
Computed By:MHD
Checked By : TAC
Report Date:11-15-94

Specific Gravity = 2.744
Flask No. = 24.00
Soil Wt.(gm) = 50.00
Temp.(deg.c.) = 23.50
Total Wt.(gm) =707.45

Moisture Determination
Dry Wt.+Tare(gm)= 557.20
Tare Wt(gm) = 103.30

Hygroscopic Moisture
Wet Wt.+Tare(gm)= 67.90
Tare Wt(gm) = 37.90
Dry Wt.+Tare(gm)= 67.20
Moisture(%) = 2.39

Liquid Limit
Blows = 30.00
Wet Wt.(gm) = 10.05
Dry Wt.(gm) = 7.74
Tare Wt.(gm) = 4.06
Liquid Limit(%) = 64.16
Plasticity Index= 32.49

Plastic Limit
Wet Wt.(gm) = 15.77
Dry Wt.(gm) = 12.97
Tare Wt.(gm) = 4.13
Plastic Limit(%)= 31.67

Sieve and Hydrometer Analysis
Total Dry Weight(gm) = 453.9

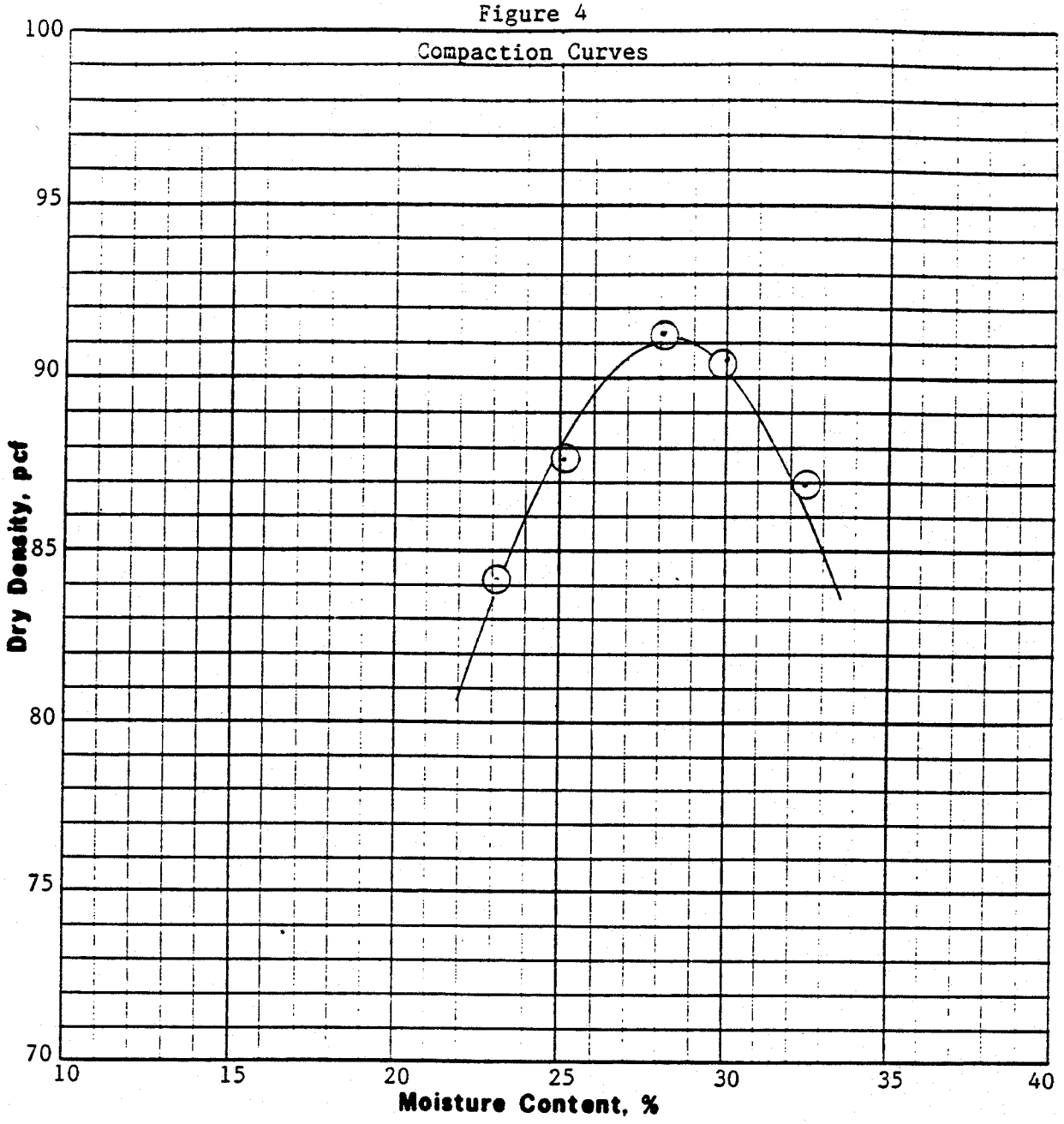
Sieve	Wt.Ret.	% Pass.	Size(mm)
3 in.	0.0	100.0	76.2000
2 in.	0.0	100.0	50.8000
1.5 in.	0.0	100.0	38.1000
1 in.	0.0	100.0	25.4000
3/4 in.	0.0	100.0	19.0500
3/8 in.	3.8	99.2	9.5300
NO.4	16.7	96.3	4.7500
NO.10	44.6	90.2	2.0000
NO.20	1.7	87.0	0.8500
NO.40	2.6	85.4	0.4250
NO.50	3.0	84.6	0.3000
NO.100	3.9	83.0	0.1500
NO.200	4.9	81.1	0.0750

Air Dry Weight(gm)= 50.00
Corrected Weight(gm)= 48.83

Time	Temp.	Hyd.Rdg	Corr	% Pass	Size(mm)
1 min.	21.3	50.0	7.0	77.8	0.0368
4 min.	21.3	48.5	7.0	75.1	0.0187
15 min.	21.3	46.5	7.0	71.5	0.0098
1 hour	21.3	43.0	7.0	65.1	0.0051
4 hours	21.3	39.0	7.0	57.9	0.0026

Soil Symbol= CH/MH (Inorganic clayey silt of high plasticity)
Gravel(%)= 4 Sand(%)=15 Silt(%)= 16 Clay(%)= 65

Figure 4



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH-I	12	10	12	66	2.71	72	39	28.1	91.2

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:
Red Fat Clay mixed with 10% Chert
6-in. mold
Borrow (Rogers Group)

Project Bull Run Fossil Plant

Feature Stage 2 Dry Fly Ash Stack

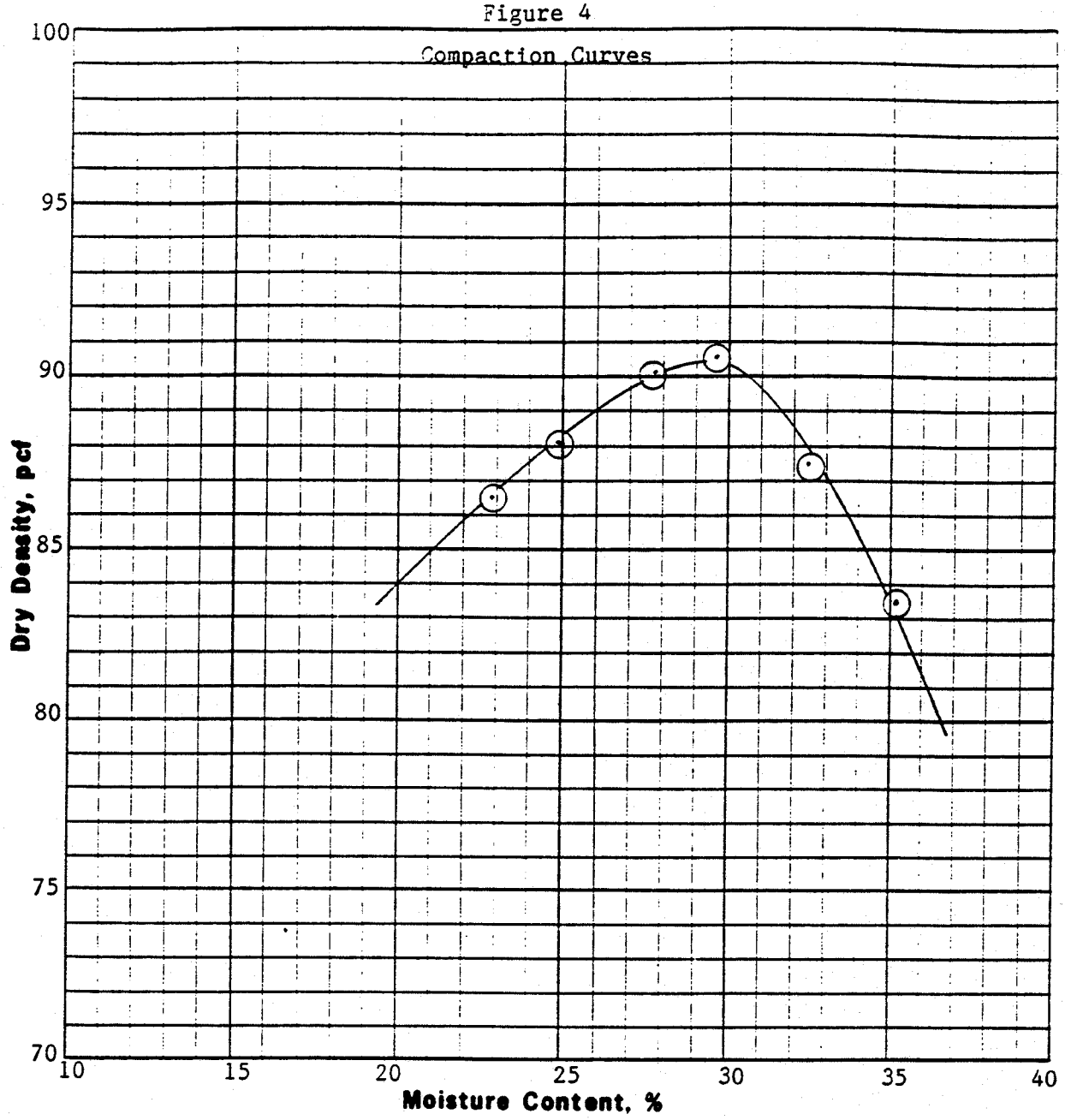
ASTM Designation D 698C

Date Tested 8/13/94

COMPACTION TEST (FAMILY OF CURVES)

T... AFI ... TAL

Figure 4



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
CH/MH-II	4	15	16	65	2.74	64	33	29.6	90.7

Plus No. 4 Specific Gravity, S S D	
Plus No. 4 Absorption, %	

Remarks:

Red Fat Clay

Borrow (Rogers Group)

Project Bull Run Fossil Plant

Feature Stage 2 Dry Fly Ash Stack

ASTM Designation 698A

Date Tested 8/13/94

COMPACTION TEST (FAMILY OF CURVES)

*** PERMEABILITY ANALYSIS ***

PROJECT: BULL RUN FP - STAGE 2, DRY FLY ASH STACK
FEATURE: H-LINE -1.0'
TEST NO: 1 8+50

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	0.7123	0.3656	39.35	12.22	79200.0	165.60	155.89	0.000000057
2	14.0	0.7123	0.3656	39.35	12.22	50400.0	165.10	159.50	0.000000051
3	14.0	0.7123	0.3656	39.35	12.22	58800.0	165.60	163.00	0.000000020
4	14.0	0.7123	0.3656	39.35	12.22	54000.0	165.60	158.69	0.000000059
								Avg=	4.70023E-08

REMARKS:

*** PERMEABILITY ANALYSIS ***

PROJECT: BULL RUN FP - STAGE 2, DRY FLY ASH STACK
FEATURE: G-LINE -1.0'
TEST NO: 2 6+00

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	0.7123	0.3918	39.44	13.04	79200.0	164.60	157.14	0.000000049
2	14.0	0.7123	0.3918	39.44	13.04	79200.0	164.60	158.21	0.000000041
3	14.0	0.7123	0.3918	39.44	13.04	28800.0	165.10	162.26	0.000000050
4	14.0	0.7123	0.3918	39.44	13.04	54000.0	164.60	159.27	0.000000051
								Avg=	4.80138E-08

REMARKS:

*** PERMEABILITY ANALYSIS ***

PROJECT: BULL RUN FP - STAGE 2, DRY FLY ASH STACK
FEATURE: A-LINE -1.0'
TEST NO: 3 8+00

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	0.7123	0.3777	39.53	12.94	79200.0	165.20	157.80	0.0000000468
2	14.0	0.7123	0.3777	39.53	12.94	79200.0	165.10	154.79	0.0000000658
3	14.0	0.7123	0.3777	39.53	12.94	50400.0	165.20	158.63	0.0000000651
4	14.0	0.7123	0.3777	39.53	12.94	54000.0	163.60	155.21	0.0000000788
								Avg=	6.40902E-08

REMARKS:

*** PERMEABILITY ANALYSIS ***

PROJECT: BULL RUN FP - STAGE 2, DRY FLY ASH STACK
FEATURE: A-LINE -1.0'
TEST NO: 4 5+00

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	0.7123	0.3821	39.52	12.37	79200.0	167.60	162.44	0.0000000307
2	14.0	0.7123	0.3821	39.52	12.37	79200.0	167.20	162.50	0.0000000280
3	14.0	0.7123	0.3821	39.52	12.37	50400.0	165.60	161.62	0.0000000376
4	14.0	0.7123	0.3821	39.52	12.37	54000.0	165.10	160.76	0.0000000384
								Avg=	3.36859E-08

REMARKS:

*** PERMEABILITY ANALYSIS ***

PROJECT: BULL RUN FP - STAGE 2, DRY FLY ASH STACK
FEATURE: A-LINE -0.0'
TEST NO: 5 7+00

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	0.7123	0.3872	39.44	12.38	32400.0	166.60	165.17	0.0000000210
2	14.0	0.7123	0.3872	39.44	12.38	50400.0	166.80	163.58	0.0000000305
3	14.0	0.7123	0.3872	39.44	12.38	28800.0	166.80	164.83	0.0000000325
4	14.0	0.7123	0.3872	39.44	12.38	54000.0	165.60	162.68	0.0000000259
								Avg=	2.74665E-08

REMARKS:

*** PERMEABILITY ANALYSIS ***

PROJECT: BULL RUN FP - STAGE 2, DRY FLY ASH STACK
FEATURE: F-LINE -0.0'
TEST NO: 6 7+00

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	0.7123	0.3829	39.35	12.26	32400.0	166.60	161.18	0.0000000792
2	14.0	0.7123	0.3829	39.35	12.26	50400.0	166.30	159.44	0.0000000649
3	14.0	0.7123	0.3829	39.35	12.26	28800.0	166.60	153.27	0.0000002247
4	14.0	0.7123	0.3829	39.35	12.26	54000.0	166.60	160.46	0.0000000540
								Avg=	1.05681E-07

REMARKS:

*** PERMEABILITY ANALYSIS ***

PROJECT: BULL RUN FP
FEATURE: STAGE 2 DRY FLY ASH STACK
TEST NO: 7 -1.0' 4+00 G-LINE

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	FINAL CM	PERMEABILITY K CM/SEC
1	14.0	19.8650	0.3040	39.85	12.23	61200.0	188.60	183.00	0.0000000453
2	14.0	19.8650	0.3040	39.85	12.23	32400.0	188.60	185.30	0.0000000501
3	14.0	19.8650	0.3040	39.85	12.23	27000.0	188.60	185.90	0.0000000491
4	14.0	19.8650	0.3040	39.85	12.23	61200.0	188.10	182.90	0.0000000421
								Avg=	4.66287E-08

REMARKS:

*** PERMEABILITY ANALYSIS ***

PROJECT: BULL RUN FP - STAGE 2 DRY FLY ASH STACK
FEATURE: H-LINE -1.0'
TEST NO: 8 1+00

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	19.8650	0.3040	39.85	11.80	25200.0	188.60	187.20	0.0000000262
2	14.0	19.8650	0.3040	39.85	11.80	32400.0	188.60	187.20	0.0000000204
3	14.0	19.8650	0.3040	39.85	11.80	27000.0	188.60	187.40	0.0000000210
4	14.0	19.8650	0.3040	39.85	11.80	61200.0	188.10	186.40	0.0000000132
								Avg=	2.01796E-08

REMARKS:

*** PERMEABILITY ANALYSIS ***

PROJECT: BULL RUN FP - STAGE 2 DRY FLY ASH STACK
FEATURE: D-LINE -0.0'
TEST NO: 9 2+50

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	19.8650	0.3040	39.85	11.17	61200.0	188.60	184.60	0.0000000294
2	14.0	19.8650	0.3040	39.85	11.17	25200.0	188.60	186.60	0.0000000355
3	14.0	19.8650	0.3040	39.85	11.17	27000.0	188.60	186.90	0.0000000281
4	14.0	19.8650	0.3040	39.85	11.17	61200.0	188.10	184.90	0.0000000235
								Avg=	2.91381E-08

REMARKS:

*** PERMEABILITY ANALYSIS ***

PROJECT: BULL RUN FP - STAGE 2 DRY FLY ASH STACK
FEATURE: B-LINE -1.0'
TEST NO: 10 1+00

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	19.8650	0.3040	39.85	12.17	61200.0	181.60	177.30	0.0000000358
2	14.0	19.8650	0.3040	39.85	12.17	27000.0	186.60	184.60	0.0000000365
3	14.0	19.8650	0.3040	39.85	12.17	61200.0	185.60	182.10	0.0000000285
4	14.0	19.8650	0.3040	39.85	12.17	61200.0	184.10	180.60	0.0000000287
								Avg=	3.23704E-08

REMARKS:

*** PERMEABILITY ANALYSIS ***

PROJECT: BULL RUN FP - STAGE 2 DRY FLY ASH STACK
FEATURE: F-LINE - 0'
TEST NO: 11 3+00

RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	19.8650	0.3040	39.85	10.64	27000.0	186.60	181.10	0.0000000886
2	14.0	19.8650	0.3040	39.85	10.64	61200.0	185.60	176.00	0.0000000694
3	14.0	19.8650	0.3040	39.85	10.64	21600.0	186.60	182.60	0.0000000802
4	14.0	19.8650	0.3040	39.85	10.64	61200.0	194.10	173.10	0.0000001496
								Avg=	9.69649E-08

REMARKS:

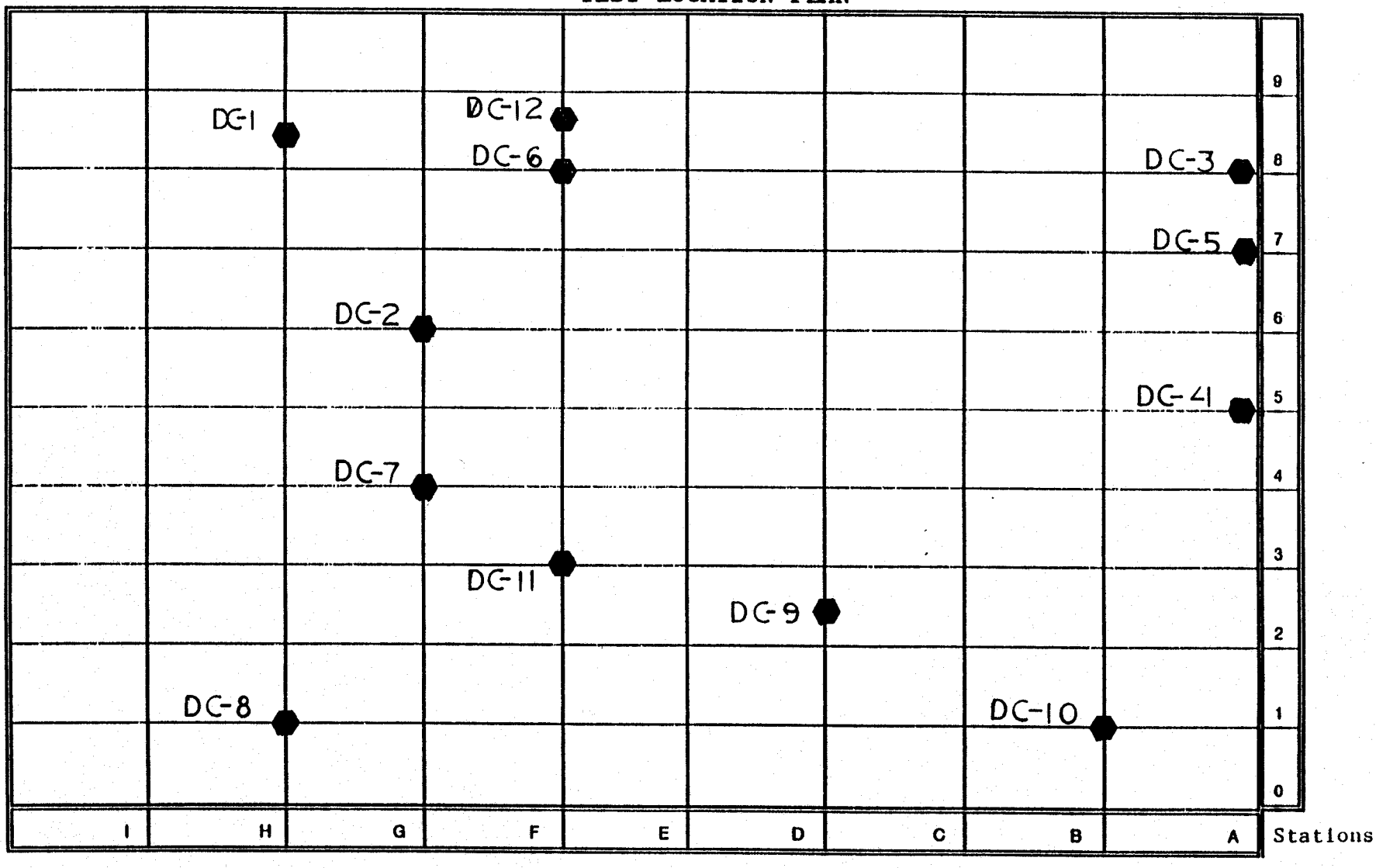
*** PERMEABILITY ANALYSIS ***

PROJECT: BULL RUN FP - STAGE 2 DRY FLY ASH STACK
FEATURE: F-LINE _0.0'
TEST NO: 12 8+50

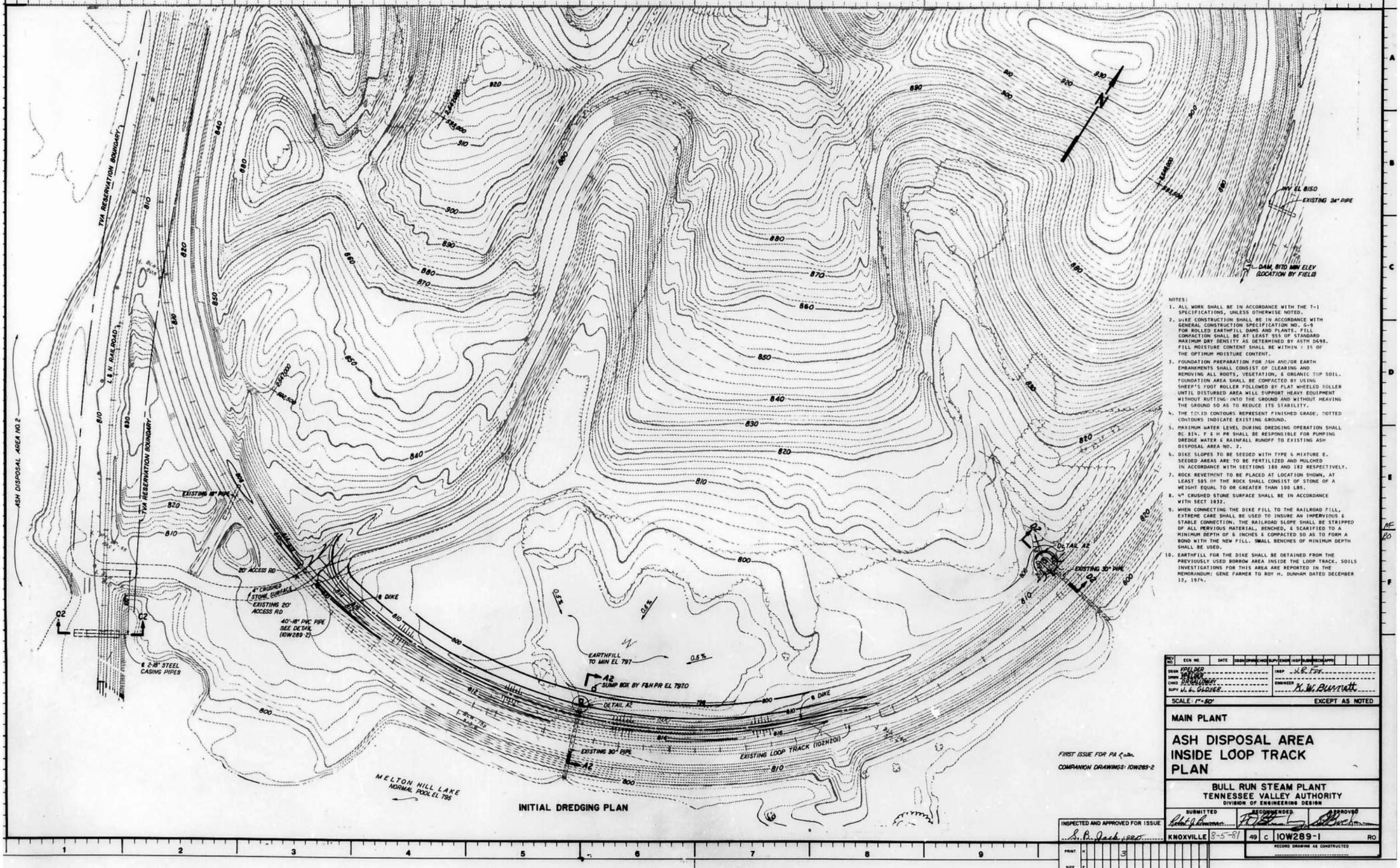
RUN NO.	CONF. PRESS PSI	AREA PIPETTE IN CM2	AREA PIPETTE OUT CM2	AREA SPEC CM2	HT SPEC CM	TIME INTERVAL SEC	HEAD DIFF INITIAL CM	HEAD DIFF FINAL CM	PERMEABILITY K CM/SEC
1	14.0	19.8650	0.3040	39.85	12.19	27000.0	186.60	152.60	0.0000006821
2	14.0	19.8650	0.3040	39.85	12.19	61200.0	185.60	138.10	0.0000004423
3	14.0	19.8650	0.3040	39.85	12.19	21600.0	185.60	167.10	0.0000004451
4	14.0	19.8650	0.3040	39.85	12.19	61200.0	184.10	123.10	0.0000006022
								Avg=	5.42932E-07

REMARKS:

TVA BULL RUN FOSSIL PLANT
DRY FLY ASH STACK STAGE II - GEOLOGIC BUFFER
TEST LOCATION PLAN



ATTACHMENT C
TVA DRAWINGS



INITIAL DREDGING PLAN

NOTES:

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE T-1 SPECIFICATIONS, UNLESS OTHERWISE NOTED.
2. DIKE CONSTRUCTION SHALL BE IN ACCORDANCE WITH GENERAL CONSTRUCTION SPECIFICATION NO. G-9 FOR ROLLED EARTHFILL DAMS AND PLANTS. FILL COMPACTION SHALL BE AT LEAST 95% OF STANDARD MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D698. FILL MOISTURE CONTENT SHALL BE WITHIN ± 3% OF THE OPTIMUM MOISTURE CONTENT.
3. FOUNDATION PREPARATION FOR ASH AND/OR EARTH EMBANKMENTS SHALL CONSIST OF CLEARING AND REMOVING ALL ROOTS, VEGETATION, & ORGANIC TOP SOIL. FOUNDATION AREA SHALL BE COMPACTED BY USING SHEEPS 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.
4. THE SOLID CONTOURS REPRESENT FINISHED GRADE; DOTTED CONTOURS INDICATE EXISTING GROUND.
5. MAXIMUM WATER LEVEL DURING DREDGING OPERATION SHALL BE 814. F & H PR SHALL BE RESPONSIBLE FOR PUMPING DREDGE WATER & RAINFALL RUNOFF TO EXISTING ASH DISPOSAL AREA NO. 2.
6. DIKE SLOPES TO BE SEEDED WITH TYPE 6 MIXTURE E. SEEDED AREAS ARE TO BE FERTILIZED AND MULCHED IN ACCORDANCE WITH SECTIONS 180 AND 182 RESPECTIVELY.
7. ROCK REVETMENT TO BE PLACED AT LOCATION SHOWN, AT LEAST 50% OF THE ROCK SHALL CONSIST OF STONE OF A WEIGHT EQUAL TO OR GREATER THAN 100 LBS.
8. 4" CRUSHED STONE SURFACE SHALL BE IN ACCORDANCE WITH SECT 1032.
9. WHEN CONNECTING THE DIKE FILL TO THE RAILROAD FILL, EXTREME CARE SHALL BE USED TO INSURE AN IMPERVIOUS & STABLE CONNECTION. THE RAILROAD SLOPE SHALL BE STRIPPED OF ALL PERVIOUS MATERIAL, BENCHED, & SCARIFIED TO A MINIMUM DEPTH OF 6 INCHES & COMPACTED SO AS TO FORM A BOND WITH THE NEW FILL. SMALL BENCHES OF MINIMUM DEPTH SHALL BE USED.
10. EARTHFILL FOR THE DIKE SHALL BE OBTAINED FROM THE PREVIOUSLY USED BORROW AREA INSIDE THE LOOP TRACK. SOILS INVESTIGATIONS FOR THIS AREA ARE REPORTED IN THE MEMORANDUM: GENE FARMER TO ROY H. DUNHAM DATED DECEMBER 12, 1974.

FIRST ISSUE FOR PA Letter
COMPANION DRAWINGS: 10W289-2

INSPECTED AND APPROVED FOR ISSUE
S. P. Jack, PROJ. ENGR.

REV NO	ECN NO.	DATE	DSGN	DRWN	CHKD	SUPV	CHGR	INSP	SUBM	RECM	APPD
			VPELDER								

DSGN VPELDER
DRWN [illegible]
CHKD [illegible]
SUPV J. L. GLOVER
INSP J. R. Fox
ENGINEER K. W. Burnett

SCALE: 1"=80' EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA INSIDE LOOP TRACK PLAN

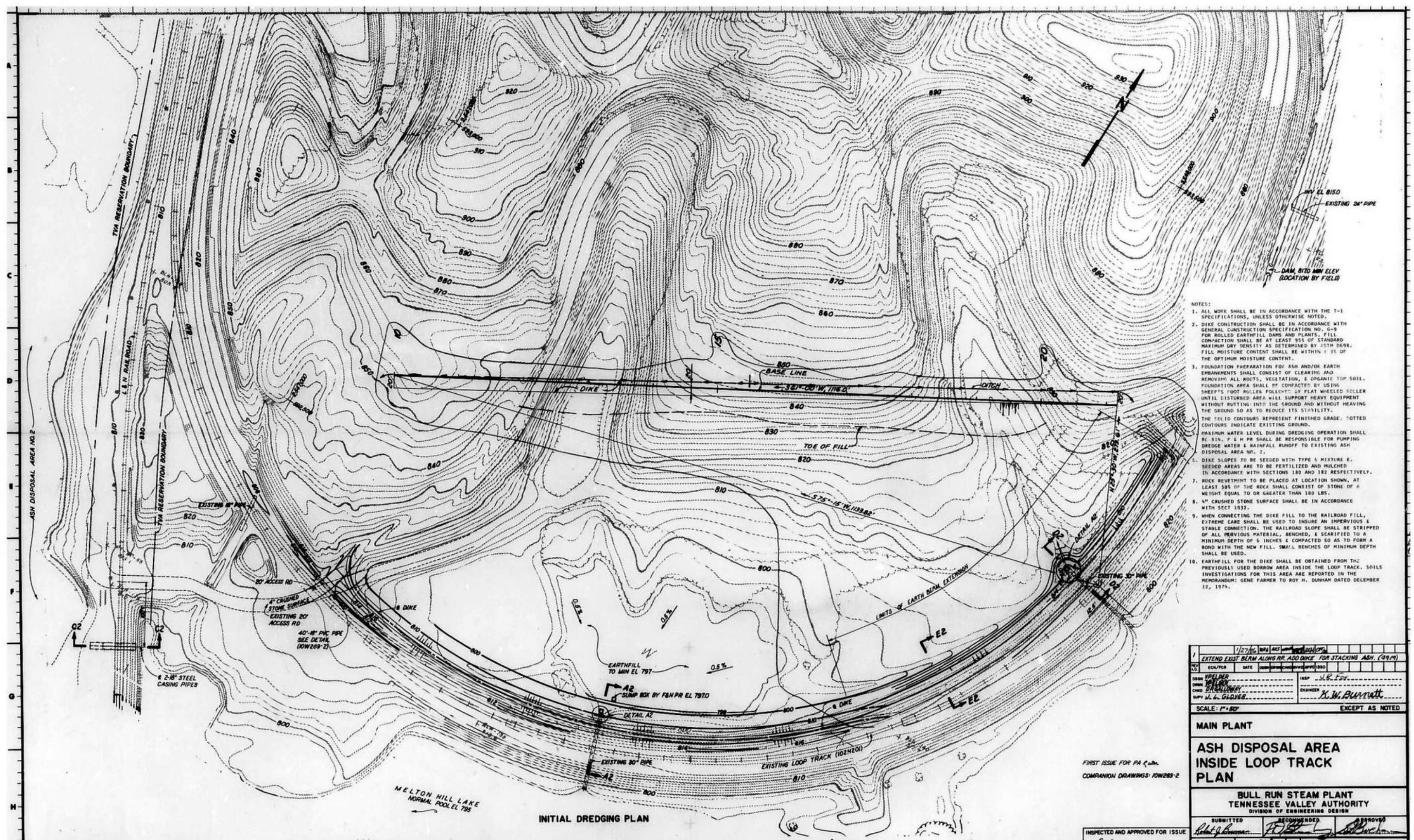
BULL RUN STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

SUBMITTED	RECOMMENDED	APPROVED
Robt J Newman	F H Brown	Carl Borchers

KNOXVILLE 8-5-81 | 49 | C | 10W289-1 | RO

RECORD DRAWING AS CONSTRUCTED

PRINT H 3
SIZE F



NOTES:

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE T-I SPECIFICATIONS, UNLESS OTHERWISE NOTED.
2. DIKE CONSTRUCTION SHALL BE IN ACCORDANCE WITH GENERAL CONSTRUCTION SPECIFICATION NO. G-9 FOR ROLLED EARTHFILL DAMS AND PLANTS. FILL COMPACTION SHALL BE AT LEAST 95% OF STANDARD MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D698. FILL MOISTURE CONTENT SHALL BE WITHIN ± 3% OF THE OPTIMUM MOISTURE CONTENT.
3. FOUNDATION PREPARATION FOR ASH AND/OR EARTH EMBANKMENTS SHALL CONSIST OF CLEARING AND REMOVING ALL ROOTS, VEGETATION, & ORGANIC TOP SOIL. FOUNDATION AREA SHALL BE COMPACTED BY USING SHEEPS 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.
4. THE SOLID CONTOURS REPRESENT FINISHED GRADE, DOTTED CONTOURS INDICATE EXISTING GROUND.
5. MAXIMUM WATER LEVEL DURING DREDGING OPERATION SHALL BE 814. F & H PR SHALL BE RESPONSIBLE FOR PUMPING DREDGE WATER & RAINFALL RUNOFF TO EXISTING ASH DISPOSAL AREA NO. 2.
6. DIKE SLOPES TO BE SEEDED WITH TYPE 6 MIXTURE E. SEEDED AREAS ARE TO BE FERTILIZED AND MULCHED IN ACCORDANCE WITH SECTIONS 180 AND 182 RESPECTIVELY.
7. ROCK REVETMENT TO BE PLACED AT LOCATION SHOWN, AT LEAST 50% OF THE ROCK SHALL CONSIST OF STONE OF A WEIGHT EQUAL TO OR GREATER THAN 100 LBS.
8. 4" CRUSHED STONE SURFACE SHALL BE IN ACCORDANCE WITH SECT 1032.
9. WHEN CONNECTING THE DIKE FILL TO THE RAILROAD FILL, EXTREME CARE SHALL BE USED TO INSURE AN IMPERVIOUS & STABLE CONNECTION. THE RAILROAD SLOPE SHALL BE STRIPPED OF ALL PERVIOUS MATERIAL, BENCHED, & SCARIFIED TO A MINIMUM DEPTH OF 6 INCHES & COMPACTED SO AS TO FORM A BOND WITH THE NEW FILL. SMALL BENCHES OF MINIMUM DEPTH SHALL BE USED.
10. EARTHFILL FOR THE DIKE SHALL BE OBTAINED FROM THE PREVIOUSLY USED BORROW AREA INSIDE THE LOOP TRACK. SOILS INVESTIGATIONS FOR THIS AREA ARE REPORTED IN THE MEMORANDUM: GENE FARMER TO ROY H. DUNHAM DATED DECEMBER 12, 1974.

FIRST ISSUE FOR PA Rev.

COMPANION DRAWINGS: 10W289-2

REV NO	ECN/PCR	DATE	DESIGN	DRAWN	CHECK	SUPV	APPD	ISSD
1	EXTEND EXIST BERM ALONG RR, ADD DIKE FOR STACKING ASH. (3979)	1/27/76	MPS	AKT	WEH	DCH	CPW	

DESIGN KPELDER
DRAWN WELLOX
CHECK BHOLLOWAY
SUPV W. L. GLOVER

INSP N.B. Fox
ENGINEER R. W. Burnett

SCALE: 1"=60' EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA INSIDE LOOP TRACK PLAN

BULL RUN STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

SUBMITTED	RECOMMENDED	APPROVED
Robert J. Bowman		

INSPECTED AND APPROVED FOR ISSUE
S. R. Jack 1980

KNOXVILLE 8-5-81 | 49 | C | 10W289-1 | R1

RECORD DRAWING AS CONSTRUCTED

PRINT H 3
SIZE F
BW OR PRINTS REQD: BW EE CE AD CO ED MD SW BL PA

10N213 | 4 | C | 49

ASSUMED NORTH

SUMMARY OF QUANTITIES - DIKES TO INITIAL EL 800

Area	Item No. Location	120 Unclass. Exc. Cu. Yd.	123 Earth Bar. Cu Yd	210 Surfacing Ton	403 Dens. Str. Cu. Yd.	418 Relief Steel lb	620 Class. III Relief Conc. Pipe - Lin. Ft. 18"	36	40	#36 Filter Blanket Tus	830 Riprap - Cu. Yd. Type A	Type B	Type C	Type D	Rock Fill Cu. Yd.
Ash Disposal Dike 1	1-A - 1-B		7,050	130						290		415			
	1-C - 1-E		15,100	285	4.6	630	11	96	12	650		18	1440		
	1-E - 1-F		23,250	455	4.6	630	11	96	12	835	460	18	1830		
	1-F - 1-G		16,950	270						885	540	1800			
	Sub Total		62,350	1170	9.2	1260	14	192	24	2660	1000	1951	3270		
Ash Disposal Dike 2	2-A - 2-B		31,850	280						930	625	1900			
	2-B - 2-C		112,300	780	9.2	1260	22	192	24	2610	2234	36	5435		
	Curve @ 2-F													705	
	2-C - 2-F		103,100	520	4.6	630	11	104	12	3390	1420	18	7310		
	Sub Total		250,050	1580	18.8	1830	36	274	36	6930	4279	1434	18765	705	
Channel Dikes	D-1 - D-2		17,750	75						230		360			
	D-2 - D-3		42,500	210						1040		370	1170		
	Corner @ D-3													940	
	D-2 - T-1		34,800	190						770		445	1899		
	T-1 - T-2		22,100	295						930		610	1130		
	T-2 - T-4		48,600	155						550		30	1170		
Skimmer Wall Dike	S-1		2200							43		30	50		
	Sub Total		167,950	925						3573		1795	4520	940	
Underwater Dam A	A-5 - T-6														2900
Underwater Dam B	B-6 - T-7														2600
Channel		91,240													
	Totals	91,240	498,350	3675	23.0	3150	58	466	60	13,146	5278	4980	20,535	1645	5500

CAPACITY ASH DISPOSAL AREAS
ACCUMULATION OF UNIT YEARS

AREA NO. 1 Elevations	Unit yrs.*	AREA NO. 2 Elevations	Unit yrs.*
750	1.2	790	4.11
795	2.3	795	7.8
800	3.8	800	11.8
805	5.6	805	15.3
810	7.6	810	19.1

*Based on 900,000 KW Unit

Scale: 1" = 200'

MAIN PLANT

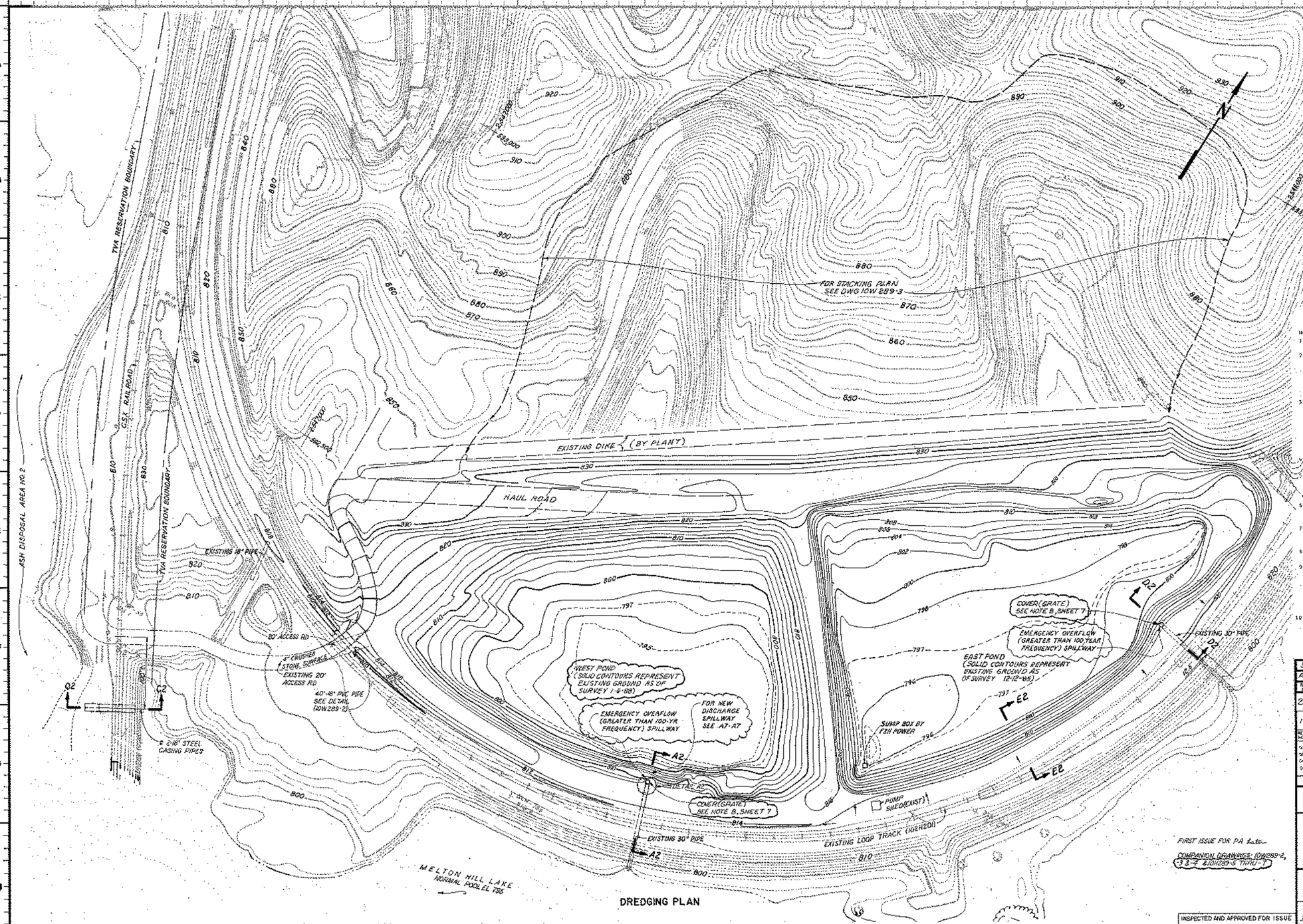
ASH DISPOSAL AREAS AND DIKES

BULL RUN STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF DESIGN

SUBMITTED	RECOMMENDED	APPROVED
	W.M. Calvert	W.C. Bray
KNOXVILLE	4-20-62	49 C 4 10N213 RH

RECORD DRAWING AS CONSTRUCTED
Nov. 2 1970

COMPANION DRAWINGS: 10N212, 214, 284



NOTES:

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE F-1 SPECIFICATIONS, UNLESS OTHERWISE NOTED.
2. DIKE CONSTRUCTION SHALL BE IN ACCORDANCE WITH GENERAL CONSTRUCTION SPECIFICATION NO. G-5 FOR ROLLED EARTHFILL DAMS AND PLANTS. FILL COMPACTION SHALL BE AT LEAST 95% OF STANDARD MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D698. FILL MOISTURE CONTENT SHALL BE WITHIN ± 3% OF THE OPTIMUM MOISTURE CONTENT.
3. FOUNDATION PREPARATION FOR ASH AND/OR EARTH EMBANKMENTS SHALL CONSIST OF CLEARING AND REMOVING ALL ROOTS, VEGETATION, & 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.
4. THE SOLID CONTOURS REPRESENT FINISHED GRADE. DOTTED CONTOURS INDICATE EXISTING GROUND.
5. MAXIMUM WATER LEVEL DURING DREDGING OPERATION SHALL NOT EXCEED EL 795. CONTRACTOR SHALL BE RESPONSIBLE FOR PUMPING SEEPAGE WATER & RAINFALL RUNOFF TO EXISTING ASH DISPOSAL AREA NO. 2.
6. DIKE SLOPES TO BE SEEDED WITH TYPE A MIXTURE C. SEEDED AREAS ARE TO BE FERTILIZED AND MULCHED IN ACCORDANCE WITH SECTIONS 130 AND 132 RESPECTIVELY.
7. ROCK RIVETMENT TO BE PLACED AT LOCATION SHOWN. AT LEAST 50% OF THE ROCK SHALL CONSIST OF STONE OF A WEIGHT EQUAL TO OR GREATER THAN 100 LBS.
8. 4" CRUSHED STONE SURFACE SHALL BE IN ACCORDANCE WITH SECT 1039.
9. WHEN CONNECTING THE DIKE FILL TO THE RAILROAD FILL, EXTREME CARE SHALL BE USED TO INSURE AN IMPERVIOUS & STABLE CONNECTION. THE RAILROAD SLOPE SHALL BE STRIPPED OF ALL PERVIOUS MATERIAL, BENCHED, & SCARIFIED TO A MINIMUM DEPTH OF 6 INCHES & COMPACTED SO AS TO FORM A BOND WITH THE NEW FILL. SMALL BENCHES OF MINIMUM DEPTH SHALL BE USED.
10. EARTHFILL FOR THE DIKE SHALL BE OBTAINED FROM THE PREVIOUSLY USED BORROW AREA INSIDE THE LOOP TRACK. SOILS INVESTIGATIONS FOR THIS AREA ARE REPORTED IN THE MEMORANDUM: GENE FARMER TO ROY H. SUBHAN DATED DECEMBER 12, 1974.

REV NO	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	FSSD	AS EXPST
3	12-21-93	VANSOYE	EVR	JLG	KWB	RAS			
REV WEST POND CONTOURS & ADD COVER ON SPILLWAY.									
2	WO #20625 7/6/87								
REVISED EAST POND CONTOURS. WO 544050-20826									
1	12/7/86								
EXTEND EXIST BERM ALONG RH. ADD DIKE FOR STACKING ASH. (49M)									

NO.	ENG/PGR	DATE	DSGN	DRWN	CHKD	RVWD	APPD	FSSD

DSGN VPELDER — INSP J.P. Fox
DRWN VPELDER
CHKD DMCALLOWAY — ENGINEER K.W. Burnett
SUPV J. L. GLOVER

SCALE: 1"=50' EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA INSIDE LOOP TRACK PLAN

BULL RUN STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

SUBMITTED	RECOMMENDED	APPROVED

INSPECTED AND APPROVED FOR ISSUE
S. B. Jack 3-22-88

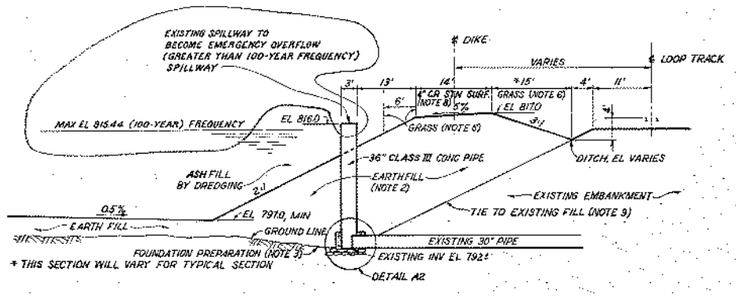
KNOXVILLE 3-5-87 | 49 | C | 10W289-1 | R3

RECORD DRAWING AS CONSTRUCTED

FIRST ISSUE FOR PA date

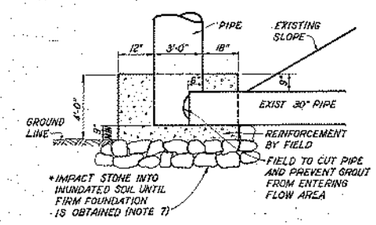
COMPANION DRAWINGS: 10W289-2, 3 & 4 & 10H289-5 THRU 7

PRINT
SIZE
GM CM PROJ ME EE CE AD LD EG MS SW PL PA
PRINTS REQD-R



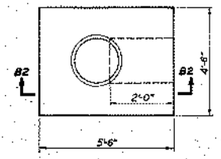
SECTION A2-A2

SCALE 1"=10'



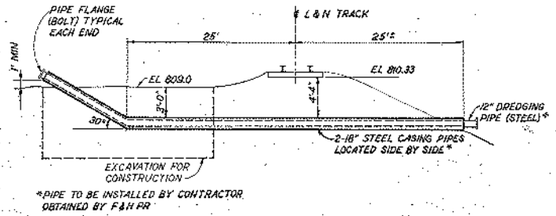
B2-B2

*STONE NOT REQUIRED FOR D2-D2



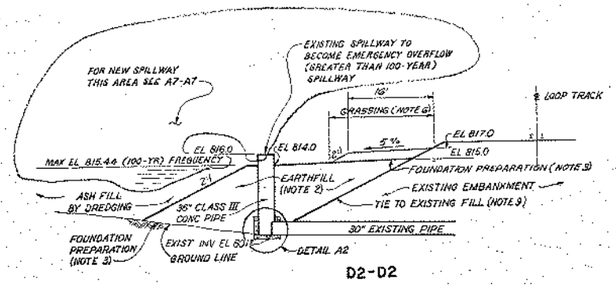
PLAN

DETAIL A2

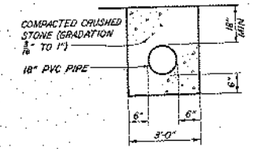


*PIPE TO BE INSTALLED BY CONTRACTOR OBTAINED BY F&H FR

SECTION C2-C2

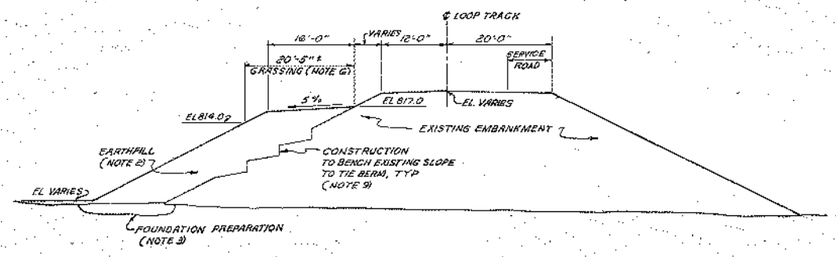


D2-D2



BEDDING DETAIL FOR 18" PVC PIPE

SUMMARY OF QUANTITIES					
		DREDGE POND		DRY STACK	
ITEM	DESCRIPTION	QUANTITY	UNIT	QUANTITY	UNIT
101	CLEARING & GRUBBING	5	ACRES		
123	EARTH BORROW	40,000	CY		
210	CRUSHED STONE SURFACING	400	TONS		
402	CLASS B CONCRETE	5	CY		
602	36" CONCRETE PIPE	40	LF		
157	ROCK REVETMENT	8	CY		
180 & 182	GRASSING & MULCHING	800	SY		
	BERM EXTENSION, SECTION E2-E2 (1985 CONST.)				
120	UNCLASSIFIED EXCAVATION	600	CY		
123	EARTH BORROW	7500	CY		
180 & 182	GRASSING & MULCHING	1600	SY		



E2-E2

EARTH BERM EXTENSION TYPICAL SECTION

NOTES:
1. FOR GENERAL NOTES SEE 10W289-1.

FIRST ISSUE FOR PA 2 mos.

COMPANION DRAWINGS 10W289-1, 3, 4, & 10W289-5

REV NO	DATE	DSGN	DRWN	CHKD	SURV	RVWD	APPD	ISSD	AS CONST
3	12-21-93	EWR	MBH	JLG	JLG	KWB	RCT		
	REVISED SECTS A2-A2 & D2-D2.								
2	10-5-87	AHS				KWB	CWD	DEN	JLG
	REMOVED PROFILE-DIKE ON HILL SIDE ADDED CONST DATE.								
REV NO	CHANGE REF	DATE	DRWN	DSGN	CHKD	RVWD	APPD	ISSD	
1	10178/6	RBS	MPC	JLG	DCH	CFE			
	ADD SECT E2-E2 & PROFILE-DIKE ON HILL SIDE (49M)								
REV NO	DESCRIPTION	DATE	DSGN	DRWN	CHKD	RVWD	APPD	ISSD	

DSGN VP ELDER
DRWN VP ELDER
CHKD D R GALLOWAY
SUPV J. L. GLOVER
INDEP. J.E. Fox
ENGINEER K. W. Burnett

SCALE NTS — EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA INSIDE LOOP TRACK SECTIONS & DETAILS

BULL RUN STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

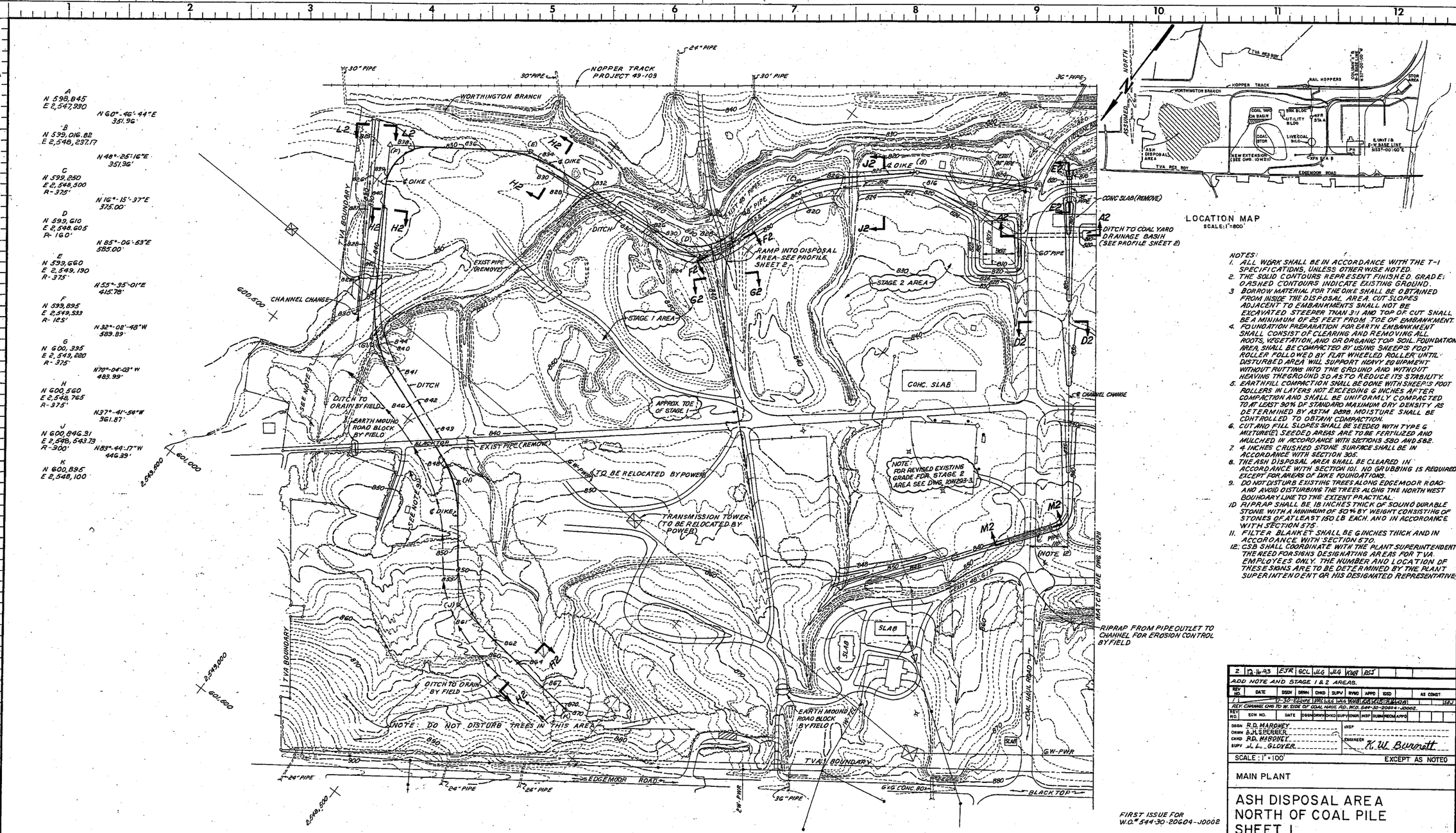
SUBMITTED	RECOMMENDED	APPROVED
Robert J. Bauman		

INSPECTED AND APPROVED FOR ISSUE
S. B. Jack 1980

KNOXVILLE | 9-5-81 | 49 | C | 10W289-2 | R3

RECORD DRAWING AS CONSTRUCTED

OPEN REVISION



LOCATION MAP
SCALE: 1"=800'

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 DISPOSAL AREA. CUT SLOPES ADJACENT TO EMBANKMENTS SHALL NOT BE EXCAVATED STEEPER THAN 3:1 AND TOP OF CUT SHALL BE A MINIMUM OF 25 FEET FROM TOE OF EMBANKMENT.
4. FOUNDATION PREPARATION FOR EARTH EMBANKMENT 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. EARTHFILL COMPACTION SHALL BE DONE WITH SHEEP'S FOOT ROLLERS IN LAYERS NOT EXCEEDING 6 INCHES AFTER COMPACTION AND SHALL BE UNIFORMLY COMPACTED TO AT LEAST 90% OF STANDARD MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D698. MOISTURE SHALL BE CONTROLLED TO OBTAIN COMPACTION.
6. CUT AND FILL SLOPES SHALL BE SEEDED WITH TYPE G MIXTURE. SEEDED AREAS ARE TO BE FERTILIZED AND MULCHED IN ACCORDANCE WITH SECTIONS 580 AND 582.
7. 4 INCHES CRUSHED STONE SURFACE SHALL BE IN ACCORDANCE WITH SECTION 305.
8. THE ASH DISPOSAL AREA SHALL BE CLEARED IN ACCORDANCE WITH SECTION 101. NO GRUBBING IS REQUIRED EXCEPT FOR AREAS OF DIKE FOUNDATIONS.
9. DO NOT DISTURB EXISTING TREES ALONG EDGEMOOR ROAD AND AVOID DISTURBING THE TREES ALONG THE NORTH WEST BOUNDARY LINE TO THE EXTENT PRACTICAL.
10. RIPRAP SHALL BE 18 INCHES THICK OF SOUND DURABLE STONE WITH A MINIMUM OF 50% BY WEIGHT CONSISTING OF STONES OF AT LEAST 150 LB EACH, AND IN ACCORDANCE WITH SECTION 575.
11. FILTER BLANKET SHALL BE 6 INCHES THICK AND IN ACCORDANCE WITH SECTION 570.
12. CSB SHALL COORDINATE WITH THE PLANT SUPERINTENDENT THE NEED FOR SIGNS DESIGNATING AREAS FOR TVA EMPLOYEES ONLY. THE NUMBER AND LOCATION OF THESE SIGNS ARE TO BE DETERMINED BY THE PLANT SUPERINTENDENT OR HIS DESIGNATED REPRESENTATIVE.

REV NO.	DATE	DSGN	DRWN	CHKD	SUPV	RVWD	APPD	ISSD	AS CONST
2	12-16-83	EJR	GCL	JLG	JLG	KWB	RCS		

ADD NOTE AND STAGE 1 & 2 AREAS.

REV NO.	ECN NO.	DATE	DSGN	DRWN	CHKD	SUPV	ENGR	INSP	SUBM	RECM	APPD
1		12-30-82	LWC	JLG	JLG	WOB	RCS				

REV. CHANNEL CHG TO W. SIDE OF COAL HAUL RD. W.O. 544-30-20604-J0002.

DSGN R.D. MAROney
DRWN B.H. SPERRER
CHKD R.D. MAROney
SUPV J.L. GLOVER
INSP
ENGINEER K.W. Burnett

SCALE: 1" = 100' EXCEPT AS NOTED

MAIN PLANT

ASH DISPOSAL AREA NORTH OF COAL PILE SHEET 1

BULL RUN STEAM PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF ENGINEERING DESIGN

SUBMITTED	RECOMMENDED	APPROVED
Robert G. Samson	R.D. Stone	K.W. Burnett
KNOXVILLE 6-3-82		

49 | C | 10W293-1 R2
RECORD DRAWING AS CONSTRUCTED

FIRST ISSUE FOR W.O.# 544-30-20604-J0002

COMPANION DWG: 10W293-2

INSPECTED AND APPROVED FOR ISSUE

PRINT H 3 1
SIZE F
BR OR PROJ | ME | EE | CE | AD | CO | ED | MD | SW | BL | PA
PRINTS REQD—R 6

PCI

APPENDIX P
BACKGROUND SOIL SAP

Background Soil Sampling and Analysis Plan Bull Run Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Bull Run Fossil Plant
Clinton, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 17, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	October 27, 2017
2	Addresses January 29, 2018 TDEC Review Comments and Issued for TDEC Review	March 30, 2018
3	Addresses May 22, 2018 TDEC Review Comments and Issued for TDEC review	July 13, 2018
4	Addresses TDEC Comments, Applicable Programmatic Revisions, and Issued for TDEC Approval	December 17, 2018

BACKGROUND SOIL
SAMPLING AND ANALYSIS PLAN
BULL RUN FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Background Soil
Sampling and Analysis Plan
Bull Run Fossil Plant
Tennessee Valley Authority
Clinton, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 17, 2018 Revision 4

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: 12/13/18

McClung, Nicholas Anthony — Digitally signed by McClung, Nicholas Anthony Date: 2018.12.07 09:54:01 -05'00'

TVA Investigation Field Lead — Date

Health, Safety and Environmental (HSE) Manager — Date: 12/13/18

Investigation Project Manager — Date: 12/6/2018

Rock J. Vitale — Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.12.11 12:58:57 -05'00'

QA Oversight Manager — Date

Laboratory Project Manager — Date: 12.12.18

Charles L. Head
TDEC Senior Advisor — Date

Robert Wilkinson
TDEC CCR Technical Manager — Date

Stantec

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Background
December 17, 2018

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 Bull Run Fossil Plant (BRF) on July 13-14, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at BRF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference.

On September 13, 2016, TDEC issued 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 January 9, 2017, TVA submitted BRF 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 Background Soil Sampling and Analysis Plan (SAP) has been developed to characterize background soils in the vicinity of BRF site conditions. The results from implementation of this SAP will be evaluated and addressed in the Environmental Assessment Report (EAR).

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 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 eighteen-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 points. 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.

Boring advancement through unconsolidated soils to refusal will be conducted at locations shown on Figure 1, all of which are within a one-mile radius of the Plant. 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.

In addition to collection of soil samples from the eighteen-background soil boring locations, accessible rock, and residuum outcrops in the vicinity of the Plant, along with existing rock cores recovered during the investigation of the proposed CCR landfill area, will be visually inspected in an attempt to determine if naturally occurring sources of metallic ore minerals are present in the area. This visual inspection is needed due to the presence of mineral deposits listed by the United States Geological Survey in Anderson County, Tennessee. The presence of metallic ore deposits, including barium, manganese, and thorium, in the area could naturally increase the concentrations of these elements in the background soils. If the visual inspections identify potential naturally occurring sources of metallic ore minerals, rock samples will be collected for further assessment.

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
- Complete required health and safety paperwork and confirm field team members have completed required training
- Coordinate field activities with the Laboratory Coordinator to ensure 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 ensure 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 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 – 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. widemouth glass jar to be used 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
Sulfate	SW-846 9056A Modified	Cool to <6° C	4 oz. glass	28 days
pH	SW-846 9045D Modified	Cool to <6° 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.) 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 ensure 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 ensure the label is not removed. 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 are 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.
- 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

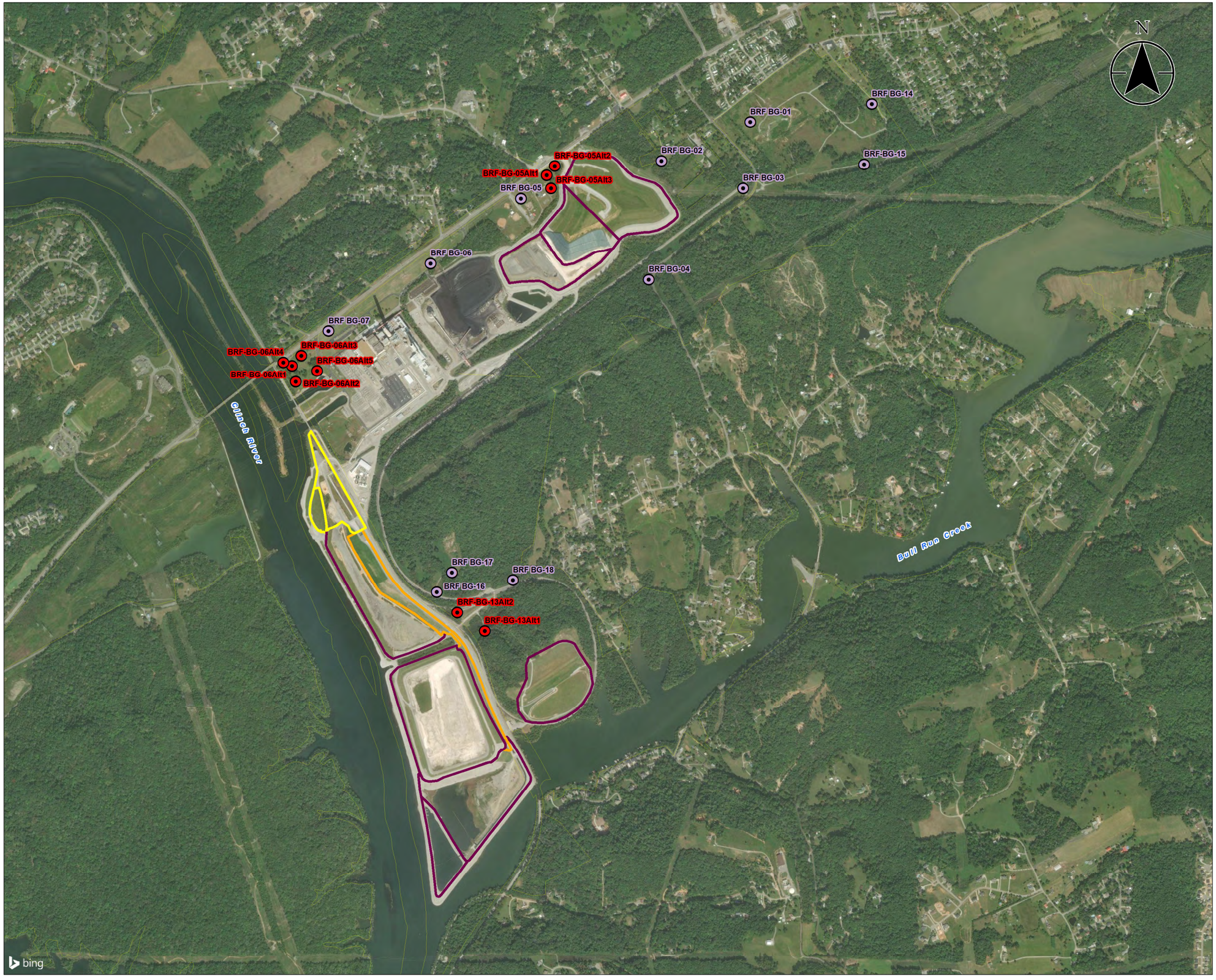

Figure No.
1

Title
Proposed Soil Sampling Locations

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-12-14
Technical Review by TG on 2018-12-14

0 700 1,400 2,100 2,800 Feet
1:8,400 (At original document size of 22x34)

Legend

- Alternate Proposed Background Soil Sample Location
- Final Background Soil Sample Location
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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TVA

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U:\TVA-EBP\175568274_BRF_Phase2\gis\mxd\BRF_Proposed_Soil_Sampling.mxd Revised: 2018-12-14 By: mbough

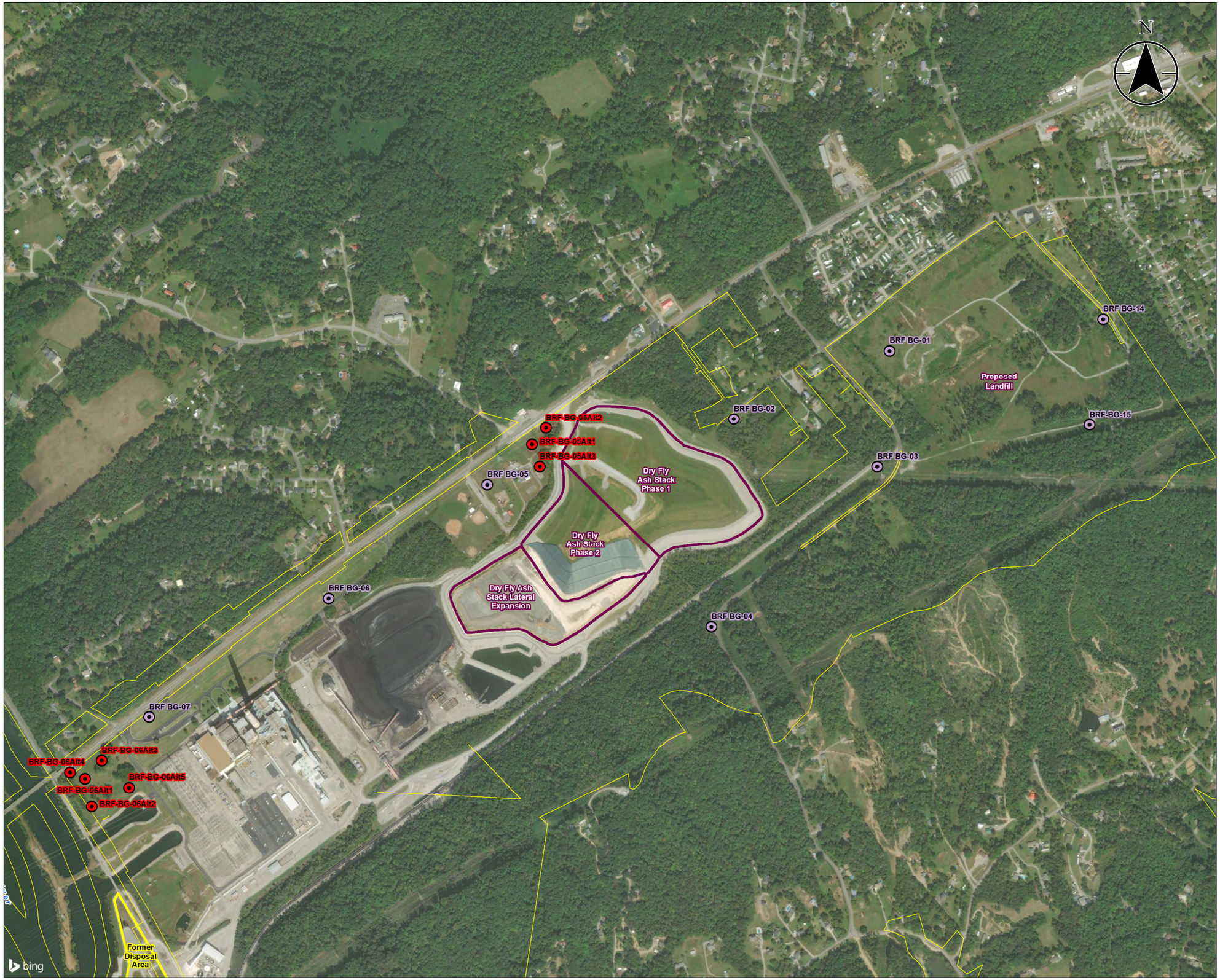

Figure No.

1A

Title

Proposed Background Soil Sample Locations – Dry Fly Ash Stack Area

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by LMB on 2018-12-14
Technical Review by TG on 2018-12-14

0 400 800 1,200 1,600 Feet

1:4,800 (At original document size of 22x34)

Legend

- Alternate Proposed Background Soil Sample Location
- Final Background Soil Sample Location
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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Figure No.

1B

Title

Proposed Background Soil Sample Locations – Railroad Loop Area

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location

Clinton, Tennessee

175566346

Prepared by LMB on 2018-12-14
Technical Review by TG on 2018-12-14

0 150 300 450 600 Feet

1:1,800 (At original document size of 22x34)

Legend

- Alternate Proposed Background Soil Sample Location
- Final Background Soil Sample Location
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)
- TVA Property Boundary

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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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 Q
BENTHIC SAP

Benthic
Sampling and Analysis Plan
Bull Run Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Bull Run Fossil Plant
Clinton, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 17, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	October 27, 2017
2	Addresses January 29, 2018 TDEC Review Comments and Issued for TDEC Review	March 30, 2018
3	Addresses May 22, 2018 TDEC Review Comments and Issued for TDEC Review	July 13, 2018
4	Addresses TDEC Comments, Applicable Programmatic Revisions, and Issued for TDEC Approval	December 17, 2018

BENTHIC
SAMPLING AND ANALYSIS PLAN
BULL RUN FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Benthic
Sampling and Analysis Plan
Bull Run Fossil Plant
Tennessee Valley Authority
Clinton, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 17, 2018 Revision 4

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	12/13/18 Date
TVA Investigation Field Lead	12/14/18 Date
Health, Safety, and Environmental (HSE) Manager	12/13/18 Date
Investigation Project Manager	12/6/2018 Date
QA Oversight Manager Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envstd.com, c=US Date: 2018.12.11 12:59:26 -05'00'	Date
Laboratory Project Manager Tod Noltemeyer	12.12.18 Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

Stantec

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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 Bull Run Fossil Plant (BRF) on July 13-14, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at BRF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference.

On September 13, 2016, TDEC issued 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 January 9, 2017, TVA submitted BRF 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 requests for greater clarification in TVA's phased approach for evaluating whether CCR material has migrated from the BRF Plant (Plant) into surface streams on or adjacent to the Plant. Based on these requests, a Benthic Sampling and Analysis Plan (SAP) and associated sediment sampling locations have been developed.

This Benthic SAP has been prepared to describe TVA's phased approach for evaluating whether CCR material has migrated from the Plant into surface streams on or adjacent to the Plant. This Benthic SAP has also been prepared to assess potential impacts of CCR constituents on aquatic life as part of the biological studies at the Plant and to assist in providing a good overall view of conditions at the Plant. The results from implementation of this SAP will be evaluated and addressed in the Environmental Assessment Report (EAR).

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 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 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

Fourteen 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 Bull Run Creek and upstream of the Plant on the Clinch River are proposed to provide baseline sediment data for CCR parameter concentrations. Additional transects are proposed in the Clinch River and Bull Run Creek adjacent to the Plant and in the Clinch River downstream of the Plant. See Table 1 below for a summary of transect locations and Figure 1 for proposed sediment sampling transects. Water samples will also be taken at coincident sediment sampling locations as described in the Surface Stream SAP. The number and/or location of the proposed sediment samples may be modified based on conditions encountered in the field.

Table 1. Proposed Sediment Sample Location

Transect ID	Description
SED-CR01	Clinch River Upstream of Plant (Background)
SED-CR02	Clinch River Upstream of Plant (Background)
SED-CR03	Clinch River Upstream of Plant (Background)
SED-CR04	Clinch River Downstream from Outfall
SED-CR05	Clinch River Adjacent to Historic Seep
SED-CR06	Clinch River Downstream from Fly Ash Stilling Pond 2C with Seeps
SED-CR07	Clinch River Downstream from Plant
SED-CR08	Clinch River Downstream from Plant at Historical Sediment Sampling Location
SED-BRC01	Bull Run Creek Upstream of Plant (Background)
SED-BRC02	Bull Run Creek Upstream of Plant (Background)
SED-BRC03	Bull Run Creek Adjacent to Plant

Transect ID	Description
SED-BRC04	Bull Run Creek Adjacent to Historic Seep
SED-WB01	Worthington Branch Upstream Sampling Location
SED-WB02	Worthington Branch Downstream Sampling Location

4.2 BENTHIC INVERTEBRATE SAMPLING LOCATIONS

Quantitative benthic invertebrate sampling will also be conducted during Phase 1. The benthic invertebrate samples will be collected along transects at the locations depicted on Figure 2. See Table 2 below for a summary of transect locations. Benthic invertebrate 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-CR01*	Clinch River Upstream of Plant (Background)
MAC-CR02*	Clinch River Upstream of Plant (Background)
MAC-CR03	Clinch River Upstream of Plant (Background)
MAC-CR04	Clinch River Downstream from Outfall
MAC-CR05*	Clinch River Adjacent to Plant
MAC-CR06	Clinch River Downstream from Fly Ash Stilling Pond 2C with Seeps
MAC-CR07*	Clinch River Downstream from Plant
MAC-BRC01	Bull Run Creek Upstream of Plant (Background)

Transect ID	Description
MAC-BRC02	Bull Run Creek Upstream of Plant (Background)
MAC-BRC03	Bull Run Creek Adjacent to Plant
MAC-BRC04	Bull Run Creek Adjacent to Plant
MAC-WB01	Worthington Branch Upstream Location
MAC-WB02	Worthington Branch Downstream Location

* Coincides with historical benthic macroinvertebrate sample transect location

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 3. 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

Transect ID	Description
CRU	Clinch River Upstream from Plant
CRA	Clinch River Adjacent to Plant
CRD	Clinch River Downstream from Plant
BRCA	Bull Run Creek Adjacent to Plant

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. BRF 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
STR-CR01	SED-CR01	MAC-CR01	NA	NA
STR-CR02	SED-CR02	MAC-CR02	CRU	CRU
STR-CR03	SED-CR03	MAC-CR03	NA	NA
STR-CR04	SED-CR04	MAC-CR04	CRA	CRA
STR-CR05	SED-CR05	MAC-CR05		
STR-CR06	SED-CR06	MAC-CR06		
STR-CR07	SED-CR07	MAC-CR07		
STR-CR08	SED-CR08	NA	NA	NA
STR-CR09	NA	NA	CRD	CRD
STR-BRC01	SED-BRC01	MAC-BRC01	NA	NA
STR-BRC02	SED-BRC02	MAC-BRC02	NA	NA
STR-BRC03	SED-BRC03	MAC-BRC03	BRCA	BRCA
STR-BRC04	SED-BRC04	MAC-BRC04		
STR-WB01	SED-WB01	MAC-WB01	NA	NA
STR-WB02	SED-WB02	MAC-WB02	NA	NA

NA – Not Applicable

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*.

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 and Standard Operating Procedures (SOPs), Quality Assurance Project Plan (QAPP; Appendix D to the EIP), SAPs, and HASP.
- Complete required health and safety paperwork and 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*

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.

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 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 a 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 (°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 °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. 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

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-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 Tables 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

Constituent	Analytical Method	Preservative(s)	Container(s)	Holding Time
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 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 year. If approval to proceed is received too late in the year, sampling will not proceed until the following year.

9.0 REFERENCES

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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

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-02-21
Technical Review by TG on 2018-02-21

0 1,400 2,800 4,200 5,600 Feet

1:16,800 (At original document size of 22x34)

Legend

- Sediment Sampling Transect
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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.

I:\TVA\EIP\175566346\gis\mxds\BRF_Sediment_Sampling.mxd Revised: 2018-02-21 By: trink

Figure No.
2

Title
Benthic Macroinvertebrates Sampling

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-02-21
Technical Review by TG on 2018-02-21

0 1,400 2,800 4,200 5,600 Feet

1:16,800 (At original document size of 22x34)

Legend

- Transect
- TVA Property Boundary
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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.

I:\TVA\EIP\175566346\gis\mxds\BRF_Benthic_Transects.mxd Revised: 2018-02-21 By: tmk

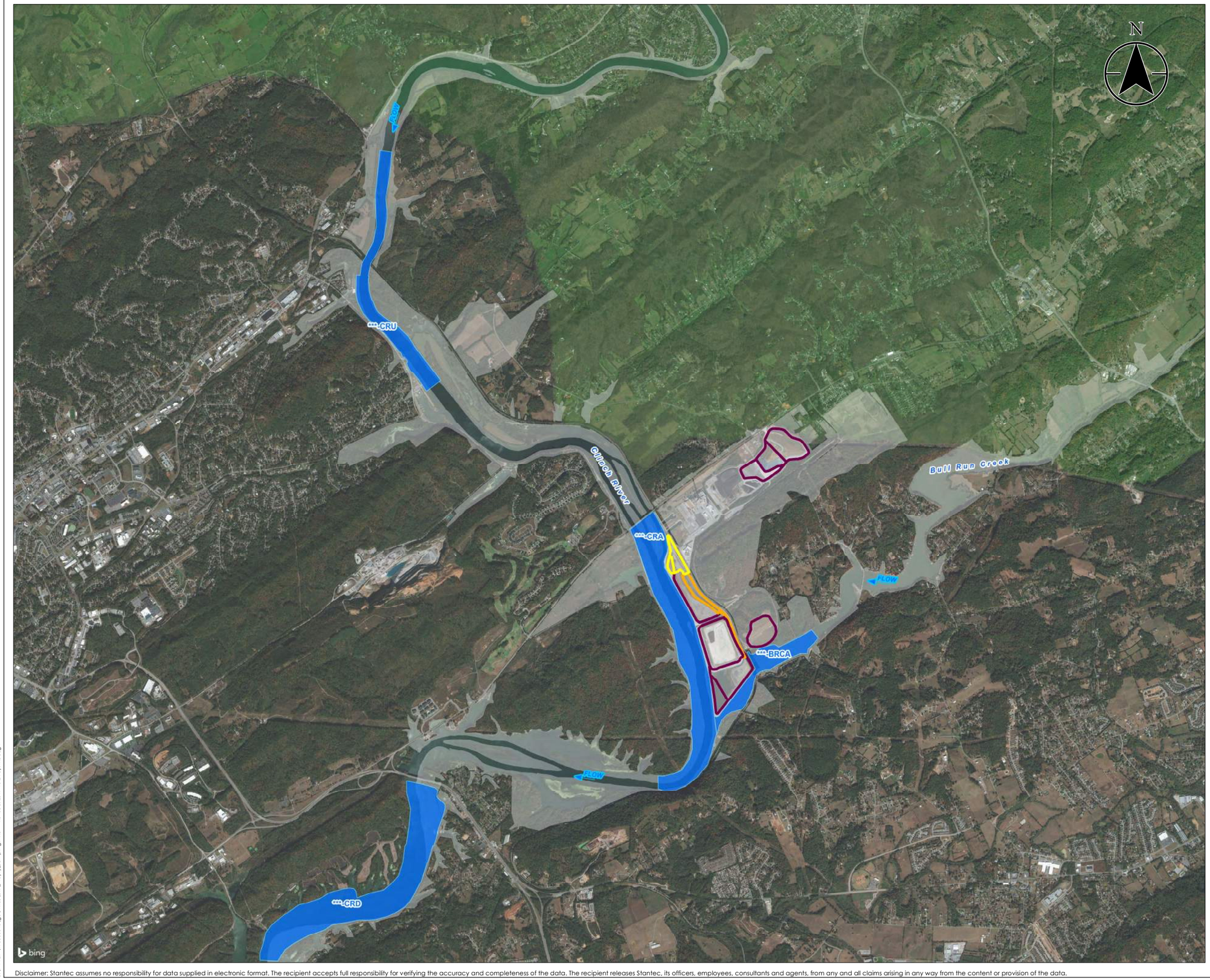

Figure No.
3

Title
Mayfly Sampling
Adult Mayflies, Purated Mayfly Nymphs, & Non-Purated Mayfly Nymphs

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

0 1,800 3,600 5,400 7,200 Feet

1:21,600 (At original document size of 22x34)

Legend

- Mayfly Sample Location
- TVA Property Boundary
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

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 Bing Imagery

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.

J:\TVA-EBP\175566346\gis\mxds\BRF_Mayfly_Sampling.mxd Revised: 2017-10-24 By: mbaugh

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 R
NPDES SAMPLING DATA

Summary of NPDES Outfall Analytical Results

Bull Run Fossil Plant

Clinton, Tennessee

Flow

DATCOL	SYM	VALUE
10/02/2013		10.29
10/10/2013		10.94
10/15/2013		10.29
10/21/2013		9.66
11/01/2013		3.25
11/05/2013		6.7
11/06/2013		6.16
11/15/2013		6.16
11/20/2013		7.26
11/26/2013		8.43
12/05/2013		8.43
12/06/2013		9.66
12/11/2013		9.04
12/19/2013		7.84
12/26/2013		9.04
12/30/2013		9.66
01/03/2014		7.84
01/09/2014		10.29
01/14/2014		9.66
01/23/2014		9.66
01/30/2014		9.04
02/06/2014		7.84
02/12/2014		7.84
02/17/2014		7.84
02/20/2014		9.66
02/25/2014		9.66
03/05/2014		14.37
03/06/2014		14.37
03/14/2014		14.37
03/21/2014		14.37
03/28/2014		14.37
04/02/2014		12.96
04/11/2014		13.66
04/16/2014		13.66
04/24/2014		13.66
04/28/2014		13.66
05/05/2014		12.96
05/07/2014		12.96
05/12/2014		10.94
05/20/2014		10.94
05/29/2014		5.63
06/05/2014		9.66
06/13/2014		13.66
06/20/2014		13.66
06/27/2014		13.66
07/01/2014		12.96
07/08/2014		10.94
07/16/2014		10.29
07/22/2014		8.43
08/01/2014		12.27
08/08/2014		13.66
08/13/2014		12.27
08/15/2014		11.6
08/18/2014		12.96
08/26/2014		10.94

pH

DATCOL	SYM	VALUE
10/09/2013		8.13
10/15/2013		8.01
10/21/2013		8.02
11/01/2013		7.85
11/06/2013		8.08
11/15/2013		8.21
11/18/2013		8.16
11/26/2013		8.19
12/05/2013		8.05
12/11/2013		7.82
12/19/2013		8.01
12/19/2013		8
12/26/2013		8.12
12/30/2013		7.83
01/03/2014		7.49
01/09/2014		7.87
01/14/2014		7.74
01/23/2014		7.94
01/30/2014		7.85
02/06/2014		8.19
02/12/2014		7.97
02/17/2014		7.5
02/20/2014		7.81
02/25/2014		7.99
02/25/2014		7.98
03/05/2014		7.64
03/06/2014		7.75
03/14/2014		7.87
03/21/2014		7.93
03/28/2014		7.91
04/02/2014		7.64
04/11/2014		7.72
04/16/2014		7.94
04/24/2014		7.97
04/28/2014		7.92
04/28/2014		7.91
05/05/2014		7.99
05/12/2014		8.2
05/20/2014		8.03
05/29/2014		8.09
06/05/2014		7.93
06/13/2014		7.94
06/20/2014		7.89
06/27/2014		7.92
07/01/2014		7.46
07/08/2014		8.11
07/08/2014		8.12
07/16/2014		7.97
07/22/2014		8.12
08/01/2014		7.99
08/08/2014		7.94
08/15/2014		8.01
08/18/2014		7.5
08/26/2014		7.56
09/02/2014		7.97

Summary of NPDES Outfall Analytical Results
Bull Run Fossil Plant
Clinton, Tennessee

Flow

DATCOL	SYM	VALUE
09/02/2014		12.96
09/10/2014		14.37
09/17/2014		12.27
09/25/2014		11.6
10/01/2014		11.6
10/09/2014		13.66
10/16/2014		12.27
10/22/2014		10.29
10/31/2014		9.66
11/04/2014		5.12
11/10/2014		6.7
11/20/2014		7.84
11/24/2014		5.63
12/03/2014		5.63
12/08/2014		5.63
12/15/2014		7.84
12/16/2014		6.7
12/22/2014		9.04
12/29/2014		10.94
01/06/2015		10.94
01/13/2015		10.94
01/21/2015		11.6
01/26/2015		11.6
02/02/2015		11.6
02/10/2015		11.6
02/20/2015		9.04
02/24/2015		6.7
03/03/2015		6.16
03/10/2015		6.7
03/20/2015		7.26
03/24/2015		6.7
04/01/2015		12.96
04/07/2015		14.37
04/16/2015		7.26
04/23/2015		6.33
05/01/2015		5.79
05/08/2015		6.33
05/12/2015		5.79
05/18/2015		4.76
05/29/2015		4.76
06/01/2015		8.66
06/08/2015		5.26
06/15/2015		5.26
06/24/2015		5.79
06/30/2015		6.89
07/06/2015		14.74
07/16/2015		5.79
07/21/2015		6.89
07/28/2015		6.89
08/03/2015		6.89
08/14/2015		6.89
08/18/2015		6.89
08/24/2015		5.79
09/02/2015		8.05
09/10/2015		9.28

pH

DATCOL	SYM	VALUE
09/10/2014		7.65
09/17/2014		7.58
09/17/2014		7.59
09/25/2014		7.64
10/01/2014		7.48
10/09/2014		7.35
10/16/2014		6.97
10/22/2014		7.67
10/31/2014		7.35
11/05/2014		7.88
11/10/2014		7.33
11/20/2014		7.19
11/24/2014		7.93
11/24/2014		7.92
12/03/2014		7.91
12/08/2014		7.91
12/15/2014		7.98
12/16/2014		7.65
12/22/2014		7.93
12/29/2014		7.96
01/06/2015		7.95
01/13/2015		7.88
01/21/2015		8.03
01/26/2015		7.96
02/02/2015		7.81
02/10/2015		7.94
02/20/2015		7.9
02/24/2015		7.94
03/03/2015		7.84
03/10/2015		7.89
03/10/2015		7.89
03/20/2015		7.84
03/24/2015		7.47
04/01/2015		7.38
04/07/2015		7.92
04/16/2015		7.76
04/23/2015		7.84
05/01/2015		7.88
05/08/2015		8.25
05/12/2015		8.27
05/18/2015		7.73
05/29/2015		8.22
06/01/2015		7.49
06/08/2015		8.03
06/15/2015		8.1
06/24/2015		8.16
06/30/2015		8.1
07/06/2015		7.28
07/16/2015		7.85
07/21/2015		8.2
07/28/2015		8.12
08/03/2015		7.96
08/03/2015		7.98
08/14/2015		7.9
08/18/2015		7.88

Summary of NPDES Outfall Analytical Results
Bull Run Fossil Plant
Clinton, Tennessee

Flow

DATCOL	SYM	VALUE
09/17/2015		6.89
09/25/2015		6.33
09/30/2015		8.66
10/06/2015		8.05
10/15/2015		5.79
10/21/2015		5.79
10/28/2015		5.26
11/04/2015		5.79
11/12/2015		5.26
11/17/2015		4.27
11/23/2015		5.26
12/04/2015		5.79
12/09/2015		8.05
12/16/2015		5.79
12/22/2015		5.79
12/30/2015		5.79
01/07/2016		5.79
01/13/2016		5.79
01/21/2016		5.79
01/29/2016		5.79
02/01/2016		5.79
02/09/2016		5.79
02/18/2016		6.33
02/25/2016		5.79
03/01/2016		5.79
03/02/2016		6.89
03/11/2016		5.79
03/17/2016		4.27
03/25/2016		5.79
04/01/2016		6.89
04/06/2016		6.89
04/13/2016		4.27
04/20/2016		5.79
04/27/2016		5.26
05/02/2016		6.89
05/12/2016		6.89
05/19/2016		7.46
05/25/2016		8.66
06/01/2016		9.28
06/06/2016		13.3
06/15/2016		9.92
06/24/2016		14.01
07/01/2016		5.79
07/05/2016		6.89
07/13/2016		6.89
07/15/2016		5.79
07/21/2016		6.33
07/25/2016		5.79
08/05/2016		6.89
08/08/2016		7.46
08/19/2016		6.89
08/26/2016		5.79
09/01/2016		8.66
09/08/2016		9.28
09/15/2016		9.28

pH

DATCOL	SYM	VALUE
08/24/2015		7.91
09/02/2015		7.9
09/10/2015		8
09/17/2015		7.8
09/25/2015		8.1
09/30/2015		8.02
10/06/2015		7.83
10/15/2015		7.85
10/15/2015		7.85
10/21/2015		7.84
10/28/2015		8.05
11/04/2015		7.98
11/12/2015		8.09
11/17/2015		8.09
11/23/2015		8.14
12/04/2015		7.83
12/09/2015		7.72
12/16/2015		7.96
12/22/2015		7.99
12/22/2015		8
12/30/2015		7.86
01/07/2016		7.5
01/13/2016		7.75
01/21/2016		7.84
01/29/2016		7.86
02/01/2016		7.75
02/09/2016		8.03
02/18/2016		7.95
02/25/2016		7.95
03/01/2016		7.86
03/11/2016		7.94
03/11/2016		7.93
03/17/2016		8.18
03/25/2016		8.12
04/01/2016		8
04/06/2016		7.81
04/13/2016		8.2
04/20/2016		7.95
04/27/2016		8.31
05/02/2016		7.9
05/12/2016		7.82
05/19/2016		8
05/19/2016		8.01
05/25/2016		8.14
06/01/2016		8.08
06/06/2016		7.77
06/15/2016		8.19
06/24/2016		8.25
07/01/2016		8.18
07/05/2016		8.04
07/13/2016		8.27
07/21/2016		8.24
07/25/2016		8.27
07/26/2016		8.26
08/05/2016		8.24

Summary of NPDES Outfall Analytical Results
Bull Run Fossil Plant
Clinton, Tennessee

Flow

DATCOL	SYM	VALUE
09/22/2016		9.28
09/28/2016		9.28
10/06/2016		5.26
10/13/2016		5.79
10/20/2016		6.89
10/25/2016		6.89
10/27/2016		6.89
10/31/2016		6.89
11/10/2016		6.33
11/15/2016		6.89
11/23/2016		6.89
11/28/2016		6.89
12/07/2016		8.05
12/12/2016		8.05
12/20/2016		6.89
12/28/2016		6.89
01/05/2017		7.46
01/09/2017		7.46
01/17/2017		9.92
01/27/2017		10.56
02/03/2017		9.92
02/07/2017		10.56
02/13/2017		8.66
02/24/2017		6.89
03/02/2017		5.79
03/10/2017		8.05
03/17/2017		6.89
03/23/2017		5.79
03/31/2017		4.27
04/04/2017		5.79
04/12/2017		4.76
04/20/2017		4.76
04/25/2017		8.05
05/04/2017		9.28
05/12/2017		8.05
05/18/2017		9.92
05/24/2017		9.92
06/01/2017		9.92
06/08/2017		9.92
06/16/2017		10.56
06/20/2017		9.92
06/29/2017		9.92
07/07/2017		7.46
07/13/2017		8.05
07/20/2017		7.46
07/28/2017		7.46
08/04/2017		8.05
08/08/2017		11.9
08/15/2017		10.56
08/22/2017		9.28
09/05/2017		9.28
09/11/2017		10.56
09/20/2017		11.9
09/28/2017		11.23
10/02/2017		8.05

pH

DATCOL	SYM	VALUE
08/08/2016		8.23
08/19/2016		7.86
08/26/2016		7.94
09/01/2016		8.13
09/08/2016		8.18
09/15/2016		8.29
09/22/2016		7.83
09/28/2016		8.03
10/06/2016		7.91
10/06/2016		7.91
10/13/2016		7.96
10/20/2016		8.04
10/25/2016		8.05
10/31/2016		8.1
11/10/2016		7.93
11/15/2016		8.07
11/23/2016		8.07
11/28/2016		8.1
12/07/2016		7.88
12/12/2016		7.92
12/12/2016		7.92
12/20/2016		7.87
12/28/2016		7.89
01/05/2017		7.86
01/09/2017		7.82
01/17/2017		7.88
01/27/2017		7.65
02/03/2017		7.82
02/07/2017		7.7
02/13/2017		7.85
02/24/2017		8.08
03/02/2017		7.81
03/10/2017		7.02
03/10/2017		7.01
03/17/2017		7.57
03/23/2017		7.61
03/31/2017		7.76
04/04/2017		7.75
04/12/2017		7.96
04/20/2017		8.01
04/25/2017		7.85
05/04/2017		7.82
05/12/2017		7.95
05/18/2017		8.08
05/18/2017		8.07
05/24/2017		7.92
06/01/2017		7.86
06/08/2017		7.95
06/16/2017		7.91
06/20/2017		7.88
06/29/2017		7.92
07/07/2017		7.67
07/13/2017		7.74
07/20/2017		7.85
07/28/2017		7.92

Summary of NPDES Outfall Analytical Results
Bull Run Fossil Plant
Clinton, Tennessee

Flow

DATCOL	SYM	VALUE
10/10/2017		9.28
10/20/2017		10.56
10/26/2017		9.92
11/03/2017		11.23
11/08/2017		9.28
11/17/2017		8.05
11/21/2017		6.89
11/28/2017		5.8
12/04/2017		5.4
12/06/2017		3.66
12/13/2017		4.89
12/18/2017		5.01
12/27/2017		4.6
01/03/2018		5.16
01/10/2018		5.88
01/11/2018		5.96
01/15/2018		8.67
01/22/2018		7.7
02/01/2018		7.7
02/06/2018		7.2
02/13/2018		10.8
02/22/2018		0.11
02/27/2018		8.66

pH

DATCOL	SYM	VALUE
07/28/2017		7.91
08/04/2017		8.1
08/08/2017		8.26
08/15/2017		8.17
08/22/2017		8.18
09/05/2017		8.24
09/11/2017		8.16
09/20/2017		8.12
09/28/2017		8.1
10/02/2017		7.98
10/02/2017		7.99
10/10/2017		7.92
10/20/2017		7.84
10/26/2017		7.81
11/03/2017		7.09
11/08/2017		7.57
11/17/2017		7.93
11/21/2017		8.21
11/28/2017		8.21
12/06/2017		7.72
12/13/2017		7.83
12/13/2017		7.3
12/18/2017		8.02
12/27/2017		8.43
01/03/2018		8.21
01/10/2018		7.86
01/15/2018		7.92
01/22/2018		7.85
02/01/2018		7.95
02/06/2018		8
02/13/2018		7.91
02/22/2018		7.84
02/27/2018		8.04

Summary of NPDES Outfall Analytical Results
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Aluminum

DATCOL	SYM	VALUE
10/02/2013		0.127
11/05/2013		0.115
12/11/2013		0.46
01/03/2014		0.304
02/17/2014		0.197
03/05/2014		0.611
04/02/2014		0.261
05/07/2014		0.186
06/13/2014		0.206
07/01/2014		0.251
08/13/2014		0.172
09/25/2014		0.239
10/01/2014		0.187
11/20/2014		0.108
12/16/2014	<	0.1
01/13/2015		0.39
02/02/2015		0.32
03/24/2015		0.134
04/01/2015		0.202
05/18/2015	<	0.1
06/01/2015		0.128
07/07/2015		0.244
08/03/2015	<	0.1
09/02/2015	<	0.1
10/21/2015		0.146
11/04/2015		0.1215
12/09/2015		0.262
01/07/2016		0.171
02/01/2016		0.108
03/02/2016		0.155
04/06/2016		0.1
05/02/2016	<	0.1
06/06/2016		0.158
07/05/2016		0.102
08/05/2016	<	0.2
09/08/2016	<	0.2
10/25/2016	<	0.2
11/15/2016	<	0.2
12/12/2016		0.0868
01/17/2017		0.335
02/03/2017		0.337
03/02/2017	<	0.2
04/12/2017	<	0.2
05/18/2017		0.2
06/20/2017	<	0.2
07/13/2017	<	0.2
08/08/2017		0.209
09/05/2017	<	0.2
10/02/2017	<	0.2
11/08/2017		0.303
12/06/2017	<	0.2
01/11/2018		0.318
02/27/2018		0.282

Antimony

DATCOL	SYM	VALUE
10/02/2013	<	0.002
11/05/2013	<	0.002
12/11/2013	<	0.002
01/03/2014	<	0.002
02/17/2014	<	0.002
03/05/2014	<	0.002
04/02/2014	<	0.002
05/07/2014	<	0.002
06/13/2014	<	0.002
07/01/2014	<	0.002
08/13/2014	<	0.002
09/25/2014	<	0.002
10/01/2014	<	0.002
11/20/2014	<	0.002
12/16/2014	<	0.002
01/13/2015	<	0.02
02/02/2015	<	0.002
03/24/2015	<	0.002
04/01/2015	<	0.002
05/18/2015	<	0.002
06/01/2015	<	0.002
07/06/2015	<	0.002
08/03/2015	<	0.002
09/02/2015	<	0.002
10/21/2015	<	0.002
11/04/2015	<	0.002
12/09/2015	<	0.01
01/07/2016	<	0.002
02/02/2016	<	0.002
03/02/2016	<	0.002
04/06/2016	<	0.002
05/02/2016	<	0.002
06/06/2016	<	0.002
07/05/2016	<	0.002
08/05/2016	<	0.01
09/08/2016	<	0.01
10/25/2016	<	0.01
11/15/2016	<	0.01
12/12/2016	<	0.01
01/17/2017	<	0.01
02/03/2017	<	0.002
03/02/2017	<	0.002
04/12/2017	<	0.002
05/18/2017	<	0.002
06/20/2017	<	0.002
07/13/2017	<	0.002
08/08/2017	<	0.002
09/06/2017	<	0.002
10/02/2017	<	0.002
11/08/2017	<	0.002
12/06/2017	<	0.002
01/11/2018	<	0.002
02/27/2018	<	0.002

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Arsenic

DATCOL	SYM	VALUE
10/02/2013		0.00444
11/05/2013		0.00746
12/11/2013		0.00852
01/03/2014		0.00763
02/17/2014		0.0086
03/05/2014		0.0112
04/02/2014		0.0115
05/07/2014		0.0135
06/13/2014		0.00913
07/01/2014		0.00945
08/13/2014		0.0101
09/25/2014		0.0105
10/01/2014		0.0102
11/20/2014		0.0112
12/16/2014		0.00951
01/13/2015	<	0.02
02/02/2015		0.00939
03/24/2015		0.0126
04/01/2015		0.00994
05/18/2015		0.00824
06/01/2015		0.00948
07/06/2015		0.00994
08/03/2015		0.0104
09/02/2015		0.0112
10/21/2015		0.00931
11/04/2015		0.01025
12/09/2015	<	0.01
01/07/2016		0.00885
02/01/2016		0.00635
03/02/2016		0.0094
04/06/2016		0.00604
05/02/2016		0.00798
06/06/2016		0.00987
07/05/2016		0.0119
08/05/2016		0.0122
09/08/2016		0.0132
10/25/2016	<	0.01
11/15/2016	<	0.01
12/12/2016	<	0.01
01/17/2017	<	0.01
02/03/2017		0.0723
03/02/2017		0.00777
04/12/2017		0.00756
05/18/2017		0.00514
06/20/2017		0.0059
07/13/2017		0.00449
08/08/2017		0.00665
09/05/2017		0.00514
10/02/2017		0.00504
11/08/2017		0.00461
12/06/2017		0.00219
01/11/2018		0.00787
02/27/2018		0.00629

Barium

DATCOL	SYM	VALUE
10/02/2013		0.0422
11/05/2013		0.0408
12/11/2013		0.0403
01/03/2014		0.03725
02/17/2014		0.0359
03/05/2014		0.047
04/02/2014		0.053
05/07/2014		0.048
06/13/2014		0.046
07/01/2014		0.0538
08/13/2014		0.0539
09/25/2014		0.04455
10/01/2014		0.0519
11/20/2014		0.0418
12/16/2014		0.0384
01/13/2015		0.051
02/02/2015		0.0465
03/24/2015		0.0406
04/01/2015		0.0407
05/18/2015		0.034
06/01/2015		0.0378
07/06/2015		0.0536
08/03/2015		0.0602
09/02/2015		0.0434
10/21/2015		0.0447
11/04/2015		0.0492
12/09/2015		0.053
01/07/2016		0.0419
02/01/2016		0.0685
03/02/2016		0.0378
04/06/2016		0.0401
05/02/2016		0.045
06/07/2016		0.0673
07/05/2016		0.0766
08/05/2016		0.0636
09/08/2016		0.0717
10/25/2016		0.0439
11/15/2016		0.065
12/12/2016		0.0477
01/17/2017		0.0624
02/03/2017		0.0586
03/02/2017		0.0475
04/12/2017		0.0427
05/18/2017		0.0377
06/20/2017		0.061
07/13/2017		0.0403
08/08/2017		0.0714
09/05/2017		0.0671
10/02/2017		0.0404
11/08/2017		0.0495
12/06/2017		0.0376
01/11/2018		0.0504
02/27/2018		0.0465

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Beryllium

DATCOL	SYM	VALUE
10/02/2013	<	0.002
11/05/2013	<	0.002
12/11/2013	<	0.002
01/03/2014	<	0.002
02/24/2014	<	0.002
03/05/2014	<	0.002
04/02/2014	<	0.002
05/07/2014	<	0.002
06/13/2014	<	0.002
07/02/2014	<	0.001
08/13/2014	<	0.002
09/25/2014	<	0.002
10/01/2014	<	0.002
11/20/2014	<	0.002
12/16/2014	<	0.002
01/13/2015	<	0.002
02/02/2015	<	0.002
03/24/2015	<	0.002
04/01/2015	<	0.002
05/18/2015	<	0.002
06/01/2015	<	0.002
07/06/2015	<	0.002
08/04/2015	<	0.002
09/02/2015	<	0.002
10/21/2015	<	0.002
11/04/2015	<	0.002
12/09/2015	<	0.002
01/07/2016	<	0.002
02/01/2016	<	0.002
03/02/2016	<	0.002
04/06/2016	<	0.002
05/02/2016	<	0.002
06/06/2016	<	0.002
07/05/2016	<	0.002
08/05/2016	<	0.002
09/09/2016	<	0.002
10/25/2016	<	0.002
11/15/2016	<	0.002
12/12/2016	<	0.002
01/17/2017	<	0.002
02/03/2017	<	0.001
03/02/2017	<	0.001
04/12/2017	<	0.001
05/18/2017	<	0.001
06/20/2017	<	0.001
07/13/2017	<	0.001
08/08/2017	<	0.001
09/05/2017	<	0.001
10/02/2017	<	0.01
11/08/2017	<	0.001
12/07/2017	<	0.001
01/11/2018	<	0.001
02/27/2018	<	0.001

Cadmium

DATCOL	SYM	VALUE
10/02/2013	<	0.001
11/04/2013	<	0.001
12/11/2013	<	0.001
01/03/2014	<	0.001
02/17/2014	<	0.001
03/05/2014	<	0.001
04/02/2014	<	0.001
05/08/2014	<	0.001
06/13/2014	<	0.001
07/01/2014	<	0.001
08/14/2014	<	0.001
09/25/2014	<	0.001
10/01/2014	<	0.001
11/20/2014	<	0.001
12/16/2014	<	0.001
01/13/2015	<	0.005
02/02/2015	<	0.001
03/24/2015	<	0.001
04/01/2015	<	0.001
05/18/2015	<	0.001
06/01/2015	<	0.001
07/06/2015		0.00107
08/03/2015	<	0.001
09/02/2015	<	0.001
10/21/2015	<	0.001
11/04/2015	<	0.001
12/09/2015	<	0.002
01/07/2016	<	0.001
02/01/2016		0.00343
03/02/2016	<	0.001
04/06/2016	<	0.001
05/02/2016	<	0.001
06/06/2016	<	0.001
07/05/2016		0.0019
08/05/2016	<	0.002
09/08/2016	<	0.002
10/25/2016	<	0.002
11/15/2016	<	0.002
12/12/2016	<	0.002
01/17/2017	<	0.002
02/03/2017		0.00166
03/02/2017	<	0.001
04/13/2017	<	0.001
05/18/2017	<	0.001
06/20/2017		0.00153
07/13/2017	<	0.001
08/08/2017		0.00131
09/05/2017		0.0017
10/03/2017	<	0.001
11/08/2017	<	0.001
12/06/2017	<	0.001
01/11/2018	<	0.001
02/27/2018	<	0.001

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Chromium

DATCOL	SYM	VALUE
10/02/2013	<	0.002
11/05/2013	<	0.002
12/11/2013	<	0.002
01/03/2014	<	0.002
02/17/2014		0.0052
03/05/2014	<	0.002
04/02/2014	<	0.002
05/07/2014	<	0.002
06/14/2014	<	0.002
07/01/2014	<	0.002
08/13/2014	<	0.002
09/25/2014	<	0.002
10/01/2014	<	0.002
11/20/2014	<	0.002
12/16/2014	<	0.002
01/13/2015	<	0.01
02/02/2015		0.0104
03/24/2015	<	0.002
04/01/2015	<	0.002
05/18/2015	<	0.002
06/01/2015	<	0.002
07/06/2015	<	0.002
08/03/2015	<	0.002
09/02/2015	<	0.002
10/21/2015	<	0.002
11/04/2015	<	0.002
12/09/2015	<	0.01
01/07/2016	<	0.002
02/01/2016	<	0.002
03/02/2016	<	0.002
04/06/2016	<	0.002
05/02/2016	<	0.002
06/06/2016	<	0.002
07/05/2016	<	0.002
08/05/2016	<	0.01
09/08/2016	<	0.01
10/25/2016	<	0.01
11/15/2016	<	0.01
12/12/2016	<	0.01
01/17/2017	<	0.01
02/03/2017		0.0018
03/02/2017	<	0.001
04/12/2017	<	0.001
05/18/2017	<	0.001
06/20/2017	<	0.001
07/13/2017	<	0.001
08/08/2017		0.00467
09/05/2017	<	0.001
10/02/2017	<	0.001
11/08/2017		0.00116
12/06/2017	<	0.001
01/11/2018	<	0.001
02/27/2018	<	0.001

Copper

DATCOL	SYM	VALUE
10/02/2013		0.00227
11/05/2013		0.00232
12/11/2013		0.00314
01/03/2014		0.00277
02/17/2014	<	0.002
03/05/2014		0.00266
04/02/2014		0.00248
05/07/2014		0.00413
06/13/2014	<	0.002
07/01/2014	<	0.002
08/13/2014	<	0.002
09/25/2014	<	0.002
10/01/2014	<	0.002
11/20/2014		0.00229
12/16/2014		0.00218
01/13/2015	<	0.02
02/02/2015		0.00288
03/24/2015		0.00231
04/01/2015		0.0022
05/18/2015		0.0026
06/01/2015		0.00257
07/06/2015		0.00239
08/03/2015	<	0.002
09/02/2015		0.0023
10/21/2015		0.00453
11/04/2015		0.0023
12/09/2015	<	0.01
01/07/2016		0.00524
02/01/2016		0.00238
03/02/2016		0.0024
04/06/2016		0.00236
05/02/2016	<	0.002
06/06/2016	<	0.002
07/05/2016		0.00229
08/05/2016	<	0.01
09/09/2016	<	0.01
10/25/2016	<	0.01
11/15/2016	<	0.01
12/12/2016	<	0.001
01/17/2017	<	0.01
02/03/2017		0.00206
03/02/2017		0.00204
04/13/2017		0.0067
05/18/2017		0.00201
06/20/2017		0.00186
07/13/2017		0.00175
08/09/2017		0.00273
09/05/2017		0.00193
10/02/2017		0.0018
11/08/2017		0.00353
12/06/2017		0.00157
01/11/2018		0.0032
02/27/2018		0.00443

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Cyanide

DATCOL	SYM	VALUE
10/02/2013	<	0.01
11/05/2013	<	0.01
12/11/2013	<	0.01
01/03/2014	<	0.01
02/17/2014	<	0.1
03/05/2014	<	0.01
04/02/2014	<	0.01
05/07/2014	<	0.01
06/13/2014	<	0.01
07/01/2014	<	0.01
08/13/2014	<	0.01
09/25/2014	<	0.01
10/01/2014	<	0.01
11/20/2014	<	0.01
12/16/2014	<	0.01
01/13/2015	<	0.005
02/02/2015	<	0.01
03/24/2015	<	0.01
04/01/2015		0.213
05/18/2015	<	0.01
06/02/2015	<	0.01
07/07/2015		0.0137
08/03/2015	<	0.01
09/02/2015	<	0.01
10/21/2015	<	0.01
11/04/2015	<	0.0105
12/09/2015	<	0.005
01/07/2016	<	0.01
02/01/2016	<	0.01
03/02/2016	<	0.01
04/06/2016	<	0.01
05/02/2016	<	0.01
06/01/2016	<	0.01
06/06/2016	<	0.01
07/05/2016	<	0.01
08/05/2016	<	0.005
09/08/2016	<	0.005
10/25/2016	<	0.005
11/15/2016	<	0.005
12/12/2016	<	0.005
01/17/2017		0.00871
02/03/2017	<	0.005
03/02/2017	<	0.005
04/12/2017	<	0.005
05/18/2017	<	0.005
06/20/2017	<	0.005
07/13/2017	<	0.005
08/08/2017	<	0.005
09/05/2017	<	0.005
10/02/2017	<	0.005
11/08/2017	<	0.005
12/06/2017	<	0.005
01/11/2018	<	0.005
02/27/2018	<	0.005

Iron

DATCOL	SYM	VALUE
10/02/2013		0.411
11/05/2013		0.376
12/11/2013		1.01
01/03/2014		0.647
02/17/2014		0.67
03/05/2014		0.708
04/02/2014		0.496
05/07/2014		0.357
06/13/2014		0.437
07/01/2014		0.436
08/13/2014		0.363
09/25/2014		0.423
10/02/2014		0.407
11/20/2014		0.735
12/16/2014		0.483
01/13/2015		0.55
02/02/2015		0.556
03/24/2015		0.457
04/01/2015		0.382
05/18/2015		0.238
06/01/2015		0.278
07/06/2015		0.46
08/04/2015		0.297
09/02/2015		0.262
10/21/2015		0.287
11/04/2015		0.275
12/09/2015		0.577
01/07/2016		0.653
02/01/2016		0.367
03/02/2016		0.608
04/06/2016		0.352
05/02/2016		0.281
06/06/2016		0.319
07/05/2016		0.255
08/05/2016		0.133
09/08/2016		0.289
10/25/2016		0.259
11/15/2016		0.327
12/12/2016		0.802
01/17/2017		0.336
02/03/2017		0.439
03/02/2017		0.377
04/12/2017		0.318
05/18/2017		0.196
06/20/2017		0.225
07/13/2017		0.192
08/08/2017		0.179
09/05/2017		0.181
10/02/2017		0.233
11/08/2017		0.508
12/06/2017		0.306
01/11/2018		0.686
02/27/2018		0.482

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Lead

DATCOL	SYM	VALUE
10/02/2013	<	0.002
11/05/2013	<	0.002
12/11/2013	<	0.002
01/03/2014	<	0.002
02/17/2014	<	0.002
03/05/2014	<	0.002
04/02/2014	<	0.002
05/07/2014	<	0.002
06/13/2014	<	0.002
07/01/2014	<	0.002
08/13/2014	<	0.002
09/25/2014	<	0.002
10/01/2014	<	0.002
11/20/2014	<	0.002
12/16/2014	<	0.002
01/13/2015	<	0.005
02/02/2015	<	0.002
03/24/2015	<	0.002
04/01/2015	<	0.002
05/18/2015	<	0.002
06/01/2015	<	0.002
07/06/2015	<	0.002
08/03/2015	<	0.002
09/02/2015	<	0.002
10/21/2015	<	0.002
11/04/2015	<	0.002
12/09/2015	<	0.005
01/07/2016	<	0.002
02/01/2016	<	0.002
03/02/2016	<	0.002
04/06/2016	<	0.002
05/02/2016	<	0.002
06/06/2016	<	0.002
07/05/2016	<	0.002
08/05/2016	<	0.005
09/08/2016	<	0.005
10/25/2016	<	0.005
11/15/2016	<	0.005
12/12/2016	<	0.005
01/17/2017	<	0.005
02/03/2017	<	0.001
03/02/2017	<	0.001
04/12/2017	<	0.001
05/18/2017	<	0.001
06/20/2017	<	0.001
07/13/2017	<	0.001
08/08/2017	<	0.001
09/05/2017	<	0.001
10/02/2017	<	0.001
11/08/2017	<	0.001
12/06/2017	<	0.001
01/11/2018	<	0.001
02/27/2018	<	0.001

Manganese

DATCOL	SYM	VALUE
10/02/2013		0.0635
11/05/2013		0.064
12/11/2013		0.121
01/03/2014		0.107
02/17/2014		0.134
03/05/2014		0.167
04/02/2014		0.121
05/07/2014		0.0752
06/13/2014		0.0823
07/01/2014		0.0731
08/13/2014		0.0602
09/25/2014		0.06815
10/01/2014		0.0642
11/20/2014		0.168
12/16/2014		0.111
01/13/2015		0.089
02/02/2015		0.11
03/24/2015		0.15
04/01/2015		0.119
05/18/2015		0.0621
06/01/2015		0.0911
07/06/2015		0.158
08/03/2015		0.184
09/02/2015		0.0718
10/21/2015		0.0835
11/04/2015		0.0922
12/09/2015		0.214
01/07/2016		0.139
02/01/2016		0.486
03/02/2016		0.126
04/06/2016		0.0785
05/02/2016		0.0621
06/06/2016		0.177
07/05/2016		0.282
08/05/2016		0.0942
09/08/2016		0.174
10/25/2016		0.0509
11/15/2016		0.137
12/12/2016		0.134
01/17/2017		0.23
02/03/2017		0.278
03/02/2017		0.115
04/12/2017		0.107
05/18/2017		0.0451
06/20/2017		0.203
07/13/2017		0.0683
08/08/2017		0.0131
09/05/2017		0.149
10/02/2017		0.0739
11/08/2017		0.136
12/06/2017		0.0871
01/11/2018		0.148
02/27/2018		0.127

Summary of NPDES Outfall Analytical Results
Bull Run Fossil Plant
Clinton, Tennessee

Mercury (ng/L)

DATCOL	SYM	VALUE
10/02/2013		3.52
11/05/2013		2.04
12/11/2013		3.64
01/03/2014		3.05
02/17/2014		1.76
03/05/2014		8.44
04/02/2014		22.7
05/07/2014		26.4
06/13/2014		4.63
07/01/2014		5.14
08/13/2014		9.34
09/25/2014		7.635
10/01/2014		10
11/20/2014		3.83
12/16/2014		2.56
01/13/2015		379
02/02/2015		15.9
03/24/2015		8.16
04/01/2015		11.7
05/18/2015		3.73
06/01/2015		10.4
07/06/2015		0.252
08/03/2015		5.96
09/02/2015		12.1
10/21/2015		3.88
11/04/2015		5.215
12/09/2015		10.1
01/07/2016		3
02/01/2016		14.4
03/02/2016		57.7
04/06/2016		3.22
05/02/2016		4.02
06/01/2016		7.06
06/06/2016		4.67
07/05/2016		6.64
08/05/2016		4.13
09/08/2016		1.19
10/25/2016		1.84
11/15/2016		6.96
12/12/2016		32.5
01/17/2017		59.8
02/03/2017		10.2
03/02/2017		8.89
04/12/2017		7.46
05/18/2017		4.54
06/20/2017		15.4
07/13/2017		8.18
08/08/2017		7.33
09/05/2017		3.19
10/02/2017		31.2
11/08/2017		6.68
12/06/2017		1.37
01/11/2018		60.9
02/27/2018		6.88

Nickel

DATCOL	SYM	VALUE
10/02/2013		0.00275
11/05/2013	<	0.002
12/11/2013		0.00286
01/03/2014		0.00245
02/17/2014		0.00204
03/05/2014		0.00343
04/02/2014		0.00371
05/07/2014		0.00746
06/13/2014		0.00231
07/01/2014		0.00264
08/13/2014		0.0225
09/25/2014		0.002385
10/01/2014		0.00268
11/21/2014		0.00738
12/16/2014		0.00278
01/13/2015	<	0.02
02/02/2015		0.0057
03/24/2015		0.00358
04/01/2015		0.00403
05/18/2015	<	0.002
06/01/2015		0.00204
07/06/2015		0.00772
08/03/2015		0.00484
09/02/2015		0.00308
10/21/2015		0.00306
11/04/2015		0.00272
12/09/2015		0.014
01/07/2016		0.0119
02/01/2016		0.0176
03/02/2016		0.00567
04/06/2016		0.00225
05/02/2016	<	0.002
06/06/2016		0.00592
07/05/2016		0.0096
08/05/2016	<	0.01
09/08/2016	<	0.01
10/25/2016	<	0.01
11/15/2016	<	0.01
12/12/2016		0.0116
01/17/2017	<	0.01
02/03/2017		0.00993
03/02/2017		0.00576
04/12/2017		0.00485
05/18/2017		0.00214
06/20/2017		0.00814
07/14/2017		0.00456
08/08/2017		0.0123
09/05/2017		0.0112
10/02/2017		0.00266
11/08/2017		0.0112
12/06/2017		0.00255
01/11/2018		0.014
02/27/2018		0.00848

Summary of NPDES Outfall Analytical Results
Bull Run Fossil Plant
Clinton, Tennessee

Ammonia Nitrogen

DATCOL	SYM	VALUE
10/02/2013		0.082
11/05/2013	<	0.1
12/11/2013	<	0.1
01/03/2014		0.0035
02/17/2014		0
03/05/2014		0.039
04/02/2014	<	0.1
05/07/2014		0.015
06/13/2014	<	0.1
07/01/2014		0.022
08/13/2014		0.033
09/25/2014	<	0.063
10/01/2014	<	0.1
11/21/2014		0
12/16/2014		0
01/13/2015		0
02/02/2015		0
03/24/2015	<	0.1
04/01/2015		0.0822
05/18/2015		0.061
06/01/2015		0
07/06/2015	<	0.1
08/03/2015		0
09/02/2015		0.0074
10/21/2015		0
11/04/2015		0.0134
12/09/2015		0
01/07/2016		0
02/01/2016		0.099
03/02/2016		0.013
04/06/2016	<	0.1
05/02/2016	<	0.1
06/06/2016		0
07/05/2016		0
08/05/2016		0
09/08/2016		0
10/25/2016		0
11/15/2016		0
12/12/2016		0
01/17/2017	<	0.1
02/03/2017		0
03/02/2017		0
04/12/2017		0.003
05/18/2017		0
06/20/2017		0
07/13/2017		0.004
08/08/2017	<	0.1
09/05/2017		0
10/02/2017		0.032
11/08/2017		0
12/06/2017		0
01/11/2018		2.43
02/27/2018		0.148

Oil & Grease

DATCOL	SYM	VALUE
10/02/2013	<	4.47
11/05/2013	<	4.3
12/11/2013	<	4.57
01/03/2014	<	4.305
02/17/2014	<	4.36
03/05/2014	<	4.47
04/04/2014	<	4.13
05/07/2014	<	4.57
06/13/2014	<	4.13
07/01/2014	<	4.52
08/13/2014	<	4.13
09/25/2014	<	4.075
10/01/2014	<	4.27
11/20/2014	<	5.12
12/16/2014	<	4.31
01/13/2015	<	5.6
02/02/2015	<	4.63
03/24/2015	<	4.31
04/01/2015	<	4
05/18/2015	<	4.27
06/01/2015	<	4.57
07/06/2015	<	4.63
08/03/2015	<	4.41
09/02/2015	<	4.52
10/21/2015	<	4.63
11/04/2015	<	4.31
12/09/2015	<	5.56
01/07/2016	<	4.57
02/01/2016	<	4.52
03/02/2016	<	4.31
04/06/2016	<	4.17
05/02/2016	<	4.22
06/01/2016	<	4.665
06/06/2016	<	4.68
07/05/2016	<	4.63
08/05/2016	<	5.88
09/08/2016	<	5.8
10/25/2016	<	5.57
11/15/2016	<	5.56
12/12/2016	<	5.5
01/17/2017	<	5.56
02/03/2017	<	5.68
03/02/2017	<	5.62
04/12/2017	<	5.75
05/18/2017	<	5.75
06/20/2017	<	5.75
07/13/2017		5.75
08/08/2017	<	5.62
09/06/2017	<	5.81
10/02/2017	<	5.4
11/08/2017	<	5
12/06/2017	<	5.56
01/11/2018	<	5.56
02/27/2018	<	5.56

Summary of NPDES Outfall Analytical Results
Bull Run Fossil Plant
Clinton, Tennessee

Selenium

DATCOL	SYM	VALUE
10/02/2013	<	0.002
11/05/2013	<	0.002
12/11/2013		0.00561
01/03/2014		0.002575
02/17/2014	<	0.002
03/05/2014		0.00219
04/02/2014		0.00366
05/07/2014		0.00773
06/13/2014	<	0.002
07/01/2014		0.00561
08/13/2014		0.00433
09/25/2014		0.00359
10/01/2014		0.0029
11/20/2014		0.00307
12/16/2014		0.00224
01/13/2015	<	0.02
02/02/2015		0.0081
03/24/2015		0.00639
04/01/2015		0.00476
05/18/2015	<	0.002
06/01/2015		0.00344
07/06/2015		0.0154
08/03/2015		0.0119
09/02/2015		0.00353
10/21/2015	<	0.002
11/04/2015	<	0.002
12/09/2015		0.0269
01/07/2016		0.00365
02/01/2016		0.0338
03/02/2016		0.00615
04/06/2016		0.00253
05/02/2016	<	0.002
06/06/2016		0.0196
07/05/2016		0.0485
08/05/2016		0.0236
09/08/2016		0.0132
10/25/2016	<	0.01
11/15/2016		0.0106
12/12/2016	<	0.01
01/17/2017		0.032
02/03/2017		0.0295
03/02/2017		0.00469
04/13/2017		0.00409
05/18/2017		0.0029
06/20/2017		0.0249
07/13/2017		0.00429
08/08/2017		0.0297
09/05/2017		0.0287
10/02/2017		0.00553
11/08/2017		0.00334
12/06/2017		0.00224
01/11/2018		0.00463
02/27/2018		0.00445

Silver

DATCOL	SYM	VALUE
10/02/2013	<	0.002
11/05/2013	<	0.002
12/11/2013	<	0.002
01/03/2014	<	0.002
02/17/2014	<	0.002
03/05/2014	<	0.002
04/02/2014	<	0.002
05/07/2014	<	0.002
06/13/2014	<	0.002
07/01/2014	<	0.002
08/13/2014	<	0.002
09/25/2014	<	0.002
10/01/2014	<	0.002
11/20/2014	<	0.002
12/16/2014	<	0.002
01/13/2015	<	0.01
02/02/2015	<	0.002
03/24/2015	<	0.002
04/01/2015	<	0.002
05/18/2015	<	0.002
06/01/2015	<	0.002
07/06/2015	<	0.002
08/03/2015	<	0.002
09/02/2015	<	0.002
10/21/2015	<	0.002
11/04/2015	<	0.002
12/09/2015	<	0.005
01/07/2016	<	0.002
02/01/2016	<	0.002
03/02/2016	<	0.002
04/06/2016	<	0.002
05/02/2016	<	0.002
06/06/2016	<	0.002
07/05/2016	<	0.002
08/05/2016	<	0.005
09/08/2016	<	0.005
10/25/2016	<	0.005
11/15/2016	<	0.005
12/12/2016	<	0.005
01/17/2017	<	0.005
02/03/2017	<	0.001
03/02/2017	<	0.001
04/12/2017	<	0.001
05/18/2017	<	0.001
06/20/2017	<	0.001
07/13/2017	<	0.001
08/08/2017	<	0.001
09/05/2017	<	0.001
10/02/2017	<	0.001
11/08/2017	<	0.001
12/06/2017	<	0.001
01/11/2018	<	0.001
02/27/2018	<	0.001

Summary of NPDES Outfall Analytical Results
Bull Run Fossil Plant
Clinton, Tennessee

Total Suspended Solids

DATCOL	SYM	VALUE
10/02/2013		5.8
11/05/2013		8.3
12/11/2013		17.4
01/03/2014		10.05
02/17/2014		6.8
03/05/2014		19.2
04/02/2014		9.3
05/07/2014		6.4
06/13/2014		9.73
07/01/2014		8.7
08/13/2014		3.9
09/25/2014		5.5
10/01/2014		8.4
11/20/2014		8.1
12/16/2014		12
01/13/2015		8.1
02/02/2015		8
03/24/2015		3.68
04/01/2015		5.16
05/18/2015		3.5
06/01/2015		11.3
07/06/2015		9.86
08/03/2015		6.22
09/02/2015		4.13
10/21/2015		3.4
11/04/2015		3.825
12/09/2015		5.6
01/07/2016		2.7
02/01/2016		3.5
03/02/2016		3.9
04/06/2016		5.3
05/02/2016		3.7
06/06/2016		5.1
07/05/2016		2.8
08/05/2016		2.5
09/08/2016		2.5
10/25/2016		2.5
11/15/2016		2.8
12/12/2016		10
01/17/2017		3.1
02/03/2017		5.44
03/02/2017		3.2
04/12/2017		3.3
05/18/2017		2.7
06/20/2017		4.2
07/13/2017		3.1
08/08/2017		2.5
09/05/2017		2.7
10/02/2017		2.7
11/08/2017		6.5
12/06/2017	<	2.5
01/11/2018		9.4
02/27/2018		4.4

Thallium

DATCOL	SYM	VALUE
10/02/2013	<	0.002
11/05/2013	<	0.002
12/11/2013	<	0.002
01/03/2014	<	0.002
02/17/2014	<	0.002
03/05/2014	<	0.002
04/02/2014	<	0.002
05/07/2014	<	0.002
06/13/2014	<	0.002
07/01/2014	<	0.002
08/13/2014	<	0.002
09/25/2014	<	0.002
10/01/2014	<	0.002
11/20/2014	<	0.002
12/16/2014	<	0.002
01/13/2015	<	0.02
02/02/2015	<	0.002
03/24/2015	<	0.002
04/01/2015	<	0.002
05/18/2015	<	0.002
06/01/2015	<	0.002
07/06/2015	<	0.002
08/03/2015	<	0.002
09/02/2015	<	0.002
10/21/2015	<	0.002
11/04/2015	<	0.002
12/09/2015	<	0.01
01/07/2016	<	0.002
02/01/2016	<	0.002
03/02/2016	<	0.002
04/06/2016	<	0.002
05/02/2016	<	0.002
06/06/2016	<	0.002
07/05/2016	<	0.002
08/05/2016	<	0.01
09/08/2016	<	0.005
10/25/2016	<	0.005
11/15/2016	<	0.01
12/12/2016	<	0.01
01/17/2017	<	0.01
02/03/2017	<	0.001
03/02/2017	<	0.001
04/12/2017	<	0.001
05/18/2017	<	0.001
06/20/2017		0.001
07/13/2017	<	0.001
08/08/2017	<	0.001
09/05/2017	<	0.001
10/02/2017	<	0.001
11/08/2017	<	0.001
12/06/2017	<	0.001
01/11/2018	<	0.001
02/27/2018		0.00153

Summary of NPDES Outfall Analytical Results
Bull Run Fossil Plant
Clinton, Tennessee

Zinc

DATCOL	SYM	VALUE
10/02/2013	<	0.025
11/05/2013	<	0.025
12/11/2013	<	0.025
01/03/2014	<	0.025
02/17/2014	<	0.025
03/05/2014	<	0.025
04/02/2014	<	0.025
05/07/2014	<	0.025
06/13/2014	<	0.025
07/01/2014		0.025
08/13/2014	<	0.025
09/25/2014	<	0.025
10/01/2014	<	0.025
11/20/2014	<	0.025
12/16/2014	<	0.025
01/13/2015	<	0.05
02/02/2015	<	0.025
03/24/2015	<	0.025
04/01/2015	<	0.025
05/18/2015	<	0.025
06/02/2015	<	0.025
07/06/2015		0.0606
08/03/2015	<	0.025
09/02/2015	<	0.025
10/21/2015	<	0.025
11/04/2015	<	0.025
12/09/2015	<	0.05
01/07/2016	<	0.025
02/01/2016		0.0646
03/02/2016	<	0.025
04/06/2016		0.0321
05/02/2016	<	0.025
06/06/2016	<	0.025
07/06/2016		0.0479
08/05/2016	<	0.05
09/08/2016	<	0.05
10/25/2016	<	0.05
11/15/2016	<	0.05
12/12/2016	<	0.05
01/17/2017		0.0662
02/03/2017		0.0568
03/02/2017		0.0239
04/12/2017	<	0.01
05/18/2017	<	0.01
06/20/2017		0.0473
07/13/2017		0.0119
08/08/2017		0.0282
09/05/2017		0.0533
10/02/2017	<	0.001
11/08/2017		0.0221
12/06/2017	<	0.01
01/11/2018		0.0131
02/27/2018		0.013

APPENDIX S
HISTORIC SEEPAGE SUMMARY

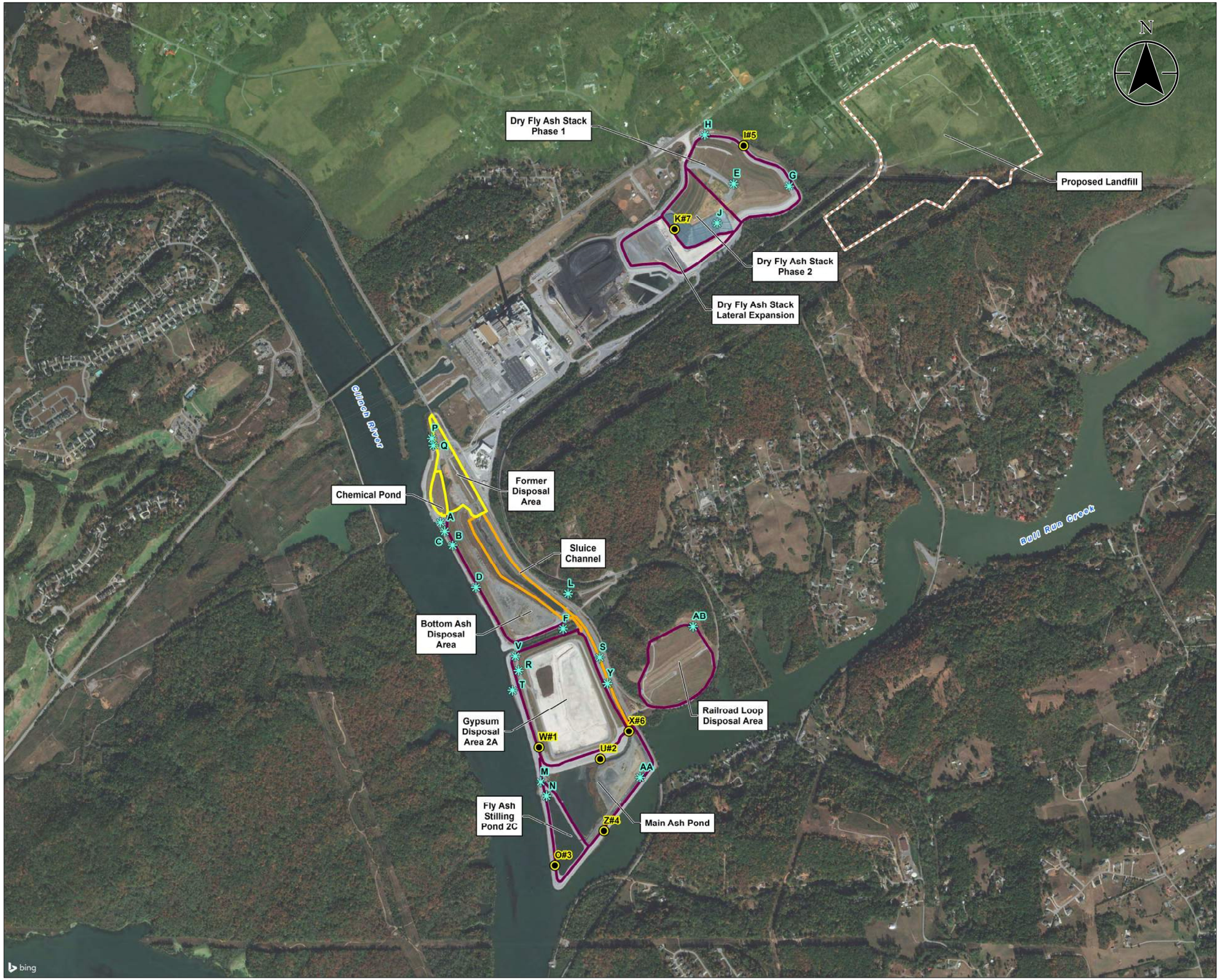

Figure No.
1

Title
Bull Run Fossil Plant
Site Map

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-02-28
Technical Review by TG on 2018-02-28

0 700 1,400 2,100 2,800 Feet

1:8,400 (At original document size of 22x34)

Legend

- Historic Seep (Map ID)
- Area of Concern (AOC) (MapID/AOC #)
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)
- Proposed Landfill (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

Stantec

TVA

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I:\TVA-EP\175566346\gis\mxds\BRF_Historic_Seep_Location.mxd Revised: 2018-02-28 By: tink

Seepage History Summary

TVA has conducted annual dike inspections at BRF since 1968. These inspections identify seeps, evaluate potential impacts of these seeps, and recommend remedial measures to correct the seeps. NPDES Permit No. TN0005410 was issued by TDEC to BRF. Under the NPDES permit, TVA visually inspects the dikes and toe areas at least quarterly for seepage and submits an annual report to TDEC documenting the findings of the inspections and remedial activities implemented.

Major remedial activities at BRF include the regrading of slopes, construction of ditches, stabilization of soft soil areas, and the installation of a reverse graded filter in Phase I of the Dry Fly Ash Stack; the regrading of slopes, construction of ditches, and modification of stormwater structures and pipes along the northwest and southwest slopes of Phase II of the Dry Fly Ash Stack; and the construction of a rock buttress in Gypsum Disposal Area 2A.

TVA maintains a Seepage Action Plan (Stantec, 2010) which identifies areas of concern (AOC) by a unique number and documents the date of discovery, description, size, mitigation status, and current status. A map depicting historic seepage areas is shown on Figure 1. A summary of the seep history for KIF is provided in Table 1.

Table 1. Seepage History Summary			
Map ID	Seepage Action Plan AOC No.	CCR Unit	Description
A	N/A	Bottom Ash Disposal Area	Seepage was observed in 1967 where the dike and the causeway between Ash Disposal Areas 1A and 1B intersected. TVA addressed this seep by placing clay fill on the inside of the dike. The seep was not observed in subsequent inspections.
B	N/A	Bottom Ash Disposal Area	Seepage occurred through the west dike of Ash Disposal Area 1 in 1976. Visual inspection of the corrective work showed no signs of seepage according to an inspection memorandum dated April 5, 1976.
C	N/A	Bottom Ash Disposal Area	Leaching was observed along the shoreline of Melton Hill Reservoir adjacent to the west dike in 1981, but did not appear to affect the structural stability of the dike and no repairs were recommended.
D	N/A	Bottom Ash Disposal Area	In 1996, a soft spot was observed on the west side of the area at the toe of the dike. The report stated the seep did not appear to affect the structural stability of the dike.
E	N/A	Dry Fly Ash Stack Phase I	A large seep on the western dike of Phase I was observed in 1998. A gravel blanket was constructed between Phase I and Phase II in 2006 to correct this seep.
F	N/A	Bottom Ash Disposal Area	A 2010 annual inspection found a red water seep at the toe of the south slope of Ash Disposal Area 1. A red water seep was observed again in the area in 2014. The report recommended monitoring this seep in accordance with the BRF Seepage Action Plan.
G	N/A	Dry Fly Ash Stack Phase I	A seep was observed in the southeastern portion of the dike in 1998. Seeps were again observed in this area during a 2011 inspection. The seeps were not observed in subsequent inspections after 2011.
H	N/A	Dry Fly Ash Stack Phase I	A seep on the northern side of Phase I near a transmission tower was observed in 2005. This seep was not observed during a 2006 inspection. A seep was again observed in this area in 2011. Work to repair this seep, including the removal of topsoil and cover soil, subgrade stabilization, the installation of a reverse graded filter, and the armoring and stabilization of the slopes, was completed in 2013.

I	5	Dry Fly Ash Stack Phase I	A seep was discovered east of the existing seep on the northern side of Phase I near the transmission tower in 2005. During the 2010 and 2011 inspections, seeps were again observed in this area. Work to repair this seep, including the removal of topsoil and cover soil, subgrade stabilization, the installation of a reverse graded filter, and the armoring and stabilization of the slopes, was completed in 2013.
J	N/A	Dry Fly Ash Stack Phase II	Seeps were observed on the south slope of Phase II in 2010 and 2011. Seeps were not identified in subsequent inspections.
K	7	Dry Fly Ash Stack Phase II	In 2010, seeps were observed on the southwest slope of Phase II. Work including the regrading of ditches, stripping of soil, stabilization of ash material, installation of a reverse graded filter, and installation of a stone buttress was completed between 2011 and 2013 to correct these seeps.
L	N/A	East of Bottom Ash Disposal Area	A 1994 inspection reported a seep located across the railroad from the southeast corner of Ash Disposal Area 1. The water discharged into an unnamed creek before entering Melton Hill Reservoir. The seep was not observed in subsequent inspections.
M	N/A	Fly Ash Stilling Pond 2C	Damp, soft material was observed on top of the original dikes of Ash Disposal Area 2 during the 1976, 1977, and 1978 inspections. Soil samples were taken, but pH readings from the samples were inconclusive. Soil borings were completed at two locations within the damp area and it was concluded that the dike was stable and in good condition.
N	N/A	Fly Ash Stilling Pond 2C	A 1998 inspection found water seeping through a cracked area in the center discharge pipe. The 2001 inspection report stated the pipe had been grouted.
O	3	Fly Ash Stilling Pond 2C	Numerous wet areas along the exterior slopes of the southwest dike of Ash Disposal Area 2 were noted during a 2009 inspection. The water level of the pond was lowered to stop the seeps.
P	N/A	Former Disposal Area	A small amount of seepage through the ash dike was observed during a 1971 inspection. A drainage ditch was constructed along the toe of the north dike in Area 1 to carry seepage into the lake.

Q	N/A	Former Disposal Area	Seepage was observed in October 1979 along the toe of the north end of the west dike of Ash Disposal Area 1, with water collecting between the toe of the dike slope and the east bank of Melton Hill Reservoir. The previous seepage repair of the west dike of Ash Disposal Area 1 one was extended to the north end of the dike to address seepage at this location. No seepage was observed in 1980.
R	N/A	Gypsum Disposal Area 2A	A 1994 inspection identified a seepage area in the northwest corner of Ash Disposal Area 2. The seep was not observed in subsequent inspections.
S	N/A	Gypsum Disposal Area 2A	A seep area along the eastern edge of the Railroad Loop Area was observed in 1994. The inspection report stated it is no longer an active seepage area.
T	N/A	Gypsum Disposal Area 2A	An apparent red water seep was observed in the river bank in 2007 due to the low water level of Melton Hill Lake. The seep was not observed in subsequent inspections.
U	2	Gypsum Disposal Area 2A	The 2010 annual inspection report found numerous red water seeps on the south slope above the Fly Ash Pond. A 2011 report found that these seeps had been corrected through the construction of a rock buttress on the south slope.
V	N/A	Gypsum Disposal Area 2A	In 2010, a red water seep was observed on the west slope above the perimeter road. A 2011 inspection found that the seep had been corrected and it was not observed in subsequent inspections.
W	1	Gypsum Disposal Area 2A	A red water seep was piping material into the ditch adjacent to the perimeter road on the southwest corner of the Gypsum Disposal Area in 2010. It was temporarily repaired with sandbags and gravel. A 2011 inspection found that the seep had been corrected and it was not observed in subsequent inspections.
X	6	Gypsum Disposal Area 2A	In 2011, red water seeps were observed in the southeastern corner of the area above the sluice ditch. A stone buttress was constructed to eliminate the seep.
Y	N/A	Gypsum Disposal Area 2A	The 2014 annual inspection found staining in the sluice ditch east of the Gypsum Disposal Area. The inspection report recommended monitoring the seep in accordance with the BRF Seepage Plan.

Z	4	Main Ash Pond	A small, damp area was observed on the berm adjacent to Bull Run Creek during a 1986 inspection. The inspection report stated the area did not appear to affect the structural stability of the dike. This seep was not identified in subsequent inspections.
AA	N/A	Main Ash Pond	A seep was observed on the south exterior slope in 2014. The seep was not observed in subsequent inspections.
AB	N/A	Railroad Loop Disposal Area	A seep was observed on the northeast corner of the east dredge cell at the toe of the northern dike in 2006. In 2007 and 2008, the same seep was observed exhibiting the characteristics of a red water seep. Seeps were not noted in subsequent inspections of the dredge cells.

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APPENDIX T
SEEP SAP

Seep
Sampling and Analysis Plan
Bull Run Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Bull Run Fossil Plant
Clinton, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 17, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	October 27, 2017
2	Addresses January 29, 2018 TDEC Review Comments and Issued for TDEC Review	March 30, 2018
3	Addresses May 22, 2018 TDEC Review Comments and Issued for TDEC Review	July 13, 2018
4	Addresses TDEC Comments, Applicable Programmatic Revisions, and Issued for TDEC Approval	December 17, 2018

SEEP
SAMPLING AND ANALYSIS PLAN
BULL RUN FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Seep
Sampling and Analysis Plan
Bull Run Fossil Plant
Tennessee Valley Authority
Clinton, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 17, 2018 Revision 4

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	12/13/18 Date
McClung, Nicholas Anthony Digitally signed by McClung, Nicholas Anthony Date: 2018.12.07 09:55:07 -05'00'	
TVA Investigation Field Lead	Date
Health, Safety, and Environmental (HSE) Manager	12/13/18 Date
Investigation Project Manager	12/6/2018 Date
Rock J. Vitale Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=vitale@envsld.com, c=US Date: 2018.12.11 12:00:08 -05'00'	
QA Oversight Manager	Date
Laboratory Project Manager	12-12-18 Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

Stantec

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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 Bull Run Fossil Plant (BRF) on July 13-14, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at BRF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference.

On September 13, 2016, TDEC issued 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 January 9, 2017, TVA submitted BRF 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 BRF 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)
- 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

Figure 1 (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 that is not captured and managed through a permitted unit. 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 collected. 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 and Standard Operating Procedures (SOPs), Quality Assurance Project Plan (QAPP; Appendix D to the EIP), SAPs, and HASP.
- Complete required health and safety paperwork and 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 (DI) 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 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*
- EMA-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.

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
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

Table 5. Analytical Methods, Preservatives, Containers, and Holding Times

Parameter	Analytical Methods	Preservative(s)	Container(s)	Holding Times
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 DI 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 DI 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 DI 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.

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
FIGURE

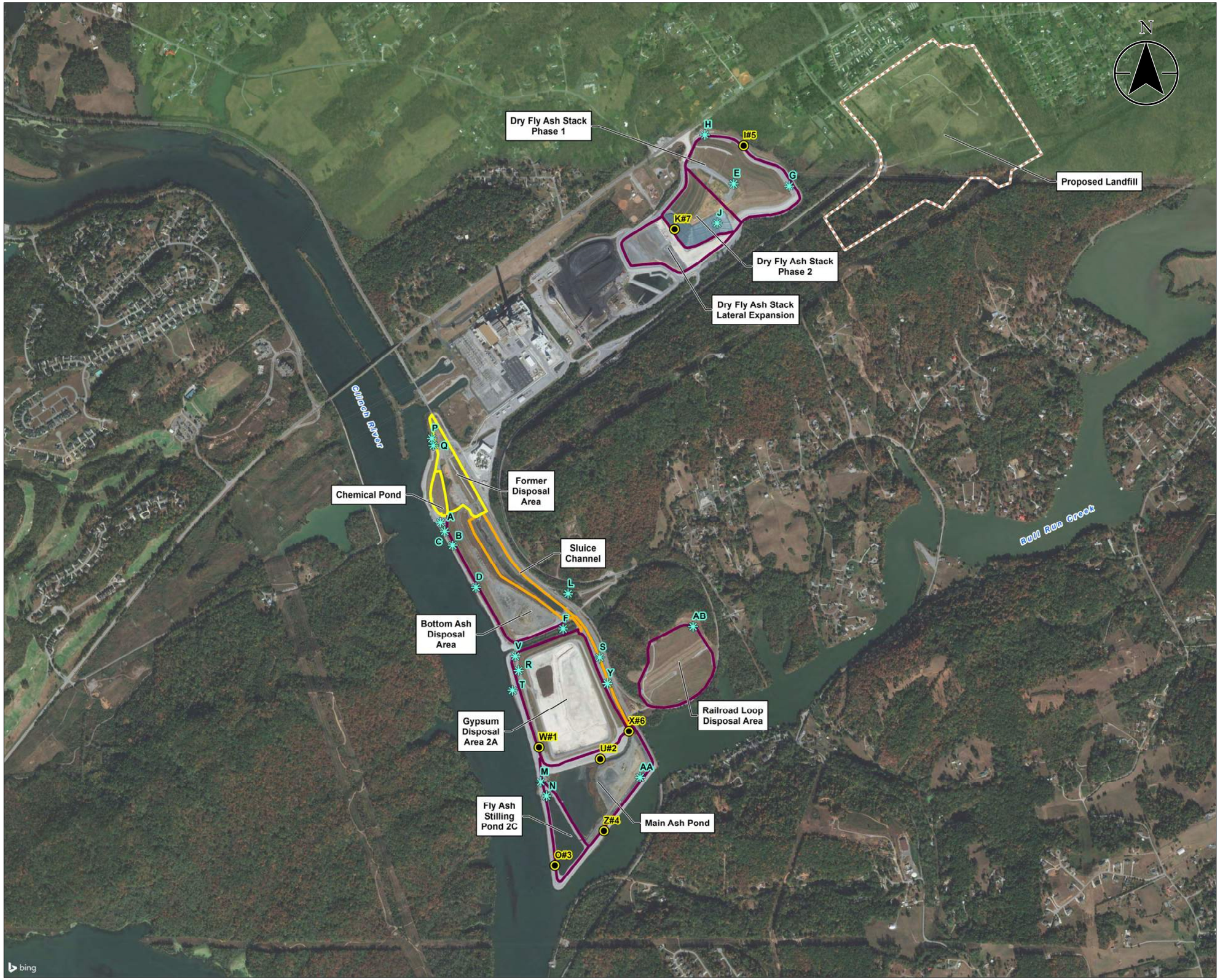

Figure No.
1

Title
Bull Run Fossil Plant
Site Map

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-02-28
Technical Review by TG on 2018-02-28

0 700 1,400 2,100 2,800 Feet

1:8,400 (At original document size of 22x34)

Legend

- Historic Seep (Map ID)
- Area of Concern (AOC) (MapID/AOC #)
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)
- Proposed Landfill (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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TVA

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I:\TVA-EP\175566346\gis\mxds\BRF_Historic_Seep_Location.mxd Revised: 2018-02-28 By: tink

ATTACHMENT B
FIELD EQUIPMENT LIST

Field Equipment List
Seep Investigations

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 U
SURFACE STREAM SAP

Surface Stream
Sampling And Analysis Plan
Bull Run Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Bull Run Fossil Plant
Clinton, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 17, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	October 27, 2017
2	Addresses January 29, 2017 TDEC Review Comments and Issued for TDEC Review	March 30, 2018
3	Addresses May 22, 2018 TDEC Review Comments and Issued for TDEC Review	July 13, 2018
4	Addresses TDEC Comments, Applicable Programmatic Revisions, and Issued for TDEC Approval	December 17, 2018

SURFACE STREAM
SAMPLING AND ANALYSIS PLAN
BULL RUN FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Surface Stream
Sampling and Analysis Plan
Bull Run Fossil Plant
Tennessee Valley Authority
Clinton, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 17, 2018 Revision 4

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	12/13/18 Date
TVA Investigation Field Lead	12/14/18 Date
Health, Safety, and Environmental (HSE) Manager	12/13/18 Date
Investigation Project Manager	12/6/2018 Date
QA Oversight Manager (Rock J. Vitale — Digitally signed by Rock J. Vitale, DN: cn=Rock J. Vitale, o, ou, email=rvitale@tvastd.com, c=US, Date: 2018.12.11 13:00:34 -05'00')	Date
Laboratory Project Manager	12.17.18 Date
Charles L. Head TDEC Senior Advisor	Date
Robert Wilkinson TDEC CCR Technical Manager	Date

Stantec

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ATTACHMENT B **FIELD EQUIPMENT LIST**

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 Bull Run Fossil Plant (BRF) on July 13-14, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at BRF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference.

On September 13, 2016, TDEC issued 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 January 9, 2017, TVA submitted BRF 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 BRF 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 to 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 Rule 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 Rule 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.

During planning and sampling activities, procedures to ensure safety will be incorporated according to the TVA Standard Programs and Processes (SPP) TVA-SPP-18.005, Plan Jobs Safely, which provides information on using job safety analyses (JSAs) and/or pre-job briefings (PJB).

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 Clinch River/Melton Hill Reservoir, Worthington Branch, and Bull Run Creek (Attachment A; Figure 1) were selected to evaluate whether ash processing at the Plant has had, or is having, any adverse effects on water quality.

Fifteen surface stream sample locations are planned. Nine sampling locations are proposed in the Clinch River/Melton Hill Reservoir to evaluate water quality upstream of the CCR Units, adjacent to the CCR Units, and downstream of the CCR Units. Four sampling locations are proposed in Bull Run Creek to evaluate water quality upstream of the CCR units, adjacent to the CCR Units, and at the confluence of the Clinch River. Two sampling locations are proposed in Worthington Branch. Samples will be analyzed for total and dissolved CCR Parameters and selected cations to calculate Total Hardness. The Surface Stream SAP for Phase 1 is written such that sediment and surface stream sampling would be conducted during the same sampling event. Sampling methodology and laboratory-specific information is covered in more detail in the Quality Assurance Project Plan (QAPP).

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 impacts. 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-CR01	Clinch River Upstream of BRF (Background - coincides with fish tissue sampling)
STR-CR02	Clinch River Upstream of BRF (Background)
STR-CR03	Clinch River Upstream of BRF (Background)
STR-CR04	Clinch River adjacent to The Formal Disposal Area and Chemical Pond
STR-CR05	Clinch River adjacent to CCR Unit Area and Seep 1 (2010)
STR-CR06	Clinch River adjacent to Gypsum Disposal Area and Seep 3 (2010)
STR-CR07	Clinch River downstream of Seep 1 and Seep 3 (2010)
STR-CR08	Clinch River Downstream of BRF
STR-CR09	Clinch River Downstream of BRF (coincides with fish tissue sampling)
STR-BRC01	Bull Run Creek Upstream - Background
STR-BRC02	Bull Run Creek Upstream - Background
STR-BRC03	Bull Run Creek, upstream of Seep 6 (2010)
STR-BRC04	Bull Run Creek adjacent to Fly Ash Pond and Seep 4 (2010)
STR-WB01	Worthington Branch Upstream Sampling Location
STR-WB02	Worthington Branch Downstream Sampling Location
STR-OF001	Effluent at NPDES Permitted Outfall 001

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. BRF 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
STR-CR01	SED-CR01	MAC-CR01	NA	NA
STR-CR02	SED-CR02	MAC-CR02	CRU	CRU
STR-CR03	SED-CR03	MAC-CR03	NA	NA
STR-CR04	SED-CR04	MAC-CR04	CRA	CRA
STR-CR05	SED-CR05	MAC-CR05		
STR-CR06	SED-CR06	MAC-CR06		
STR-CR07	SED-CR07	MAC-CR07		
STR-CR08	SED-CR08	NA	NA	NA
STR-CR09	NA	NA	CRD	CRD
STR-BRC01	SED-BRC01	MAC-BRC01	NA	NA
STR-BRC02	SED-BRC02	MAC-BRC02	NA	NA
STR-BRC03	SED-BRC03	MAC-BRC03	BRCA	BRCA
STR-BRC04	SED-BRC04	MAC-BRC04		
STR-WB01	SED-WB01	MAC-WB01	NA	NA
STR-WB02	SED-WB02	MAC-WB02	NA	NA

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 and Standard Operating Procedures (SOPs), QAPP, SAPs, and HASP.
- Complete required health and safety paperwork and field readiness checklist 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 seasonal mean 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 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*
- ENV-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 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 (°C)
- Dissolved Oxygen (milligrams per Liter; mg/L)
- Specific Conductivity (microSiemens per centimeter; µS/cm)
- 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 team members 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

Project-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 QC 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 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 will be measured as described above 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. 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 Clinch River at the nearest United States Geological Survey (USGS) gage. 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. Furthermore, samples are to be collected upstream and away from the boat and motor, where applicable.

- 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 benthic 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 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:

  Clinch River/ Melton Hill Reservoir – 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 midway between bottom of thermocline and streambed, mid-epilimnion midway between top of 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.

Bull Run & Worthington Branch – Due to the intermittent conditions and relatively low flow volumes in Worthington Branch, mid-depth samples will be collected from the thalweg at each transect. Bull Run will be sampled consistently with other perennial surface streams onsite.

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 to confirm that the samples remain at less than 6 degrees Celsius (°C) 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 form 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, the original copy will be placed in cooler 1 of X with copies (marked as such) placed in the additional coolers.

Two signed/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. 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 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 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. 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 surface water sampling. 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 at the same time as benthic sampling 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 unless stream sampling is separated from benthic sampling.

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.

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. "Field Measurement Using a Multi-Parameter Sonde." Technical Instruction ENV-TI-05.80.46, Revision 0000. March 31.

ATTACHMENT A
FIGURE

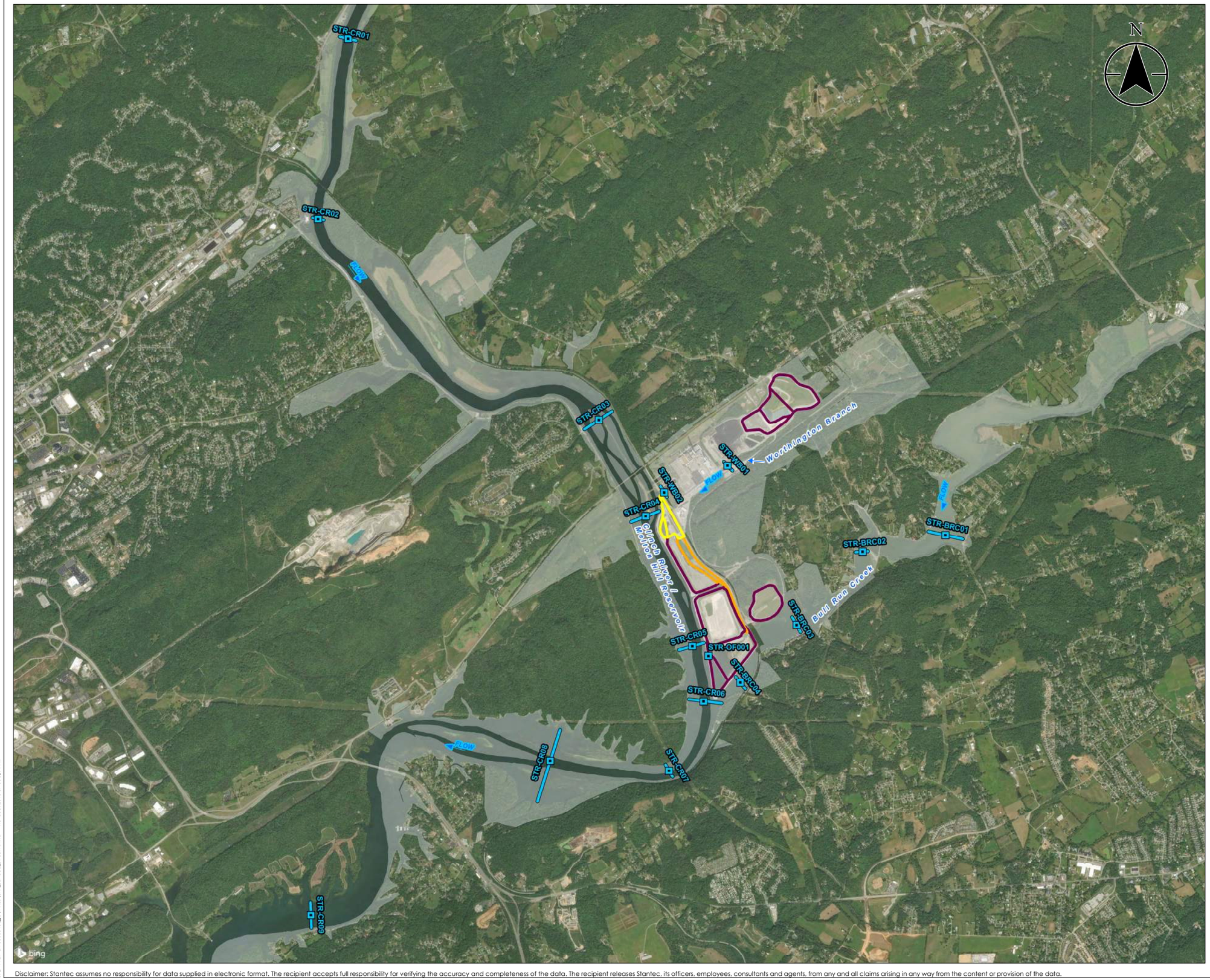

Figure No.
1

Title
Surface Stream Sampling

Client/Project
Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2018-07-06
Technical Review by TG on 2018-07-06

0 1,600 3,200 4,800 6,400 Feet
1:19,200 (At original document size of 22x34)

Legend

- Surface Stream Sample Location
- Hydrolab Transect
- TVA Property Boundary
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery
3. If Hydrolab results indicate lateral water quality variations along a transect, samples will be collected at up to four additional locations along the transect.

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.

I:\TVA-EIP\175566346\gis\mxds\BRF_Surface_Stream.mxd Revised: 2018-07-06 By: trink

ATTACHMENT B
FIELD ATTACHMENT 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
Bull Run Fossil Plant

Revision 4

TDEC Commissioner's Order:
Environmental Investigation Plan
Bull Run Fossil Plant
Clinton, Tennessee

Stantec

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

December 17, 2018

REVISION LOG

Revision	Description	Date
1	Addresses June 22, 2017 TDEC Review Comments and Issued for TDEC Review	October 27, 2017
2	Addresses January 29, 2018 TDEC Review Comments and Issued for TDEC Review	March 30, 2018
3	Addresses May 22, 2018 TDEC Review Comments and Issued for TDEC Review	July 13, 2018
4	Addresses Applicable Programmatic Revisions and Issued for TDEC Approval	December 17, 2018

FISH TISSUE
SAMPLING AND ANALYSIS PLAN
BULL RUN FOSSIL PLANT

TITLE AND REVIEW PAGE

Title of Plan: Fish Tissue
Sampling and Analysis Plan
Bull Run Fossil Plant
Tennessee Valley Authority
Clinton, Tennessee

Prepared By: Stantec Consulting Services Inc.

Prepared For: Tennessee Valley Authority

Effective Date: December 17, 2018 Revision 4

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.

Mark G. Hunt — 12/13/18
TVA Investigation Project Manager — Date

Tyler Baker — 12/14/18
TVA Investigation Field Lead — Date

George Keil — 12/18/18
Health, Safety, and Environmental (HSE) Manager — Date

[signature] — 12/6/2018
Investigation Project Manager — Date

Rock J. Vitale — Digitally signed by Rock J. Vitale DN: cn=Rock J. Vitale, o, ou, email=rvitale@envsld.com, c=US Date: 2018.12.11 13:01:06 -05'00'
QA Oversight Manager — Date

Tod Noltemeyer — Digitally signed by Tod Noltemeyer
Laboratory Project Manager — Date

Charles L. Head
TDEC Senior Advisor — Date

Robert Wilkinson
TDEC CCR Technical Manager — Date

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ATTACHMENT B **FIELD EQUIPMENT LIST**

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 Bull Run Fossil Plant (BRF) on July 13-14, 2016, at which time TVA briefed TDEC on its Coal Combustion Residuals (CCR) management plans at BRF and discussed the documentation that TVA submitted to TDEC in advance of the Investigation Conference.

On September 13, 2016, TDEC issued 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 January 9, 2017, TVA submitted BRF 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 BRF have higher concentrations of CCR-related constituents than fish from reference locations not adjacent to or downstream from the BRF 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, to confirm 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

Four reaches have been selected for the collection of fish and associated fish tissue as shown in Figure 1 (Attachment A) and Table 1. These four reaches are strategically located based on access, current hydrogeologic knowledge, and the greatest expectation of successfully capturing target fish species. Three of the reaches are located in the Clinch River and one is located in Bull Run Creek. The sampling reach CRA in the Clinch River is located adjacent to the west of the BRF Chemical Pond, Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C at river mile 46.1 and extends approximately two miles to river mile 48.1. Sample reach BRCA, in Bull Run Creek, is located adjacent to and upstream of the Railroad Loop Dispersal Area. The sample reach is approximately one mile in length. The downstream most sample reach in the Clinch River, CRD, extends from river mile 43.1 for approximately one mile to river mile 44.1 and is located approximately 2 miles downstream from BRF and the CRA sampling reach. The upstream sample reach, CRU, starts at river mile 50.3 and extends for approximately one mile to river mile 51.3. This sample reach is located approximately 2 miles upstream from the BRF facility and the CRA sampling reach; it will act as a reference site. The sampling reach locations may be modified based on conditions in the field at the time of the sampling activities. Table 1 lists each of the 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 BRF, Clinton, Tennessee.

Sampling Reach Name	Drainage	Approximate River/Creek Mile	Latitude	Longitude
CRD	Clinch River	43.1 – 44.1	35.994444	-84.187778
			35.984166	-84.194166
CRA	Clinch River	46.1 – 48.1	36.018888	-84.164444
			35.996666	-84.156111
CRU	Clinch River	50.3 – 51.3	36.045833	-84.200556
			36.033611	-84.191667
BRCA	Bull Run Creek	0 – 1.0	36.006189	-84.141313
			35.996944	-84.154444

Table 2. Corresponding Sample Locations at BRF, Clinton, Tennessee

Surface Stream Sample Location	Corresponding Sediment Sample Location	Corresponding Benthic Sampling Location	Corresponding Mayfly Sampling Location	Corresponding Fish Tissue Sampling Location
STR-CR01	SED-CR01	MAC-CR01	NA	NA
STR-CR02	SED-CR02	MAC-CR02	CRU	CRU
STR-CR03	SED-CR03	MAC-CR03	NA	NA
STR-CR04	SED-CR04	MAC-CR04	CRA	CRA
STR-CR05	SED-CR05	MAC-CR05		
STR-CR06	SED-CR06	MAC-CR06		
STR-CR07	SED-CR07	MAC-CR07		
STR-CR08	SED-CR08	NA	NA	NA
STR-CR09	NA	NA	CRD	CRD
STR-BRC01	SED-BRC01	MAC-BRC01	NA	NA
STR-BRC02	SED-BRC02	MAC-BRC02	NA	NA
STR-BRC03	SED-BRC03	MAC-BRC03	BRCA	BRCA
STR-BRC04	SED-BRC04	MAC-BRC04		
STR-WB01	SED-WB01	MAC-WB01	NA	NA
STR-WB02	SED-WB02	MAC-WB02	NA	NA

NA = Not applicable

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 and Standard Operating Procedures (SOPs), QAPP, SAPs, and HASP.
- Complete required health and safety paperwork and field readiness checklist 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 (no more than one week apart), 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 2 through 4 below. Table 5 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[1]

TDEC Appendix 1 Constituents
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 s 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 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 through 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.

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ATTACHMENT A
FIGURE

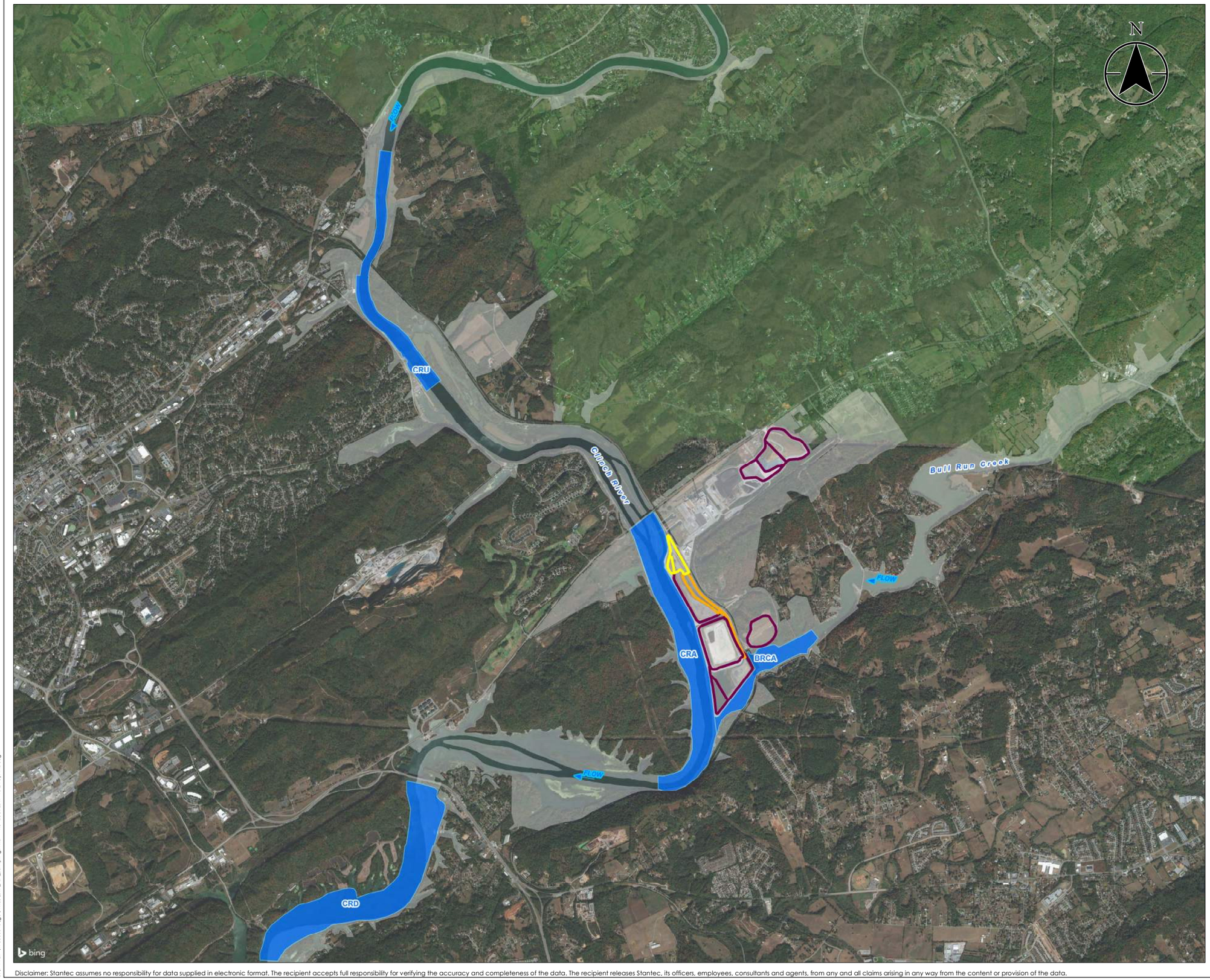

Figure No.
1

Title

Fish Sampling

Client/Project

Tennessee Valley Authority
Bull Run Fossil Plant

Project Location
Clinton, Tennessee

175566346
Prepared by TKR on 2017-10-24
Technical Review by TG on 2017-10-24

0 1,800 3,600 5,400 7,200 Feet

1:21,600 (At original document size of 22x34)

Legend

- Fish Sample Location
- TVA Property Boundary
- CCR Unit Area (Approximate)
- Former Disposal Area (Approximate)
- Sluice Channel (Approximate)

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Imagery Provided by Bing Imagery

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.

J:\TVA-EIP\175566346\gis\mxds\BRF_Fish_Sampling.mxd Revised: 2017-10-24 By: mbough

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
PUBLIC COMMENTS

Table 1
TVA Bull Run EIP Rev 4
Summary of Public Comments & TVA Responses
17-Dec-18

Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (December 17, 2018)
1	General	All	NA	NA	NA	TVA expended significant effort to inform the public of their plans. However, one public meeting is insufficient to collect a representative sample of public opinions. Please provide additional opportunity for public meetings before the November 2nd comment due date.	11/2/2018	Jan Berry	These comments are noted. As part of the TDEC Order process, TVA is in compliance with the procedures as they were outlined in the Order. There will be other opportunities for public comment as part of the Order.
2	General	All	NA	NA	NA	A literature search* indicates that "residues and waste produced by the combustion of the coal contain naturally occurring radionuclides such as 238U, 226Ra, 210Pb, 232Th and 40K." Other sources indicate that the 238U content in fly ash is so high that some countries considered reclaiming uranium from fly ash. However, sampling of the chemical composition of the Bull Run coal ash will not identify radionuclides other than Ra. From Table 4, Surface Stream Sampling and Analysis Plan Bull Run Fossil Plant (pg. 14) lists the constituents that are to be analyzed. Justify why TDEC and TVA do not plan to sample Bull Run CCR for 238U, 210Pb, 232Th or 40K. If justification cannot be made based on analytical data of the coal used for combustion over the time period of the collection of the CRR, add analysis for 238U, 210Pb, 232Th, 40K and other radionuclides that are in coal to the EIP. *Ref: https://www.ncbi.nlm.nih.gov/pubmed/28965987	11/2/2018	Jan Berry	The analyte list for these environmental investigations is based on the lists EPA published as Appendices III and IV to the CCR Rule, plus any additional analytes required by TDEC or that TVA believes would be useful in helping interpret results. EPA's lists are based on a comprehensive review that occurred over about a multi-year period and involved opportunities for public comment. On the basis of their review and responses to public comments, the only radionuclides EPA included in those lists were radium-226 and radium-228.
3	3.4.4	TDEC Bottom Ash/Gypsum Ponds Information Request No. 4	27	1	All	Sample data from existing monitoring wells were not made available to the public. These existing data help characterize the current extent of contamination and would highlight the importance of a comprehensive EIP. Make existing sample data from existing monitoring wells available to the public.	11/2/2018	Jan Berry	Existing data from State and CCR Rule groundwater monitoring is available on public websites. Open records requests can be submitted to TDEC to provide the information. Existing validated sampling data will be included in the final EAR.
4	General	All – Surface Stream SAP and Background Soil SAP	NA	NA	NA	Mercury is indicated as a sampling constituent in river sediment and was stated to already exist in sediment. However, the source of this mercury is not clear according to the TVA representative at the public information meeting. Rather he stated that "upstream industrial sources of mercury" caused the current contamination. It is important to understand the baseline contaminants in order to determine the efficacy of the EIP and subsequent remediation actions. Coal is known to contain mercury (see Table 4 as referenced above) and could be the source of sediment contamination either from previous CRR or BRF emissions. Modeling of previous, present and future contaminate spread is necessary. The EIP focuses on analysis of future contaminant spread only. Add modeling of previous contaminates (i.e., mercury) air and water dispersion from the Bull Run plant air emissions and from CRR water intrusion to the EIP.	11/2/2018	Jan Berry	Air dispersion is not part of the scope of the EI. The EIP sediment sampling program has been designed to obtain quantitative data on metals concentrations in sediment along and upgradient of the Site in accordance with TDEC requirements. The need for additional sediment study shall be determined upon the evaluation of initial analytical results obtained as part of the Environmental Investigation.
5	General	All	NA	NA	NA	The presentation implied that dry fly ash can be safely stored on site with little engineered systems needed (e.g., liner with leachate collection, cap). Please provide definitions of terms such as dry fly ash, wet fly ash, and other terms that are not commonly understood AND briefly describe plans for dry coal ash storage.	11/2/2018	Jan Berry	TVA's recently completed and proposed activities regarding dry storage of CCR are available in other publicly accessible documents. Refer to the environmental stewardship section of TVA's website for additional information. Links: https://www.tva.com/Environment/Environmental-Stewardship/TDEC-Order https://www.tva.com/Newsroom/How-TVA-Is-Storing-Its-Ash
6	General	All	NA	NA	NA	If the TVA analysis of generation assets determines that Bull Run Coal-Fired Power Plant should be shut down, please consider installing a utility scale solar power system. Consider re-training the coal plant workers to work in the solar power system.	11/2/2018	Jan Berry	These comments are noted. This is not applicable to the EIP and will be provided to the appropriate parties within TVA.
7	General	All	NA	NA	NA	NEED TO REMAKE MISSION OS SERVICE., we were denied a wheelchair size small dock on our land ///next door has a dock but dogs keep any one off their dock even kids to fish their dock was a tva relative with a permit for them, we had 10 min time with tva empl mtg with less kindness and more captain of ships property attitude. which 10000 acres are now in the command of tva we lived at home 39 yrs., walking to lake, but now have wheelchair can not go to lake edge. have to haaaaave sale move to oak ridge for wc dock use., after 38yrs of love at our lakeside & tva will have our v,v,vumc church in middle of the ash pile ., how did God help tva., we still pray for our healing heart when we move to town&.we will miss our church.,we went to 38 yrs sandy stratton sad to move sad at tva our ages 80 tva rolled on seniors again.	11/2/2018	Sandy Stratton	These comments are noted. This is not applicable to the EIP and will be provided to the appropriate parties within TVA.
8	General	Groundwater SAP Surface Stream SAP	NA	NA	NA	Excerpt from letter from Doug Colclasure dated November 1, 2018 As it is, Bull Run has many at risk water issues such as contact water, surface water and ground water that if combined with coal residuals with the high hazardous materials concentrations, pose a considerable risk to the overall fresh water supply and environment. Consider ground water tables and hydrostatic pressures resulting from the 50-70 inch average annual rainfall totals and the ever increasing frequency and intensity of extreme rainfall events from a warming climate, and the long term stability of onsite ash burial may not be achievable.	11/1/2018	Doug Colclasure	The EI will provide information about the volume and location of CCR in relation to saturated conditions. In addition, evaluating the effect of CCR materials on groundwater quality is part of the EI. The need to conduct corrective actions to remediate groundwater will be based on the results of the EI and included in the corrective action risk assessment (CARA) plan. Investigative studies are currently planned for any potable private water supply wells within the boundary, surface streams adjacent to the site, and any active seeps identified.

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TVA Bull Run EIP Rev 4
Summary of Public Comments & TVA Responses
17-Dec-18

Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (December 17, 2018)
9	General	All	NA	NA	NA	Excerpt from letter from Doug Colclasure dated November 1, 2018 At a minimum please consider a evaluation of a western/arid location for the ash by performing a limited scope test of transporting and burying all the ash generated at Bull Run for a six-month period. Even if Bull Run is eventually shut down as a coal fired generating facility a western disposal solution could be continued to incrementally over time, remove and clear all the legacy ash/residuals from the site.	11/1/2018	Doug Colclasure	These comments are noted. This is outside of the scope of the TDEC Order and not applicable to the EIP.
10	General	All	NA	NA	NA	Excerpt from letter (Comment 1) from William Kegley dated November 1, 2018 Page 3 of the EIP states that "after 60 Days of completion of EIP activities TVA will submit the EAR". What will designate the completion of activities? Completion of field work or completion of analytical analysis and interpretation? The completion of EIP activities should be defined.	11/1/2018	William Kegley	This timing is defined within the TDEC Order. The EI is considered complete upon the receipt of final lab data, data validation, interpretation and reporting. Upon confirmation by TDEC, TVA will provide the EAR within the timing defined by the Order.
11	1.4.1	Site History	3	11	All	Excerpt from letter (Comment 2) from William Kegley dated November 1, 2018 Section 1.4.1 Site History. Please describe in more detail the manner of CCR management during the early operation of BRF from 1967 – 1980 as it pertains to CCR particulates released through the smoke stack. This activity should be described as it is exceedingly relevant to the integrity of the background study because all nearby upgradient surface soil will be contaminated with CCR from this fallout. Also it is conceivable that the CCR was deposited in enough quantity that the upgradient groundwater could also be impacted from leaching of the fall out to groundwater.	11/1/2018	William Kegley	(spell out) PLM testing is being conducted on the surficial samples to confirm the presence/absence of CCR at the background soil locations. If CCR is observed at any background locations, alternative locations will be identified for determination of background concentrations.
12	4.1.1	A.1 TDEC Site Information request No.1 / Background Soil SAP	39/App P	All	All	Excerpt from letter (Comment 2) from William Kegley dated November 1, 2018 The EIP references a procedure using polarizing microscopy (R.J. Lee SOP OPT23.02) to visually estimate the amount of CCR in the surface soil (0 to 6 inch below ground surface interval) but gives no details on the procedure in the EIP (aside from table E-2 in the QAPP). Because surface soil background data may be used to determine future actions, it is important to have a full understanding of the potential for compromised background samples due to CCR. TVA needs to present the full polarizing microscopy procedure in the EIP and present studies or reference peer reviewed publicly available studies where this procedure has been successfully used to estimate CCR in soil. The description of this procedure needs to include localities where it has been successfully used in the past and under what conditions errors have been found to occur either by collection methods, sample preparation, analysis, and/or under various soil types. Background has a strong potential to become a point of contention among stakeholders. Providing a higher level of detail concerning how background will be determined in the EIP will help alieve the possible future contention.	11/1/2018	William Kegley	R.J. Lee SOP OPT.023, Determination of Coal Combustion Products in Bulk Samples by Polarized Light Microscopy, is a proprietary method developed by the R.J. Lee Group for the determination of Percent Ash. This procedure allows for identification and quantitation of coal combustion products including fly ash, bottom ash, coal slag, and coal. The Percent Ash procedure is performed by credentialed analysts trained in mineralogy and optical microscopy techniques. The procedure involves comparison of sample slides to standard reference slides containing known amounts of fly ash. Quality control analyses include daily alignment checks and blank readings; inter-analyst replicate measurements; intra-analyst replicate measurements; reference slide measurements; and refractive index oil calibration. R.J. Lee analysts participate in initial and ongoing proficiency testing and external round robin programs. The PLM procedure is an industry standard methodology for determining percent ash and has been used by several utility companies across multiple regulatory jurisdictions. This procedure has been used for a number of projects, most notably by TVA for the Kingston Recovery Project. Successful implementation of this methodology at the Kingston site and other similar coal ash spill sites is documented in many publicly available studies and reports.
13	3.1.1	TDEC General Information Request No. 1	10	1	All	Excerpt from letter (Comment 3) from William Kegley dated November 1, 2018 How will TVA estimate the impact of CCR on the groundwater background samples given the potential compromise by CCR particulate fallout as described in the comment (2) above?	11/1/2018	William Kegley	The groundwater monitoring program is designed to monitor groundwater quality downgradient of CCR units as compared to groundwater that has not passed beneath the units to identify potential contributions from the CCR units. As part of the assessment, the results of background soil sampling and observations regarding soil types made during installation of background monitoring wells will be used to evaluate the suitability of each proposed background monitoring well location. One of the goals of the evaluation will be to identify the presence and/or absence of CCR material.
14	3.1.1	TDEC General Information Request No. 1	10	1	All	Excerpt from letter (Comment 4) from William Kegley dated November 1, 2018 It is not clear in the EIP how TVA intends to demonstrate the nature and extent of groundwater contamination without considering groundwater flow under dry season and wet season influences. How will TVA determine the impact of the seasonal variation on contaminant concentration and migration in the subsurface?	11/1/2018	William Kegley	Groundwater samples will be collected bi-monthly for a year which will provide data regarding seasonal variability of groundwater quality.
15	3.2.1	TDEC Dry Ash Stack Information Request No. 1	27	All	All	Excerpt from letter (Comment 5) from William Kegley dated November 1, 2018 Carbonate dissolution is known to provide a pathway for rapid Groundwater flow through the subsurface system especially in the shallow subsurface just below DPT refusal. The location of these carbonate units that are prone to dissolution are important in understanding the flow of contaminates produced by the leachate leaking from the CCR dry storage landfills. How will TVA determine the detailed lithology of the Chickamauga group beneath the BRF EIP study area so that these carbonate units can be defined and evaluated for transport of CCR contaminated groundwater?	11/1/2018	William Kegley	TVA plans to use existing data as well as ongoing and planned studies to investigate potential fractures and other geological structures in the Chickamauga Group below the Bull Run Fossil Plant site. These investigations include evaluation of fracturing and/or faulting and the effect they have on groundwater quality and flow direction. Additional groundwater monitoring wells will be installed in the bedrock to supplement the existing monitoring well network for the BRF Study Area to further characterize the hydrogeology and evaluate groundwater quality.

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16	4.1.1	A.1 TDEC Site Information request No.1	39	All	All	Excerpt from letter (Comment 6) from William Kegley dated November 1, 2018 Based upon a review of the surface soil background locations presented in the EIP. Sample locations BRF-BG-07, BRF-BG-06 and BRF-BG-05 have a strong potential to be influenced from contamination from non CCR related activities. These locations are down slope from and near proximity to Edgemoor road and results will be influenced by pollution associated with traffic use that is unrelated to TVA activities. In addition, these locations appear to be in areas that have been affected by past BRF construction activity and may not represent naturally occurring surface soil. Background location BRF-BG-05 also may be located near or in an area where "beneficial use of CCR" has been applied. These sample locations should not be used in the calculation of background constituents in surface soil based on these reasons.	11/1/2018	William Kegley	The purpose of the background locations is to determine soil concentrations of naturally occurring, in-situ, native soils in the vicinity of the TVA BRF Plant upgradient from the CCR. Determination of the Influence by and evaluation of constituents from non-CCR related activities is outside of the scope of the EI and TVA's responsibilities under the TDEC Order. The presence of CCR will be noted during logging of soil lithologies in the borings at the upgradient, background locations. If CCR is noted, these locations will be adjusted as necessary to meet the objectives of the EI. Data collected from CCR-impacted locations will not be considered in background set. In locations where the background soils investigation has already occurred, TVA has added alternate locations to replace any borings where CCR materials have been observed.
17	4.1.1	A.1 TDEC Site Information request No.1	39	All	All	Excerpt from letter (Comment 7) from William Kegley dated November 1, 2018 Background soil locations BRF-BG-16, BRF-BG-13, and BRF-BG-18 appear to be located along the rail road loop where interference from coal and other contaminants associated with rail road activity are present. TVA should take care to ensure that these background samples are collected far enough away from the railroad to ensure the samples are not contaminated by non CCR activities.	11/1/2018	William Kegley	The purpose of the background locations is to determine soil concentrations of naturally occurring, in-situ, native soils in the vicinity of the TVA BRF Plant upgradient from the CCR. Determination of the Influence by and evaluation of constituents from non-CCR related activities is outside of the scope of the EI and TVA's responsibilities under the TDEC Order. The presence of CCR will be noted during logging of soil lithologies in the borings at the upgradient, background locations. If CCR is noted, these locations will be adjusted as necessary to meet the objectives of the EI. Data collected from CCR-impacted locations will not be considered in background set. In locations where the background soils investigation has already occurred, TVA has added alternate locations to replace any borings where CCR materials have been observed.
18	11	General	All	NA	NA	Excerpt from letter (Comment 8) from William Kegley dated November 1, 2018 TVA should carefully review the BRF construction records to determine if a grouting program was conducted at BRF before vertical construction activities of the original steam plant in the 1960's. If a grouting program was conducted please review the location of the grouting boreholes and grout injection logs do determine how much grout was injected in each particular hole. Especially note if the injected grout "daylighted" in other boreholes or surface drainage areas when grouting was taking place. This information will demonstrate the likely location of preferential GW flowpaths for contaminants in the area beneath and downstrike from the CCR Dry Storage landfills. If no grouting program occurred, please definitively state so in the BRF EIP.	11/1/2018	William Kegley	As part of the Investigation, TVA will review historical documents (such as record drawings and geotechnical reports) to summarize the design and materials used to construct the CCR units at BRF. If documentation is found that indicates significant grouting occurred at the adjacent powerhouse, it will be considered in the evaluation of groundwater flow. TVA will also prepare a hydrogeological characterization report of the geology and hydrogeology of the site. The report will provide an understanding of the groundwater flow system at BRF. These results will be delivered as part of the EAR.
19	3.1.2	TDEC General Information Request No. 2	13	1	All	Excerpt from letter (Comment 9) from William Kegley dated November 1, 2018 The Location of the Copper Creek thrust fault on the south east end of BRF as it crosses the Clinch River (as depicted on the numerous maps included in the EIP) fails to follow the "rule of the Vs" for a plane that dips greater than the topographic gradient. Based upon the straight line orientation of the Copper Creek Thrust Fault trace as it intersects the inferred strike slip fault (as shown on the maps) it is implied that the fault plane is vertical in orientation. Because of the groundwater flow implications associated with the Copper Creek Thrust Fault in the vicinity of the CCR contaminants along the Clinch River, the fault's location must be known with reasonable accuracy. It is insufficient to only reference the Clinton 7.5 minute geologic quadrangle map for the scale of this study. It is highly probable that this fault represents the boundary between two hydrogeologic flow regimes (1 flow within the Chickamauga group and 2 flow within the Rome/Conasauga units). Not to mention that the fault plane itself where it occurs in the near subsurface beneath the CCR units located along the Clinch River may be an area of preferential contaminated groundwater flow due to the increased fracturing near the fault. a) How will TVA determine the location of this fault as it crosses beneath the CCR storage units located beside the Clinch River? b) How will TVA determine if this fault serves as a preferential flow path for contaminated groundwater? c) If TVA believes the Copper Creek Fault plane is vertical as depicted in the various maps shown in the EIP, then it is recommended they include their rationale for such in the EIP.	11/1/2018	William Kegley	TVA plans to use existing data as well as ongoing and planned studies to investigate potential fractures and other geological structures below the Bull Run Fossil Plant site. These investigations include evaluation of fracturing, faulting and the effect they have on groundwater quality and flow direction. The EIP includes plans to use geophysical investigation techniques to locate faults. Additional groundwater monitoring wells will be installed in the bedrock to supplement the existing monitoring well network for the BRF Study Area to further characterize the hydrogeology and evaluate groundwater quality. Groundwater modeling will also be used to determine hydrogeologic boundaries within the groundwater flow system. The results of these data evaluations will be provided in the EAR.
20	3.1.1	TDEC General Information Request No. 1	10	1	All	Excerpt from letter (Comment 10) from William Kegley dated November 1, 2018 The EIP references the Kellberg 1959 and 1962 studies associated with the early siting and preconstruction activities of BRF but the location of the boreholes and geologic logs were not presented in the EIP. Because the elevation of top of rock and location of fractures have an impact on the flow of contaminated groundwater, it is recommended that the location of the boreholes and the geologic logs with elevation data from these studies be included as an appendix to the EIP.	11/1/2018	William Kegley	TVA plans on using the data included in the Kellberg 1959 and 1963 studies as part of the hydrogeological investigation portion of the Environmental Investigation of the Bull Run Fossil Plant. Review of historical data will be performed in accordance with the EIP and the results will be included in the EAR. When the final EAR is complete, supporting information will be made available to the public.

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21	General	All	NA	NA	NA	Excerpt from letter (Comment 11) from William Kegley dated November 1, 2018 TVA needs to include a discussion of the risk(s) to human health from exposure to CCR. The EIP fails to discuss under what scenarios current and future workers and citizens living near BRF could be exposed to CCR and CCR derived contamination. The reviewer could only find the word "risk assessment" 3 times in the entire 1000+ pages of the EIP and nowhere was there any explanation of how the risk assessment will be conducted in the EAR. a) If a determination of risk to human health from exposure to CCR contamination is not an objective of this study than the EIP should clearly state such. b) If a human health risk assessment is an objective of the this EIP than a conceptual model outlining possible exposure scenarios to current and future workers and citizens should be included with detail how the human health risk assessment will be conducted.	11/1/2018	William Kegley	Potential risks to human health and ecological receptors will be addressed in the Corrective Action Risk Assessment (CARA) Plan per the requirements of the TDEC Order, which includes a public comment process. The risk assessment will be consistent with TDEC and USEPA guidance and methodology. Information collected during implementation of the EIP for Bull Run will be evaluated in the risk assessment.
22	4.5.2	TDEC Surface Water Impacts Request No. 2	70	1	All	Excerpt from letter (Comment 12) from William Kegley dated November 1, 2018 The reviewer could not locate the specified time of year when the benthic sediment and mayfly sampling will occur. Are results from this sampling seasonally influenced? TVA should specify the time of year the biological sampling will be conducted.	11/1/2018	William Kegley	Footnote below Table 9 in Section 7.0 of the Benthic SAP indicates mayfly nymph anticipated sampling will be conducted 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.
23	General	All	NA	NA	NA	This plan does not address the problem of fly ash damaging the paint on peoples vehicles east of the Bull Run stacks. I'm aware of the scrubbers but they have little effect resolving this problem. INM@090º from stacks.	11/1/2018	James Moore	As part of the TDEC Order process, TVA will be conducting an EI as outlined in the EIP and assessing potential risks that may result from the management and disposal of CCR at the Bull Run Fossil Plant. The results of the EI will be summarized in the EAR. These comments do not provide specific suggestions pertaining to the technical approach of the current version of the EIP, which sets forth technical investigations necessary to properly evaluate CCR impacts to human health and the environment.
24	General	All	NA	NA	NA	The best way to handle coal ash going forward is to stop producing it. Let's continue TVA's policy of stable, low cost energy by moving to solar and wind. As with hydro, the fuel waste is always zero. The grid can remain stable and reliable using smart grid and additional battery storage, which includes EV battery storage.	11/1/2018	Mark Bishop	As part of the TDEC Order process, TVA will be conducting an EI as outlined in the EIP and assessing potential risks that may result from the management and disposal of CCR at the Bull Run Fossil Plant. The results of the EI will be summarized in the EAR. These comments do not provide specific suggestions pertaining to the technical approach of the current version of the EIP, which sets forth technical investigations necessary to properly evaluate CCR impacts to human health and the environment.
25	General	All	NA	NA	NA	Excerpt from letter from Southern Environmental Law Center dated November 1,2018: 1. Key Issues of Concern Our overarching concern is that the EIP is designed to determine whether coal ash contamination is occurring at the Bull Run Fossil Plant, rather than determining the nature and extent of the contamination that we already know is occurring at the site. Here are examples of conditions already established at Bull Run Fossil Plant: • Coal ash impoundments along the Clinch River and Bull Run Creek were built over original stream channels. • Coal ash is submerged in groundwater at the coal ash disposal sites along the Clinch River and Bull Run Creek, including the Gypsum Disposal Area, Bottom Ash Disposal Area, Main Ash Pond and Stilling Pond. • Groundwater is contaminated under the Dry Fly Ash Stack, Gypsum Disposal Area, and Main Ash Pond. • Coal ash is also saturated and leaking into groundwater at the Dry Fly Ash Stack. Despite these known conditions, the EIP does not focus on aggressively investigating the conditions within footprint of the ash impoundments and tracking potential pathways into the surrounding surface waters and groundwater. TVA should already be identifying and monitoring areas likely to be preferential pathways for contamination, such as original stream channels and bedding planes. Nor does the EIP focus on determining the extent of coal ash contamination of soils, despite the fact that soils are likely to be a continuing source of contamination unless and until TVA cleans up its coal ash pollution. Similarly, TVA should be doing extensive surveys along the shoreline of its Bull Run facilities, rather than using transects that run perpendicular to the shoreline.	11/1/2018	SELC	Historic surface water features, as indicated in the EIP, will be summarized in the EAR following the evaluation of the data. Surface water will be investigated as part of the EI and the results will be summarized in the EAR. The EI will provide information about the volume and location of CCR in relation to saturated conditions. In addition, evaluating the effect of CCR materials on groundwater quality is part of the EI. The need to conduct corrective actions to remediate groundwater will be based on the results of the EI and included in the corrective action risk assessment (CARA) plan.

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17-Dec-18

Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (December 17, 2018)
26	General	All	NA	NA	NA	Excerpt from letter from Southern Environmental Law Center dated November 1,2018: 2. Timeline The Commissioner signed the Order on August 7, 2015. By the time TVA and TDEC respond to comments and finalize the EIP, it will have taken more than three years to delineate the scope and terms of the environmental investigation at Bull Fossil Plant. The timeline proposed by TVA and TDEC includes an additional two years until TDEC approves any Environmental Assessment Report prepared by TVA, and even longer before TDEC requires TVA to actually implement a corrective action plan at the site. In other words, it will have taken at least five years since the issuance of the Order to even begin a discussion about appropriate corrective action to address pollution we already know has occurred and is occurring at the site. We appreciate TDEC's diligence and thoroughness in working with TVA to develop the EIP. However, the record shows that TVA has repeatedly submitted manifestly inadequate EIP drafts, despite the relatively clear mandate of the Order to comprehensively investigate and address coal ash contamination at the Bull Run Fossil Plant. The record of TDEC's comments and TVA's successive draft EIP revisions speaks for itself. TDEC should not countenance continued foot-dragging by TVA, at either the Bull Run Fossil Plant or the other six sites covered by the Order, including Cumberland Fossil Plant, Allen Fossil Plant, Kingston Fossil Plant, Johnsonville Fossil Plant, John Sevier Fossil Plant, and Watts Bar. The citizens of Tennessee have waited nearly a decade since the catastrophic Kingston coal ash for TVA to fulfill its promise to clean up its coal ash and protect our clean water. Another decade of waiting is unacceptable.	11/1/2018	SELC	The development of the EIP for the Bull Run Fossil Plant began immediately following the issuance of the TDEC Order. TDEC provided TVA with a list of general questions to be addressed. An Investigative Conference for the Bull Run Fossil Plant site was held to present TVA's initial responses to TDEC's list of questions. Following the Investigative Conference, TDEC issued an additional list of plant-specific requests. As TVA and TDEC have diligently worked together, the scope of the investigation has developed and evolved through three iterations of the EIP to ensure the plan represents a sound technical approach to understanding the conditions at the Bull Run Fossil Plant and to take into account public comments. Developing a comprehensive and sound technical plan for the environmental investigation will provide information through the TDEC Order process that adequately informs decisions about how to manage coal ash at the plant sites and to identify any corrective actions that need to occur. The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.
27	General	All	NA	NA	NA	Excerpt from letter from Southern Environmental Law Center dated November 1,2018: 3. Lack of Analysis of Existing Information As discussed in the attached comments of Global Environmental, LLC, TVA already has significant existing data in its possession regarding issues such as hydrogeology, groundwater contamination, and other subjects it is required to study under the Order. The EIP simply identifies and lists existing data sources and states that TVA plans to analyze this existing data over the next year. It should not have taken TVA three years to simply identify existing sources of information. Instead, TVA should have analyzed and discussed what it already knows based on existing data and identified discrete areas for additional investigation. TVA's apparent refusal to date to analyze data already in its possession has resulted in unnecessary delay and will continue to do so with respect to the EIP for the Bull Run site. In this EIP and EIPs for the other six sites, TDEC should require TVA to analyze and synthesize data it already possesses in the EIP itself, rather than deferring such analysis until later in the process. To the extent that TDEC is concerned about the quality of TVA's existing data, TDEC can identify such concerns as a basis for requiring further investigation. This process should happen at the outset of the EIP, not after the EIP has already been adopted and is being implemented by TVA.	11/1/2018	SELC	TVA is following the process established in the TDEC Order. After reviewing existing information and data, TVA and TDEC have identified additional investigations needed to understand the conditions and impacts at each site, and the EIP establishes the plan for these investigations. New and existing data will be subject to additional quality review processes documented in the Quality Assessment Project Plan to confirm the validity of the data. As required by the TDEC Order, TVA will evaluate and provide an analysis of both new and existing, validated data in the Environmental Assessment Report (EAR). The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.
28	General	All	NA	NA	NA	Excerpt from letter from Southern Environmental Law Center dated November 1,2018: 4. Artificial Segregation of Data and Information Obtained in Other Regulatory Processes One of the stated purposes of the Order is to ensure that TVA implements the federal Coal Ash Rule in a manner that ensures coordination and compliance with Tennessee laws governing the management and disposal of coal ash, including the Tennessee Solid Waste Disposal Act, and Tennessee Water Quality Control Act. But the EIP makes little to no effort to analyze and synthesize data and analysis TVA is required to produce under the federal Coal Ash Rule. In some cases, TVA has already produced relevant analyses under the federal Rule. For example, TVA is required to produce a history of construction of the ash impoundments at Bull Run, and this history will be available on its public website. The Order includes provisions for TVA to notify TDEC when TVA posts Coal Ash Rule information pursuant to the Rule. Why isn't this information being incorporated into the EIP? Again, if TDEC has concerns about the quality of TVA's Coal Ash Rule data and its adequacy to comply with TVA's obligations under state law, those concerns should be explicitly identified in the EIP and dealt with through additional investigation. The potentially relevant data sets and analysis from TVA's implementation of the Coal Ash Rule should not simply be ignored or segregated as irrelevant to the project of evaluating the scope of the impacts of TVA's coal ash management practices. The EIP also does not explain how data and corrective action processes required by TVA's assessment monitoring under the Tennessee Solid Waste Disposal Act will interact with the EIP and corrective action requirements in the Order. Nor does the EIP explain how information TVA discloses and analyzes under NEPA will be considered or integrated into these requirements.	11/1/2018	SELC	TVA is following the process established in the TDEC Order. Data collected for and during other regulatory programs, such as for purposes of the Federal CCR Rule, will be subject to additional quality review processes documented in the Quality Assessment Project Plan and will be evaluated along with data generated by the EI under the TDEC Order. TVA will provide an analysis of both new and existing, validated data in the EAR as required by the TDEC Order. The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.

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29	General	All	NA	NA	NA	Excerpt from letter from Southern Environmental Law Center dated November 1,2018: 5. Lack of Transparency and Accessibility of Information A stated purpose of the Order is to develop a transparent process for investigating and remediating coal ash contamination at the seven sites that are subject to the Order. But most of the correspondence, data, and other information that has been or will be generated is not easily available to the general public. Both TVA and TDEC have well-established websites for hosting large amounts of information. TVA has a CCR Rule compliance website. TDEC Division of Solid Waste has a data viewer. Either of these platforms could be used to post correspondence and comments exchanged between these two public entities regarding implementation of the Order, as well as data that is generated as part of the investigation. Such a publicly-accessible site could also host important technical documents that serve as protocols for TVA's implementation of the Order. This is important because, in response to an open records request, we recently learned that not even TDEC appears to have all of the relevant protocols TVA will employ in its investigation. The EIP also states that TVA will submit periodic EIP progress reports. These reports are described as providing updates on timelines and milestones. To keep the public and TDEC adequately informed of current environmental conditions at the site, the reports should include interim analytical results and data. We note, for example, that TVA withheld from TDEC and the public for several months disclosure of arsenic contamination at 300 times the groundwater protection standard at the Allen Fossil Plant, even though the contamination put the City of Memphis's drinking water source at risk. We strongly suggest that TDEC prevent this type of behavior from recurring by requiring greater transparency in the EIP process.	11/1/2018	SELC	Both TDEC and TVA have shared pertinent information as the development of the EIP has progressed. This has included sharing formal communications between TDEC and TVA via each organization's website as well as through Southern Environmental Law Center's standing request to TDEC under the Tennessee Open Records Act. The final draft EIP and its appendices, including the Sampling and Analysis Plans, have been provided by TDEC to the Southern Environmental Law Center and other interested parties in advance and also have been posted to TVA's website for public access. Pursuant to the TDEC Order, there will be additional opportunities for public input and participation, including a public comment period for the Corrective Action/Risk Assessment (CARA) Plan. The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.
30	General	All	NA	NA	NA	Excerpt from Mark A. Quarles, Preliminary comments (Comment 1) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. The Commissioner's Order ("Order," dated August 6, 2015) requires TVA to perform a "Site-Wide CCR Investigation Assessment, and Remediation" of the Bull Run Plant site. Any such investigation performed by TVA through its Environmental Investigation Plan ("EIP") process that omits any legacy or current disposal areas will no doubt be an incomplete assessment and remediation. "Site-wide" should include any current or former CCR disposal area that has the potential to contaminate soil, sediment, groundwater, and/or surface water.	11/1/2018	SELC	The current TVA EIP document as approved by TDEC is to assess site-wide CCR disposal at the Bull Run Fossil Plant.
31	General	All	NA	NA	NA	Excerpt from Mark A. Quarles, Preliminary comments (Comment 2) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA identified only these current or former disposal areas as being subject to the requirements of the Order and as being the "Study Area" in EIP: 1.) Dry Fly Ash Stack, 2.) Bottom Ash Disposal Area, 3.) Gypsum Disposal area 2A, 4.) Main Ash Pond, 5.) Fly Ash Stilling Pond 2C, and 6.) Railroad Loop Disposal Area. TVA therefore omitted three legacy and / or current disposal areas: 1.) Former Disposal Area, 2.) Sluice Channel, and 3.) Chemical Pond. Those three areas have the same potential as other disposal areas on-site to contaminate soil, groundwater, sediment, and surface water.	11/1/2018	SELC	The areas mentioned are all within the footprint of the current TVA EIP document as approved by TDEC and will be investigated as such.
32	General	All	NA	NA	NA	Excerpt from Mark A. Quarles, Preliminary comments (Comment 3) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. Groundwater monitoring performed by TVA shows that groundwater is contaminated with coal ash pollutants in and under many of the coal ash disposal areas at Bull Run.	11/1/2018	SELC	TVA is currently participating in assessment monitoring under the State solid waste program and is conducting detection monitoring under the CCR Rule. The EIP will include additional monitoring of groundwater downgradient of CCR units that are not covered by either of the above programs. The EIP includes site-wide geological and hydrogeological investigations as well as groundwater modeling that will be used to more fully characterize subsurface conditions affecting groundwater flow and transport. TVA will follow the requirements of the State solid waste program, CCR Rule and TDEC Order to assess and implement corrective measures, if required.
33	General	All	NA	NA	NA	Excerpt from Mark A. Quarles, Preliminary comments (Comment 4) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. For example, groundwater monitoring at the Dry Fly Ash Stack in 2008 (15 years after closure was complete in Phase 1) as an example, demonstrated contamination. Substantial contamination was present in downgradient Wells G, F45, and J, respectively – as evidenced by sulfate (210; 910; and 310 ppm), total dissolved solids (560; 1,700; and 750 ppm), and boron (1.3; 4.2; and 1 ppm) concentrations. See TVA 2008 at Appendix C. Wells G and F45 are downgradient of Phase 1, and Well J is located downgradient of Phase 2. Arsenic is another constituent of concern at this area. See TVA 2015 at 7.	11/1/2018	SELC	TVA is currently participating in assessment monitoring under the State solid waste program and is conducting detection monitoring under the CCR Rule. The EIP will include additional monitoring of groundwater downgradient of CCR units that are not covered by either of the above programs. The EIP includes site-wide geological and hydrogeological investigations as well as groundwater modeling that will be used to more fully characterize subsurface conditions affecting groundwater flow and transport. TVA will follow the requirements of the State solid waste program, CCR Rule and TDEC Order to assess and implement corrective measures, if required.
34	General	All	NA	NA	NA	Excerpt from Mark A. Quarles, Preliminary comments (Comment 5) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. More recent TVA groundwater sampling at the Dry Ash Stack in August 2014 demonstrates that contamination worsened since 2008 - as evidenced by even higher concentrations in Wells 45R and J respectively for sulfate (2,100 and 397 ppm), total dissolved solids (3,340 and 883 ppm), and boron (20.1 and 1.63 ppm). See TVA 2014(2) at Appendix C. Comparatively, the concentrations in the upgradient well (Well I) for that sampling event were much lower: sulfate, 4.22 ppm; total dissolved solids, 322 ppm; and boron, <0.05 ppm.	11/1/2018	SELC	TVA is currently participating in assessment monitoring under the State solid waste program and is conducting detection monitoring under the CCR Rule. The EIP will include additional monitoring of groundwater downgradient of CCR units that are not covered by either of the above programs. The EIP includes site-wide geological and hydrogeological investigations as well as groundwater modeling that will be used to more fully characterize subsurface conditions affecting groundwater flow and transport. TVA will follow the requirements of the State solid waste program, CCR Rule and TDEC Order to assess and implement corrective measures, if required.

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35	General	All	NA	NA	NA	Excerpt from Mark A. Quarles, Preliminary comments (Comment 6) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. Similarly, a review of the TVA groundwater monitoring data collectively from 2008 to 2016 demonstrates that groundwater quality at both the Dry Fly Ash Stack and the Gypsum Disposal Area – disposal areas with CCRs that are submerged in groundwater - has also worsened. In fact, the concentrations have gotten much worse. Groundwater monitoring by TVA for classic CCR indicator constituents (e.g. sulfate and boron) are graphed below. Note the increasing concentration trends in the tables below with the highest concentrations reported most recently. See EIP 2017 at 9 and 14.	11/1/2018	SELC	TVA is currently participating in assessment monitoring under the State solid waste program and is conducting detection monitoring under the CCR Rule. The EIP will include additional monitoring of groundwater downgradient of CCR units that are not covered by either of the above programs. The EIP includes site-wide geological and hydrogeological investigations as well as groundwater modeling that will be used to more fully characterize subsurface conditions affecting groundwater flow and transport. TVA will follow the requirements of the State solid waste program, CCR Rule and TDEC Order to assess and implement corrective measures, if required.
36	General	All	NA	NA	NA	Excerpt from Mark A. Quarles, Preliminary comments (Comment 7) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA has also admitted that groundwater in and under the Main Ash Pond is contaminated with arsenic. See TVA 2016 at 19-20 and TVA 2016(2) at 109.	11/1/2018	SELC	TVA is currently participating in assessment monitoring under the State solid waste program and is conducting detection monitoring under the CCR Rule. The EIP will include additional monitoring of groundwater downgradient of CCR units that are not covered by either of the above programs. The EIP includes site-wide geological and hydrogeological investigations as well as groundwater modeling that will be used to more fully characterize subsurface conditions affecting groundwater flow and transport. TVA will follow the requirements of the State solid waste program, CCR Rule and TDEC Order to assess and implement corrective measures, if required.
37	Appendix O	Material Quantity SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 8) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA has known since at least 1982 that ash is submerged in groundwater in surface impoundments at Bull Run – concluding that "water-table elevations are within ash ponds 1 and 2." See TVA 1982 at 19. TVA's contention that it does not already know if the CCRs are submerged and saturated is simply not based upon its own existing science and reports, as is discussed in the following paragraphs of this report. Yet according to the EIP, TVA does not plan to disclose this fact to TDEC until it submits the Environmental Assessment Report (EAR) in September 2020. See EIP Rev. 3 at Appendix A.	11/1/2018	SELC	TVA is following the process established in the TDEC Order. After reviewing existing information and data, TVA and TDEC have identified additional investigations needed to understand the conditions and impacts at each site, and the EIP establishes the plan for these investigations. New and existing data will be subject to additional quality review processes documented in the Quality Assessment Project Plan to confirm the validity of the data. As required by the TDEC Order, TVA will evaluate and provide an analysis of both new and existing, validated data in the Environmental Assessment Report (EAR). The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts. The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.
38	Appendix O	Material Quantity SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 9) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. The Clinch River adjacent to the Bull Run Plant was impounded to form Melton Hill Lake. Construction of the dam began in 1960 and was completed in 1963. The surface water elevation of the Clinch River at the Bull Run Plant was raised 27 feet from 768 to 795 feet above mean sea level (MSL) when the river was fully impounded. See TVA 2016(2) at 9. As such, the localized groundwater would have also risen at least 27 feet once the Lake level increased and after TVA began sluicing wastes into the surface impoundments. That groundwater rise perpetually submerges CCRs in groundwater at the surface impoundments along the Clinch River.	11/1/2018	SELC	TVA is following the process established in the TDEC Order. After reviewing existing information and data, TVA and TDEC have identified additional investigations needed to understand the conditions and impacts at each site, and the EIP establishes the plan for these investigations. New and existing data will be subject to additional quality review processes documented in the Quality Assessment Project Plan to confirm the validity of the data. As required by the TDEC Order, TVA will evaluate and provide an analysis of both new and existing, validated data in the Environmental Assessment Report (EAR). The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts. The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.
39	Appendix O	Material Quantity SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 10) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA built the surface impoundments over surface streams. See TVA 2016(2) at 13	11/1/2018	SELC	Historical stream channels will be taken into account when developing three-dimensional models per the Material Quantity SAP. These models will be developed to depict subsurface conditions from ground surface to bedrock. The models will be developed using data from the proposed exploratory borings, piezometers, and wells, as well as other relevant data collected during the Investigation. The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.
40	Appendix O	Material Quantity SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 11) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. Figures that TVA submitted to TDEC in the Investigation Conference slideshow in July 2016 also confirm that CCRs are submerged in groundwater because TVA sluiced the wastes at elevations that were below the normal pool elevation of the Clinch River, as illustrated in the TVA-provided figures below (see TVA 2016(2) at 76, 78, 80, and 81)	11/1/2018	SELC	TVA is following the process established in the TDEC Order. After reviewing existing information and data, TVA and TDEC have identified additional investigations needed to understand the conditions and impacts at each site, and the EIP establishes the plan for these investigations. New and existing data will be subject to additional quality review processes documented in the Quality Assessment Project Plan to confirm the validity of the data. As required by the TDEC Order, TVA will evaluate and provide an analysis of both new and existing, validated data in the Environmental Assessment Report (EAR). The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts. The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.

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41	Appendix O	Material Quantity SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 12) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. My review of the data discussed below confirms the same saturated, submerged conditions. The original ground surface beneath the disposal areas along the Clinch River indicates that the lowest ground elevations are much lower than what TVA reported in the EIP. According to pre-construction topographic maps developed by TVA, the original ground surface generally ranged from approximately 770 to 780 feet above MSL - not including the deeper stream channel depths of Worthington Branch and Bull Run Creek. See EIP Rev.3 at Exhibits 9 and 19. The 770-foot elevation is 18 feet lower than the lowest elevation (788 feet MSL) discussed in the EIP. See EIP Rev. 3 at 24. Those deeper sections of those former stream channels should be a required investigative focus area of the EIP.	11/1/2018	SELC	The commenter's reference to an elevation of 788 feet is found in one of the original EIP information requests as written by TDEC. Historical stream channels will be taken into account when developing three-dimensional models per the Material Quantity SAP. These models will be developed to depict subsurface conditions from ground surface to bedrock. The models will be developed using data from the proposed exploratory borings, piezometers, and wells, as well as other relevant data collected during the Investigation. The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.
42	Appendix O	Material Quantity SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 13) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. My comparison of the original 770 to 780-foot surface impoundment ground elevations to recent groundwater elevations reported by TVA and the normal pool elevation of the Clinch River (795 ft. MSL) demonstrate that ash is submerged in groundwater. Note that the 795-foot groundwater elevation of the uppermost aquifer illustrated below nearest the Clinch River corresponds to the normal pool elevation of the Clinch River (as should be expected for the uppermost, water table aquifer) and that groundwater elevations are up to 801 feet MSL. See TVA 2014 at Figure 2 below. As such, sluiced CCRs in some areas are now at least 25 feet below the current river normal pool elevation.	11/1/2018	SELC	TVA is following the process established in the TDEC Order. After reviewing existing information and data, TVA and TDEC have identified additional investigations needed to understand the conditions and impacts at each site, and the EIP establishes the plan for these investigations. New and existing data will be subject to additional quality review processes documented in the Quality Assessment Project Plan to confirm the validity of the data. As required by the TDEC Order, TVA will evaluate and provide an analysis of both new and existing, validated data in the Environmental Assessment Report (EAR). The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts. The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.
43	Appendix N and O	CCR Material Characteristics and Material Quantity SAP's	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 14) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA designed the SAPs in the EIP to evaluate the "potential" for pore water and groundwater to be connected. As a result, TVA is spending time and money to complete a lengthy EIP process to determine what it already knows – that wastes are submerged, pore water is connected to groundwater, and contaminated groundwater is flowing through the wastes and into receiving streams.	11/1/2018	SELC	TVA is compelled by the TDEC Order and TDEC's information requests to develop the EIP and investigate pore water, the degree of interconnection between pore water and groundwater, groundwater quality, and the interconnection between groundwater and surface water bodies. The results of the investigation are required by TDEC to be reported in the EAR. Data collected during the EI are necessary in order to define and design the best approaches for corrective action. The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.
44	Appendix N and O	CCR Material Characteristics and Material Quantity SAP's	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 15) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. Saturated wastes in the surface impoundments leach contaminants into the groundwater that flows into 1.) The unnamed tributary that flows between the Bottom Ash Pond and the Gypsum / Fly Ash Area, 2.) The Clinch River, and 3.) Bull Run Creek.	11/1/2018	SELC	TVA is compelled by the TDEC Order and TDEC's information requests to develop the EIP and investigate pore water, the degree of interconnection between pore water and groundwater, groundwater quality, and the interconnection between groundwater and surface water bodies. The results of the investigation are required by TDEC to be reported in the EAR. Data collected during the EI are necessary in order to define and design the best approaches for corrective action. The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.
45	Appendix O	Material Quantity SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 16) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. Wastes are also submerged at the Dry Fly Ash Stack even though the waste was disposed as "dry" waste and wastes were never sluiced, as illustrated below with the triangular water symbols and red ovals. Phase 1 of that disposal area was constructed – according to the diagrams below – without a liner, over a thin layer of soil, without a geologic buffer, and without a leachate collection system, as also illustrated in the diagrams below (see TVA 2016(2) at 62 and EIP Rev. 3 at Exhibit 12:	11/1/2018	SELC	The cross section drawings cited by the commenter are from analyses for now outdated geometry of a designed expansion of the Dry Fly Ash Stack (CEC 2011). Revised drawings and analyses were later prepared as part of the TDEC permitting process (CEC 2012). Only Cross Section C-C' intersects Phase 1 of the stack. The phreatic surface in the Phase 1 fill was based on 2011 piezometer readings and the phreatic surface in the proposed expansion fill was assumed. Updated stack geometry, updated piezometer data, and historical boring data will be taken into account when developing three-dimensional models per the Material Quantity SAP. These models will be developed to depict subsurface conditions from ground surface to bedrock. The models will be developed using data from the proposed exploratory borings, piezometers, and wells, as well as other relevant data collected during the Investigation.
46	Appendix O	Material Quantity SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 17) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA is required to determine how much CCR is saturated in each disposal area. TVA stated that it will determine the volume CCRs both above and below both "groundwater" and / or "piezometric water" levels. See EIP Rev. 3 at 46. TVA did not however, describe how it intends to differentiate those two different types of water that are present in each disposal area. TDEC should require TVA to explain how it intends to make such differential claims. For closure purposes, however, it does not matter what TVA calls the water in which the CCRs are submerged. Any CCRs that are saturated after closure – regardless of what name is used – will continue to leach constituents through the unlined bottoms of disposal units and into groundwater.	11/1/2018	SELC	As part of the EI, TVA will install temporary wells within the CCR units to measure the phreatic water level, which is the boundary between saturated and unsaturated CCR. In addition, TVA will measure groundwater levels around the CCR units by recording water levels in existing and proposed monitoring wells. Results will be provided in the EAR.

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47	Appendix N	CCR Material Characteristics SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 18) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA stated in the EIP that it intends to comply with the requirement to determine CCR leachability by collecting "real time" pore water. See EIP Rev. 3 at 41. For that leachability determination to be meaningful, TVA needs to collect widespread samples of pore water at different horizontal locations and at different depths. TVA has used the surface impoundments to dispose of a combination of different types of CCRs. As such, one can expect multiple layers that vary vertically and horizontally. Differing groundwater quality is expected from those layers based upon the age of the CCRs, the types of CCRs; the source coals used at the time; the types of air pollution control equipment in use at that time; the amount of pyrite and other impurities in the mixed wastes; and the depths of the CCRs, as examples. Any TVA leachability or "real time" study that does not collect such widespread and vertically precise information would therefore inadequately characterize the disposal areas in order to determine leachability.	11/1/2018	SELC	TVA is following the process established in the TDEC Order. After reviewing existing information and data, TVA and TDEC have identified additional investigations needed to understand the conditions and impacts at each site, and the EIP establishes the plan for these investigations. New and existing data will be subject to additional quality review processes documented in the Quality Assessment Project Plan to confirm the validity of the data. As required by the TDEC Order, TVA will evaluate and provide an analysis of both new and existing, validated data in the Environmental Assessment Report (EAR). The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts. The comments do not provide specific suggestions to improve the current version of the EIP, which sets forth technical investigations necessary to properly evaluate coal ash impacts.
48	Appendix F, M & P	Hydrogeological, Exploratory Drilling and Background Soil SAP's	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 19) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA is required to "provide an analysis of the extent of soil, surface water, and groundwater contamination by CCR at the site" according to the Commissioner's Order (August 6, 2015). Instead, TVA has written SAPs that are designed to determine the "potential" level of contamination rather than focusing on defining the "extent." The "extent" of contamination of each of those mediums must include a delineation of both the vertical and horizontal extent of contamination. TVA cannot determine, for example, the extent of soil contamination beneath the disposal areas unless a thorough investigation is performed within the footprint of each disposal area. Likewise, TVA cannot determine all pollutant migration pathways necessary to demonstrate maximum horizontal and vertical groundwater flow rates, as other examples, without delineating those conditions beneath and adjacent to the disposal areas.	11/1/2018	SELC	The groundwater, benthic, seep, and surface stream SAPs are designed to identify areas of contamination through sampling and quantitative analysis. When a sample exhibits a constituent concentration above the applicable standard for the given media at a particular location, the need to extend the investigation for that media will be decided by TVA/TDEC. TVA has developed a phased approach to characterize the CCR and the inorganic constituents associated with CCR. This approach is an iterative in nature and is a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results with TDEC to identify any data gaps. If any data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC.
49	Appendix F, M	Hydrogeological, Exploratory Drilling SAP's	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 20) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA wrote the hydrogeological and exploratory drilling SAPs to determine the "potential" for contaminants to migrate from disposal areas and flow into receiving streams. Groundwater data collected by TVA for at least the last decade clearly demonstrates that this fact is already occurring. Instead of TVA focusing on determining the "potential" for contaminant migration, TVA should instead have created SAPs that located high-potential pollutant migration areas (e.g. former stream beds; bedrock fractures and bedding planes; shallow bedrock and thin soil layers; and sandy or gravelly alluvial soils), characterize the bottoms of disposal areas, and sample environmentally sensitive areas (e.g. streams on and adjacent to TVA property). TVA stated that it is still trying to determine the "potential" for these already-known facts: a) Groundwater flows along preferential pathways in the bedrock through solution-enlarged b) bedding planes and joints. c) Groundwater flow results in seeps aboveground and through dikes along surface d) waters. e) Pore water within the wastes in all disposal areas is connected to groundwater. f) Groundwater has already been contaminated by disposal operations. g) Groundwater flows into receiving streams.	11/1/2018	SELC	A phased approach to hydrogeologic characterization is being performed. Hydrogeologic data obtained from prior investigations is used to make informed decisions as to whether further data collection is needed in order to understand groundwater flow and transport pathways. As part of the proposed EI investigation, eighteen new pilot holes will be advanced at targeted locations to proposed depths 60 feet below the top of the bedrock to identify transmissive zones. Geophysical logging will be completed at each pilot hole using acoustic televiewer, gamma, caliper, resistivity, and heat pulse flowmeter methods to vertically characterize groundwater flow pathways. In addition, a surface geophysical survey will be performed at Dry Ash Stack 2 to identify potential zones of preferential flow in bedrock for pilot boring placement. Monitoring wells installed as part of the EIP will be slug tested to obtain monitored zone hydraulic conductivities. Seep samples will be collected at discharge points into surface streams. A significant portion of the hydrogeological investigation scope was specifically developed to identify groundwater migration pathways both laterally and vertically in the CCR areas. The sediment and surface stream SAPs were designed to place transects in proximity to prior releases and seepage areas, on or adjacent to the plant. TVA has developed these approaches as part of a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results with TDEC to identify data gaps. If data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC.
50	Appendix F, M & P	Hydrogeological, Exploratory Drilling and Background Soil SAP's	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 21) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. The sampling plans proposed by TVA ignore the Sluice Channel and to a lesser extent, the Former Disposal Area. Both are likely historical and continued sources of soil and groundwater contamination.	11/1/2018	SELC	With respect to the Hydrogeological Investigation SAP, the EIP includes hydrogeological investigations around the Sluice Channel and Former Disposal Area. Existing monitoring wells 47S/48S will be paired with new bedrock monitoring wells screened (if groundwater is encountered) to monitor groundwater quality downgradient of the Sluice Channel. In the Former Disposal Area, a new bedrock well, designed to be screened in the uppermost bedrock zone that is found to yield groundwater, will be paired with existing shallow monitoring well BRF-112 to monitor groundwater quality downgradient of the Former Disposal Area. Each of these new proposed boring locations will be fully characterized via lithologic and geophysical logging, packer testing and slug testing. Groundwater samples will be collected from monitoring wells upgradient and downgradient of both features. TVA has developed this approach as part of a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results with TDEC to identify data gaps. If data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC.

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51	Appendix F	Hydrogeological SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 22) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA's planned approach in the EIP instead focuses its future investigation on perimeter areas around the disposal units – rather than focusing on the most important areas beneath the disposal areas and then laterally from those areas. Perimeter sampling locations proposed by TVA likely do not represent the maximum depths of waste that are submerged in groundwater; do not represent the higher permeability alluvial soils (e.g. sands and gravels) in the former stream channels; do not represent the "foundation soil" ("clay") claims already made by TVA in the EIP; do not represent higher groundwater hydraulic conductivity zones (vertical and horizontal); and do not represent preferential pathways for pollutant migration.	11/1/2018	SELC	The location for monitoring compliance with TDEC solid waste rules and the CCR Rule is the perimeter of each CCR unit. The EIP is consistent with this standard approach to compliance monitoring. TVA has developed these approaches as part of a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results with TDEC to identify data gaps. If data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC.
52	Appendix F	Hydrogeological SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 23) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA's plan to randomly locate deeper bedrock wells does not ensure that wells will be placed in the primary pollutant migration pathways according to TVA's own report. TVA has known since at least 1982 that the bedrock at the Plant site is highly fractured due to the bedrock type and the numerous faults in the area. According to that Study, "numerous filled and open cavities were encountered by foundation boreholes beneath the finished foundation grade. The openings range in size from 0.7 to 10.6 feet." Also, "groundwater is restricted to fractures, usually enlarged by solutional processes, in the bedrock. The solution cavities tend to enlarge laterally along bedding planes and elongate parallel to joints." (See TVA 1982 at 17 and 19). The bedrock beneath the Dry Ash Stack is the Chickamauga Limestone, and those bedrock layers dip to the southeast because of Copper Creek Thrust Fault (dark solid and dashed line below) to the southeast. A strike-slip fault (dark dashed line below along the Clinch River) exists beneath the surface impoundments (current and past) located in the floodplain of and parallel with the Clinch River. The bedrock types that exist beneath that area include shale, siltstone, and / or limestone of the Conasauga Group and the Rome Formation. See EIP Rev. 3 at Exhibit 16.	11/1/2018	SELC	TVA does not dispute the presence of secondary porosity features or their potential role as groundwater flow pathways at The Site. However, borings advanced into bedrock at different areas of the site to date shows that the nature and degree of fracturing/weathering/solution cavities is not consistent across the site. The purpose of the EIP bedrock pilot borings is not random; the pilot borings were positioned to further characterize these secondary porosity features and the groundwater quality present within them. The Hydrogeological Investigation SAP includes the use of surface and borehole geophysical techniques to evaluate areas/zones that may be serving as preferential flow paths to locate bedrock borings, including the use of surface geophysical methods to locate the reported fault along the Clinch River. TVA has developed these approaches as part of a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results with TDEC to identify data gaps. If data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC.
53	Appendix P	Background Soils SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 24) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. The Order requires that TVA determine the extent of soil contamination – yet the proposed investigation is virtually non-existent for soil sampling and analysis for CCR constituents. TVA instead only focuses its "soil" investigation on historically drilled geotechnical considerations (i.e. without CCR constituent analyses) to determine soil type, thickness, and strength and to define off-site concentrations of CCR constituents (see EIP Rev. 3 at Exhibit 14) – as opposed to defining the site-wide extent of soil contamination due to CCR chemical constituents. As a result, TVA's soil sampling SAP is non-responsive to the Order.	11/1/2018	SELC	The approach in characterizing the background soils was to identify locations where naturally occurring, in-situ, native soils are present, yet unaffected by CCR material. Soil samples are being analyzed for the CCR Parameters to determine the naturally occurring constituent levels. The surficial soil at each location was additionally analyzed for percent ash, to determine the presence or absence of windblown CCR. Proposed sampling locations were evaluated for known past placement of CCR material on those areas and areas known to contain beneficial use of CCR material were not selected. Areas known or expected to be in contact with CCR constituents during rain events, flood events, or currently being influenced by groundwater flow from BRF were additionally excluded. In the event that CCR material is discovered in the subsurface at a proposed location no soil samples will be collected for analysis and inclusion in the BGS study from these locations.
54	Appendix M and P	Exploratory Drilling and Background Soils SAP's	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 25) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. The background soil sampling program proposed by TVA (see EIP Rev. 3 at Exhibits 14 and 15) fails to collect samples from alluvial and floodplain soils that are adjacent to the Clinch River. These soil types exist beneath the Bottom Ash Pond and the Gypsum Pond. Such samples are required if TVA plans to compare samples collected near those disposal areas. Further, TVA's sampling program includes soil samples east of the Bottom Ash Pond and north of the Dry Ash Stack that might be contaminated due to potential mounded groundwater and associated radial groundwater flow in those directions.	11/1/2018	SELC	The approach in characterizing the background soils was to identify locations where naturally occurring, in-situ, native soils are present, yet unaffected by CCR material. Soil samples are being analyzed for the CCR Parameters to determine the naturally occurring constituent levels. The surficial soil at each location was additionally analyzed for percent ash, to determine the presence or absence of windblown CCR. Proposed sampling locations were evaluated for known past placement of CCR material on those areas and areas known to contain beneficial use of CCR material were not selected. Areas known or expected to be in contact with CCR constituents during rain events, flood events, or currently being influenced by groundwater flow from BRF were additionally excluded. In the event that CCR material is discovered in the subsurface at a proposed location no soil samples will be collected for analysis and inclusion in the BGS study from these locations.
55	Appendix M	Exploratory Drilling SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 26) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. The diagrams in Paragraph 16 for the Dry Ash Stack illustrate that no geologic buffer exists beneath Phase 1 of the Dry Ash Stack – as required by the TDEC Division of Solid Waste Management since the mid 1990s. The diagrams also illustrate that a maximum of only approximately 5 feet of soil exists between the bottom of the wastes and the bedrock. That thickness could in fact be in doubt where the former stream channel of Worthington Branch lies beneath the unlined, Phase 1 section of the Dry Ash Stack. The diagrams provided by TVA in the EIP suggest that bedrock might have been present at or very near the original ground surface in Phase 1. The approximate range of the shoreline of the now-buried unnamed tributary beneath Phase 1 ranged from approximately 820 to 826 feet MSL (see EIP Rev. 3 at Exhibit 20) and the elevation of the top of bedrock in the same area ranged from 816.6 to 830 feet MSL (see EIP Rev. 3 at Exhibit 24).	11/1/2018	SELC	As noted in Section 4.1 of the EIP, the footprint of the Dry Fly Ash Stack Phase 1 was originally developed in 1983. This pre-dates TDEC solid waste permitting requirements related to a geologic buffer. However, as shown on Exhibit 12 (Appendix C), the uppermost foundation soil is predominantly clay or clayey fill. Historical borings and historical stream channels will be taken into account when developing three-dimensional models per the Material Quantity SAP. These models will be developed to depict subsurface conditions from ground surface to bedrock. The models will be developed using data from the proposed exploratory borings, piezometers, and wells, as well as other relevant data collected during the Investigation. Results will be reported in the EAR and considered in the CARA Plan.

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56	Appendix F	Hydrogeological SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 27) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA specified in the EIP that the bedrock "in the vicinity of" the Dry Ash stack area is "heavily weathered" and is the "predominant pathway" for groundwater flow significant groundwater transport beneath the Dry Ash Stack flow and towards Worthington Branch. See EIP Rev. 3 at 10.	11/1/2018	SELC	As part of the EIP investigation, eighteen new pilot holes will be advanced at targeted locations to proposed depths 60 feet below the top of the bedrock to identify transmissive zones. Geophysical logging will be completed at each pilot hole using acoustic televiewer, gamma, caliper, resistivity, and heat pulse flowmeter methods to vertically characterize groundwater flow pathways. In addition, a surface geophysical survey will be performed at Dry Ash Stack 2 to identify potential zones of preferential flow in bedrock for pilot boring placement. Monitoring wells installed as part of the EIP will be slug tested to obtain monitored zone hydraulic conductivities.
57	Appendix F	Hydrogeological SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 28) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. Given the shallow, fractured bedrock flow beneath the Dry Ash Stack and the significant mounding of water within that disposal area, TVA should be required to initiate a comprehensive investigation of that area to determine the groundwater flow pathways beneath the Dry Ash Stack and its connectivity to Worthington Branch that runs adjacent to the disposal area.	11/1/2018	SELC	The location for monitoring compliance with TDEC solid waste rules and the CCR Rule is the perimeter of each CCR unit. The EIP is consistent with this standard approach to compliance monitoring. TVA has developed a phased approach to characterize the CCR. This approach is an iterative investigation and is a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results with TDEC to identify any data gaps. If any data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC. Additional groundwater monitoring wells will be installed in the bedrock to supplement the existing monitoring well network for the BRF Study Area to further characterize the hydrogeology. Groundwater modeling will also be used to evaluate the groundwater flow system and connectivity to surface water. The results of these data evaluations will be provided in the EAR.
58	Appendix M	Exploratory Drilling SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 29) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA's proposed "geotechnical" investigation includes sparsely located "temporary wells" (illustrated as "TW" sampling locations in orange below) in each disposal area. The locations of those wells at the Dry Ash Stack, the Bottom Ash Pond, and the Gypsum Pond seem to be arbitrary and avoid monitoring groundwater conditions that are representative of the lowest-lying original ground topography onto which wastes were placed (e.g. former stream channels or areas of shallow bedrock). See EIP Rev. 3 at Exhibit 4, 8, and 21. Further, the sparse locations will likely miss any groundwater quality variations that might exist due to decades of mixed wastes being present.	11/1/2018	SELC	The locations of the temporary well borings were selected to accomplish multiple objectives, including to facilitate pore water sampling and to 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. TVA has developed a phased approach to characterize the CCR. This approach is an iterative investigation and is a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results (presented in the EAR) with TDEC to identify any data gaps. If any data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC.
59	Appendix F, M & P	Hydrogeological, Exploratory Drilling and Background Soil SAP's	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 30) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA should have instead proposed surface geophysical methods site-wide to provide targeted locations where critical information should be collected with a targeted drilling program. TDEC should require TVA to first perform surface geophysical methods to: a) Determine subsurface characterizations beneath the CCR units themselves – not the perimeter locations where TVA has focused its additional investigations. b) Locate such subsurface features as former stream channels, shallow bedrock, fractured weathered bedrock, bedrock conduits, and thin soil layers. c) Locate vertical and horizontal occurrence of bedrock groundwater preferential pathways along solution-enlarged bedding planes and joints due to bedrock deformation due to faults. d) Pre-locate temporary and permanent wells laterally and vertically where they are most likely to intercept preferential groundwater flow pathways – particularly in fractured and weathered bedrock and sandy / gravelly soil zones. e) Pre-locate groundwater wells in the areas with the highest hydraulic conductivities in order to properly measure the maximum anticipated vertical and horizontal flow gradients and velocities into receiving surface waters. f) Pre-locate where CCRs are submerged in water the deepest (e.g. in former stream channels) so that groundwater wells and soil borings can be placed in these areas.	11/1/2018	SELC	The Hydrogeological Investigation SAP includes the use of surface geophysical techniques to investigate areas that may be serving as preferential flow paths to locate bedrock borings, as well as to locate subsurface features that can impact groundwater flow (e.g. the reported fault along the Clinch River). The location for monitoring compliance with TDEC solid waste rules and the CCR Rule is the perimeter of each CCR unit. The EIP is consistent with this standard approach to compliance monitoring. TVA has developed a phased approach to characterize the CCR. This approach is an iterative investigation and is a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results with TDEC to identify any data gaps. If any data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC.
60	Appendix U	Surface Stream SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 31) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA's proposed plan to sample surface water fails to include very important sections of two unnamed tributaries that existed where the Dry Ash Stack is located. TVA did not disclose these two streams in the EIP. Those streams were partially relocated around the southeast and western portions of the disposal area. Sampling of the upgradient and downgradient portions of those streams is very important given that the disposal area is unlined; water is mounded in the disposal unit; highly weathered bedrock is present at or very near the original ground surface; the bedrock is a significant groundwater flow pathway; and mounded groundwater possibly flows into both unnamed tributaries and eventually into Worthington Branch. The locations of those two streams (blue lines in and around the purple Dry Ash Stack layout) are as follows (see EIP Rev. 3 at Exhibit 17)	11/1/2018	SELC	TVA has developed a phased approach to characterize the CCR. This approach is an iterative investigation and is a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results (presented in the EAR) with TDEC to identify any data gaps. If any data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC. Sample locations have been proposed in Worthington Branch as part of the initial Phase of the EI. Results from these locations will be evaluated to determine if additional sample locations are necessary.

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61	Appendix U	Surface Stream SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 32) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. Likewise to the examples above for the Dry Ash Stack, another unnamed tributary flows between the Bottom Ash Pond and the Gypsum Disposal Area. TVA did not disclose this stream in the EIP. TVA relocated a portion of this stream to build the surface impoundments. Sampling of the upgradient and downgradient portions of this stream is very important given that neither disposal area is lined; groundwater is mounded in the disposal units; and mounded groundwater very likely flows into the unnamed tributary and eventually into the Clinch River. The location of this stream is as follows (see EIP Rev. 3 at Exhibit 17 and Exhibit 8)	11/1/2018	SELC	TVA has developed a phased approach to characterize the CCR. This approach is an iterative investigation and is a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results (presented in the EAR) with TDEC to identify any data gaps. If any data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC. Sample locations have been proposed in Worthington Branch as part of the initial Phase of the EI. Results from these locations will be evaluated to determine if additional sample locations are necessary.
62	Appendix U	Surface Stream SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 33) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. The stream that exists between the Bottom Ash Pond and the Gypsum Pond is a groundwater discharge point. The surface water elevation in the creek is likely the same as the Clinch River.	11/1/2018	SELC	TVA has developed a phased approach to characterize the CCR. This approach is an iterative investigation and is a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results (presented in the EAR) with TDEC to identify any data gaps. If any data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC.
63	Appendix U	Surface Stream SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 34) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. My analysis of the groundwater potentiometric surface diagram reported by TVA in 2014 (see TVA 2014 at Figure 2 below) for both the Bottom Ash Pond and the Gypsum Pond demonstrates that TVA very likely incorrectly reported groundwater flow directions in terms of risks to the stream. Groundwater elevations along that unnamed tributary would be expected to be near 795 feet MSL (i.e. the normal pool elevation of the river) – as is demonstrated by the other wells in the diagram below. A more likely drawn potentiometric surface diagram would demonstrate that groundwater would flow southward from the Bottom Ash Pond and northward from the Gypsum Pond and into the unnamed tributary.	11/1/2018	SELC	Updated groundwater contour maps and flow directions will be developed based on the information collected during the EI and verified historical data. The updated information will be provided in the EAR. TVA has developed these approaches as part of a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results with TDEC to identify data gaps. If data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC.
64	Appendix U	Surface Stream SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 35) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. The likelihood that the unnamed tributary is a groundwater discharge pathway for two disposal areas – in addition to the fact that the unnamed tributary is relatively small with a low flow – support the importance of comprehensively investigating the sediment and surface water flow in that tributary.	11/1/2018	SELC	TVA has developed a phased approach to characterize the CCR. This approach is an iterative investigation and is a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results (presented in the EAR) with TDEC to identify any data gaps. If any data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC. Sample locations have been proposed in Worthington Branch as part of the initial Phase if the EI. Results from these locations will be evaluated to determine if additional sample locations are necessary.
65	Appendix U	Surface Stream SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 36) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. Although TVA discussed its plan to sample surface waters, it did not state which human and ecological water quality standards that it plans to compare its results. TDEC should require that TVA specify what surface water quality standards it plans to use to evaluate the samples for both ecological and human uses.	11/1/2018	SELC	Surface Stream water quality will be compared to applicable standards and criteria that apply to their regulatory designations. Analytical results from locations adjacent to, and downstream of BRF will be compared to the background control/reference locations for BRF, State of Tennessee ambient water quality criteria, and USEPA ambient water quality criteria.
66	Appendix Q	Benthic SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 37) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA is required to determine "if CCR material has moved from the TVA site into surface water on the TVA site or adjacent to the TVA site" and to propose "how it will test sediment and CCR samples taken from riverbeds to determine if CCR constituents dissolve into surface water." See EIP Rev. 3 at 70. For TVA to comply with those requirements, TVA must sample rivers and streams immediately adjacent to the TVA site and to test those sediments for CCR constituents that enter the surface water. Perpetual groundwater discharges into surface waters carry dissolved-phase constituents into the surface water. Further, CCRs can enter surface waters by dike failures and slides.	11/1/2018	SELC	The proposed Phase 1 sampling locations include transects adjacent to current and former CCR units. Samples will be collected from the right descending bank, the center of the channel, and the left descending bank of each transect in accordance with industry standards. In addition, the Seep SAP includes sampling directly adjacent to the CCR units where seeps have been identified.
67	Appendix Q	Benthic SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 38) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. The immediately adjacent shorelines along the disposal areas - areas that TVA excluded - are most likely to contain CCR constituents in the sediment. Instead, TVA's sampling plan includes transects that cross the rivers and streams perpendicular to the shoreline (see purple transects below) where the surface stream flow is the deepest and where solid and dissolved-phase contaminants are less likely to exist, as illustrated below (purple transects).	11/1/2018	SELC	Sediment samples will be collected from the right descending bank, the channel center, and the left descending bank of each sampling transect that crosses the rivers and streams perpendicular to the shoreline, in accordance with industry standards. Right descending bank and left descending bank (i.e. the immediately adjacent shorelines) will be determined with a downstream facing orientation. In addition, the Seep SAP includes sampling directly adjacent to the CCR units where seeps have been identified.

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68	Appendix Q	Benthic SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 39) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. The dike system of the Bottom Ash Pond and the Gypsum Pond along Bull Run Creek and the Clinch River has historically been demonstrated to be unstable because TVA has placed riprap on top of the dike along the water's edge. TVA should be required to identify all areas of past slides and to assess the stream bottom for the presence of CCR constituents and solid CCRs (e.g. bottom ash, fly ash, pyrite, coal fines, etc.).	11/1/2018	SELC	The perimeter dike system along the Clinch River and Bull Run Creek for the Chemical Pond, Former Disposal Area, Bottom Ash Disposal Area, Gypsum Disposal Area 2A, Main Ash Pond, and Fly Ash Stilling Pond 2C is constructed of earthfill. The outslope of the starter dike (i.e., lower dike) includes a layer of riprap for erosion protection and to improve slope stability. The available historical documents do not indicate any perimeter slope failures that have resulted in a release of CCR to the river or creek. There is no evidence of any CCR releases due to slides, however transects for sediment, benthic and surface stream sampling are proposed at three locations at the Gypsum Disposal Area 2A, the Fly Ash Pond 2B, and the Fly Ash Stilling Pond 2C corresponding to seepage locations.
69	Appendix Q	Benthic SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 40) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. Other than two downstream transects in Worthington Branch, TVA's sediment sampling plan does not include any samples adjacent to the Dry Ash Stack nor any upstream reference / background samples as a comparison. TDEC should require a detailed investigation in these areas of Worthington Branch.	11/1/2018	SELC	TVA has developed a phased approach to characterize the CCR. This approach is an iterative investigation and is a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results (presented in the EAR) with TDEC to identify any data gaps. If any data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC. Sample locations already proposed in Worthington Branch cover locations upstream and downstream as part of the initial Phase of the EI. Results from these locations will be evaluated to determine if additional sample locations are necessary.
70	Appendix Q	Benthic SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 41) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. The sediment sampling plan also does not include any sediment samples from the unnamed tributary that bisects the Bottom Ash Pond and the Gypsum Pond. A detailed sampling plan should be required because of the stream's close proximity adjacent to these disposal areas and the fact that the stream is a groundwater discharge location.	11/1/2018	SELC	TVA has developed a phased approach to characterize the CCR. This approach is an iterative investigation and is a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results (presented in the EAR) with TDEC to identify any data gaps. If any data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC. Sample locations already proposed in Worthington Branch cover locations upstream and downstream as part of the initial Phase of the EI. Results from these locations will be evaluated to determine if additional sample locations are necessary.
71	Appendix Q	Benthic SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 42) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA uses a ">20% ash" threshold to which sediment samples deeper than 6 inches will be chemically tested for CCR constituents. First, TVA did not describe the scientific relevance of why only 6 inches of sediment should be only be tested in Phase 1. Secondly, TVA did not explain why it believes that 20% ash should be the threshold to determine what deeper samples are later tested in Phase 2 for chemical CCR constituents. Ash or CCRs of any type (i.e. fly ash, bottom ash, pyrite, coal fines, etc.) are not supposed to be in any surface water and allowed to accumulate on the bottom of surface waters. Further, TVA did not state what it means by "ash" (i.e. "fly ash," "bottom ash," or combined ash of all types).	11/1/2018	SELC	At the Gallatin Fossil Plant (GAF), the phased approach for sediment sampling was set to move beyond the first tier at 20% ash. This threshold was based on the Kingston Fossil Plant recovery work, in which a higher threshold level of approximately 40% was used that could lead to benthic impacts. The phased threshold was set at 20% ash for GAF to be more conservative in its investigative approach. This conservative approach was adopted for the EIP sediment investigations under the TDEC Order. Ash is understood to be CCR (coal combustion residuals), which is defined in the CCR Rule as fly ash, bottom ash, boiler slag, and flue gas desulfurization materials generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers.
72	Appendix Q	Benthic SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 43) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. Concurrent with TVA's proposed sediment sampling program, TVA stated that it plans to conduct benthic community composition and bioaccumulation testing "in surface streams on or adjacent to the site." See EIP Rev. 3 at 70. According to TVA's plan (see EIP Rev. 3 at Exhibit 27) and similar to its sediment sampling plan, its sampling plan does not collect benthic samples from the shoreline along the disposal areas.	11/1/2018	SELC	The benthic investigative studies are conducted along transects in surface streams adjacent to the site in accordance with industry standards. Benthic invertebrate samples will be collected from five locations along each proposed transect, which will include sampling near the shoreline. Samples will be collected from the right descending bank, the channel center, and the left descending bank of each sampling transect that crosses the rivers and streams perpendicular to the shoreline, in accordance with industry standards. Mayfly nymphs collected for tissue analysis will be collected from multiple random locations within the proposed areas, including areas near the shoreline.
73	Appendix Q	Benthic SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 44) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TDEC should require that TVA submit another proposed sampling plan that collects both sediment and benthic samples "bordering the site" where contamination is most likely to be found. Those areas include these at a minimum: a) The immediate shoreline of the Clinch River adjacent to the Former Disposal Area, the Chemical Pond, the Bottom Ash Pond, the Gypsum Pond, and the Fly Ash Stilling Pond. b) The immediate shoreline of Bull Run Creek adjacent to the Railroad Loop Disposal Area and the Main Ash Pond. c) The immediate shoreline of the unnamed tributary that flows between and adjacent to the Bottom Ash Pond and the Gypsum Pond. d) The immediate shoreline of Worthington Branch adjacent to the Dry Ash Stack.	11/1/2018	SELC	TVA has developed a phased approach to characterize the CCR. This approach is an iterative investigation and is a cooperative effort with TDEC. TVA will complete the initial phase of the investigation and jointly review the results (presented in the EAR) with TDEC to identify any data gaps. If any data gaps exist, TVA will fill those gaps with additional investigation in collaboration with TDEC.
74	Appendix Q	Benthic SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 45) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TDEC should require that TVA specify what sediment standards it plans to use to evaluate the samples for both ecological and human uses.	11/1/2018	SELC	Sediment data will be compared to applicable standards and criteria that apply to their regulatory designations. Analytical results for sediment samples collected adjacent to, and downstream of BRF will be compared to the background reference location for BRF, US EPA Region 4 Ecological Screening Values, and other published values if relevant.

Table 1
TVA Bull Run EIP Rev 4
Summary of Public Comments & TVA Responses
17-Dec-18

Comment Number	Section Number	Section Title	Page	Paragraph	Line	Comment	Date	Source	TVA Response (December 17, 2018)
75	Appendix T	Seep SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 46) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA is required to perform a stream assessment to locate and analyze seeps. TVA stated that it "will investigate mitigated and active seeps or areas historically noted as seeps that have occurred in the CCR unit dikes and berms" and more specifically to focus on "active seeps" with "flowing water." See EIP Rev. 3 at 73 and 74. Most notably, TVA does not plan to look for new, previously undiscovered seeps and only plans to focus on existing, active seeps that are flowing.	11/1/2018	SELC	The Seep Investigation Sampling and Analysis Plan includes identifying and sampling active seeps. This includes new, and previously undiscovered, active seepage areas.
76	Appendix T	Seep SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 47) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA's seep sampling plan is deficient because it fails to look for new seeps – especially those that might be at times above and below the normal pool elevation of surface waters. The Clinch River is dam controlled, which means that the river can be several feet lower when the river elevation is purposefully seasonally dropped. TDEC should require that TVA perform boat-based shoreline inspections of exposed banks during the low and normal flow times of the year.	11/1/2018	SELC	The Seep Investigation Sampling and Analysis Plan includes identifying and sampling active seeps. This includes new, and previously undiscovered, active seepage areas. We do not plan on conducting the seep investigation during or immediately after rain events, but did not specifically address seasonal concerns.
77	Appendix T	Seep SAP	All	All	All	Excerpt from Mark A. Quarles, Preliminary comments (Comment 48) dated July 13, 2018 for SELC. SELC letter dated November 1, 2018. TVA stated that inspections of previously mitigated area "may require the use of a boat" and that an inspection "will include examining the bank at the base of the riprap to determine if there are continuing water discharges at those locations" and that the stream channel and the surface water at the water's edge shall be field-tested for pH, temperature, dissolved oxygen, and conductivity. TVA stated that if field testing indicates a "significant difference between the stream channel samples and samples adjacent to the stream bank, further investigation will be required to determine if there is seepage flow that is not visible." This plan is deficient in several ways: a) TDEC should require that a boat-based inspection be performed in order to provide for an unobstructed shoreline and bank assessment. b) The field sampling parameter list should be expanded to also include oxidation-reduction potential ("ORP") because it is a classic CCR-related indicator test. c) TVA did not define what it believes a "significant difference" in field parameter results that would trigger "further investigation." d) If shoreline field testing results indicate any difference in one or more parameters, TVA should automatically assume that non-visible seepage is occurring into the surface water – particularly in areas where TVA has riprap to stabilize unstable dikes.	11/1/2018	SELC	a - A boat will be used, if necessary, to evaluate the shoreline for seeps particularly where riprap inhibits observation of the stream banks. b - Oxidation-reduction potential (ORP) is a measure of sample redox conditions. Redox conditions are affected by many factors and cannot be directly correlated to the presence or absence of CCR material. Stabilization of readings and exposure to ambient air can impact the reliability of the measurements. Field testing will be conducted for pH, temperature, dissolved oxygen and conductivity to identify potential significant differences indicative of a seep. c - "Significant differences" in parameters that may indicate a groundwater seep will be determined based on field measurements of pH, temperature, dissolved oxygen, and conductivity measured at multiple locations in the stream channel and the shoreline upstream, adjacent to the suspected seep area, and downstream of the suspected seep. Enough measurements of each field parameter will be taken to demonstrate repeatability in the channel and the shoreline upstream, adjacent to, and downstream of the suspected seep. Twelve field measurements of each parameter in the stream channel and the three areas of shoreline will be used for an initial statistical evaluation. d - Some variability is expected in measurements of pH, temperature, dissolved oxygen, and conductivity in the natural environment of a moving body of water. Thus "any difference in one or more parameters" cannot be interpreted as indicative of a groundwater seep. See answer to c) above.