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# GROUNDWATER MONITORING PLAN
# Pond 2
# Landfill SWP #624
# Clinch River Plant
# Appalachian Power Company
# Carbo, Virginia

Prepared for:
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## APPENDICES

Appendix A Borehole Logs / Monitoring Well Installation Log

**ACRONYMS**

| Acronym | Definition |
|---|---|
| AEP | American Electric Power |
| bgs | below ground surface |
| ºC | Degrees Celsius |
| CCR | Coal Combustion Residual |
| CFR | Code of Federal Regulations |
| CRLE | Clinch River Landfill Expansion |
| Deep Zone | deeper hydrostratigraphic zone, characterized using monitoring wells installed in 2009, as spanning the overburden-bedrock contact |
| DO | Dissolved oxygen |
| ºF | Degrees Fahrenheit |
| ft | feet/foot |
| GMP | Groundwater Monitoring Plan |
| msl | mean sea level |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| ORP | Oxidation-reduction potential |
| PVC | polyvinyl chloride |
| QA | quality assurance |
| QC | quality control |
| SAP | Sampling and Analysis Plan |
| ID | identification |
| ID | Inner diameter |
| K | hydraulic conductivity |
| VAC | Virginia Administrative Code |
| VADEQ | Virginia Department of Environmental Quality |
| USEPA | United States Environmental Protection Agency |
| USGS | United States Geological Survey |

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## 1.0 INTRODUCTION

This Groundwater Monitoring Plan (GMP) and associated Sampling and Analysis Plan (SAP) has been prepared to document the procedures and methodology for conducting groundwater monitoring to support the closed Ash Pond 2 at the Clinch River Power Plant located in Carbo, Virginia.

This Groundwater Monitoring Plan has been developed in accordance with:

- Virginia Administrative Code (VAC), Title 9: Environment, Agency 20: Virginia Waste Management Board, Chapter 81: Solid Waste Management Regulations, Section 250: Groundwater Monitoring Program (9VAC20-81-250);
- Virginia Administrative Code (VAC), Title 9: *Environment*, Agency 20: *Virginia Waste Management Board*, Chapter 81: *Solid Waste Management Regulations*, Section 800: Part VIII Requirements for the Management of Coal Combustion Residuals (9VAC20-81-800);

The purpose of this Groundwater Monitoring Plan is to:

- Present the site-specific geologic and hydrogeologic setting that will support the proposed activities presented in this Groundwater Monitoring Plan; and,
- Present a Groundwater Monitoring Plan that will adequately characterize groundwater quality at the site in accordance with 9VAC20-81-250; and in accordance with 9VAC20-81-800.

## 2.0 BACKGROUND

### 2.1 Facility Description

The Clinch River Power Plant is located on approximately 270 acres along the Clinch River, north of Route 665, in Carbo, Russell County, Virginia (**Figure 1**). The site is owned and operated by Appalachian Power Company (APCO), a public utility subsidiary of AEP. The facility was constructed between 1955 and 1956 and originally consisted of three power generating units (each with a 235 megawatt capacity), and two ponds: Pond 1 and Pond 2, for disposing and storing coal combustion byproducts. Sluicing operations to Pond 2 ceased in 1997 and was closed in 2013 via Virginia Department of Environmental Quality (VADEQ) by means of the Virginia Pollutant Discharge Elimination System (VPDES) permit. Pond 1 is scheduled for closure during the 2017 construction season. The facility also consists of the Clinch River Landfill Expansion (CRLE), located southwest of the plant. The landfill is permitted under VADEQ Solid Waste Permit #223.

### 2.2 Pond 2 Description

Pond 2 is located approximately a half mile upstream of dumps creek from the intersection of Dumps Creek and the Clinch River, northeast of the power generating units and southeast of Route 616 (**Figure 2**). Pond 2 was constructed between 1955 and 1956 and was used for sluicing and settling of ash byproducts, after which the solids were removed by dredging. Pond 2 consists of a two tiered dike system and was originally designed for a three tiered dike system raising the height to accommodate for additional CCBs. Pond 2 was decommissioned in 1997.

Pond 2 is considered a side-hill impoundment built on an existing hillside (**Figure 3**). The Pond 2 cap consists of:

- 30 mil PVC flexible membrane liner (FML), cover by
- A double-sided geocomposite drainage net (GDN), cover by
- 24-inch thick vegetated soil cover.

## 3.0 ENVIRONMENTAL SETTING

### 3.1 Climate

The climate of Virginia's Southwestern Mountain Region is considered a humid, subtropical area with average air temperatures ranging from 60 to 85 degrees Fahrenheit (°F) in August and 24 to 44°F in January. The average annual precipitation is approximately 47 inches per year, with an average of 4.04 inches in January and an average of 4.73 inches in July. Snowfall in this region accounts for about 16.7 to 23.2 inches annually (Virginia Tourisim Corporation, 2016).

A long-term mean surface runoff component of the hydrologic budget of the Clinch River watershed was calculated by the U.S. Geological Survey (USGS) by subtracting the long-term base-flow component (base flow) from the total stream flow. With an estimated base flow of 86.9 percent (%), USGS calculated an annual runoff for the Clinch River watershed of 13.1%. This translates to 2.4 inches annually. USGS also calculated an infiltration of 43.4 inches, a riparian evapotranspiration of 1.1 inches, and a mean annual recharge of 16.8 inches for the Clinch River watershed (United States Department of Agriculture - Natural Resources Conservation Service (USDA-NRCS), 2007).

### 3.2 Topography

The site is located in an area of moderate to steep sloping uplands that slope toward trellis drainages and floodplains of the Clinch River (**Figure 3**). Elevations surrounding Pond 2 range from approximately 1,900 ft to approximately 1,500 ft above msl.

### 3.3 Soils

#### 3.3.1 Regional Soils

The soils that are identified near Pond 2 consist of well drained upland soils identified on summits, shoulders, back slopes and floodplain soils located along floodplain steps of the Clinch River. The soils surrounding the ponds include upland soils, including the Berks, Chiswell, Groseclose, and Weikert soil series; as well as the floodplain soils of the Chagrin, Grigsby, Lobdell and Orrville Soil Series (**Figure 4**). Due to historic activities at the site, much of the area adjacent to the pond is characterized as Dumps, mine-Urban land complex. This is a classification for soil that has been altered by cutting and filling, and which contains components of coal and fly ash. These types of soils are difficult to characterize due to their heterogeneous nature. Land affected by cutting and/or filling will exhibit varying characteristics based on the degree of alteration and the composition of fill material.

#### 3.3.2 Site Soils

Based upon boring logs recorded during Pond 1 monitoring well installations in 2009, soils adjacent to the pond 1 are characterized as unconsolidated fill and residuum, consisting of silty clays, sandy silts, and silty sands. (MACTEC Engineering and Consulting, Inc., 2009). There have been no borings performed adjacent to Pond 2. Based on the proximity of Pond 2 with Pond 1 and history of construction, the site soils are expected to be similar in kind.

In 2008, eight (8) borings were drilled in Pond 2 and through the dike in order to perform geotechnical analysis of Pond 2 (**Figure 5**). Borings B-3 and B-4 were drilled through the lower and middle dikes while the remaining borings were through the ash. The dike material encountered by borings B-3 and B-4 was primarily composed of medium-dense to dense fine to coarse sand. Natural soils were encountered in boring B-3 beneath the lower dike consisting of organic clayey silt and fine to medium sand above the bedrock surface. Borings B-5 and B-6 encountered between 2.5 and 5.0 feet of medium stiff silty clay and clayey silt just above the bedrock surface. The 2008 borings can be located in Appendix A. (S&ME, Inc., 2012)

### 3.4 Geology

The site is situated within the Valley and Ridge Province, which lies between the Blue Ridge Province to the east and the Appalachian Plateaus to the west. In Virginia, the Valley and Ridge consists of two distinctly different sub provinces, including the eastern Great Valley and a more mountainous western sub province known as the Ridge and Valley sub province. The site is located in the Ridge and Valley sub province, which is characterized by long linear ridges separated by linear valleys with trellis drainage patterns.

The Valley and Ridge Physiographic Province is characterized by a northeast-southwest trending series of parallel ridges and valleys composed of folded and faulted Paleozoic sedimentary rock. The primary geomorphological features are mainly the result of differential weathering of various rock types, which include limestone, dolomite, shale, sandstone, and siltstone. Larger valleys may have a comparatively thin mantle of alluvial soils ranging in size from clay to coarse sand to boulders, and deeply weathered alluvium near streams and rivers may be found both in low-lying areas and on hills, reflecting the dynamic geologic nature of the province. In areas underlain by limestone, solution weathering may result in karst development, with sinkholes as the primary and commonly recognizable feature. The structural setting of the area is reflective of episodes of uplift and mountain building to the east. The site is near the westernmost structural front of a series of imbricate, repeating stratigraphic sequences that have been moved northwestward via relatively low angle thrust faults.

Pond 2 is bisected along its long axis by the Dumps Fault, a component of the regionally extensive Clinch port fault system. This has resulted in the older, Cambrian Rome Formation being locally faulted over the younger, Devonian Chattanooga Shale and the Mississippian MacCrady Shale and Price Formation. The surficial expressions of the younger strata indicate that they are part of an overturned synclinal fold.

While the geologic map of the St. Paul and Carbo quadrangles (Evans and Troensegaard, 1991) shows the subject site as being covered by fill at the time of publication, the obscured approximate northern half of Pond 2 is likely underlain by Chattanooga Shale, given the configuration of the adjacent syncline **(Figure 6).** In the 2008 borings, bedrock was encountered in Borings B-2 through B-7 at elevations ranging from 1491.2 to 1522.4 feet above Mean Sea Level (MSL). Based on descriptions of the rock core and rock fragments obtained in the split spoon samples, bedrock at the site consists of very-soft to soft gray shale and hard gray limestone. Generally, bedrock encountered beneath the dike system consisted of the very-soft to soft shale. Both rock types exhibited massive bedding with many diagonal fractures. Rock Quality Designation of (RQD) of the limestone ranged between 26 to 64%. (S&ME, Inc., 2012). A review of boring data from previous explorations at the site do not indicate a need to shift the mapped position of the Dumps Fault.

## 3.5 Hydrology / Hydrogeology

### 3.5.1 Surface Water Hydrology

The topography surrounding Pond 2 consists of wooded areas containing moderate to steeply sloped uplands that slope toward trellis drainages and floodplains of the Clinch River. The watershed contributing runoff to the site consists of the slopes and drainages southeast and east as well as the area surrounding the pond. The total watershed area for Pond 2 encompasses approximately 43.9 acres and is divided into four subareas (Subarea A, B, C and D). The water from these subareas are either routed onto Pond 2 or captured and diverted away from the pond. The subareas and the path of surface water is shown on **Figure 7**. Surface water is found at this site predominantly as rivers and creeks. The Dumps Creek bounds Pond 2 to the west and flows directly into the Clinch River. Steep slopes are located north and south of Pond 2 that contain surface water drainages that flow down the slope towards Dumps Creek, which discharges into the Clinch River.

### 3.5.2 Groundwater

During the Closure of Pond 2, Vibrating Wire (VW) piezometers were installed to monitor water levels in the Alluvium. Based upon alluvium groundwater level measurements collected monthly, groundwater at the site is identified at elevations between 1502 and 1523 ft msl. Based upon groundwater level measurements collected on May 2017, the alluvium potentiometric surface map was developed and presented on **Figure 8**.

As shown on **Figure 8**, the potentiometric surface defined within the Shallow Zone closely mimics surface topography with groundwater flow from the northeast, east, and southeast of Pond 2. The potentiometric mapping indicates groundwater flowing predominantly northwest toward Dumps Creek.

Groundwater flow within the Deep Zone is unknown until the proposed monitoring well network is installed. It is assumed groundwater within the bedrock will have the same general flow direction as the alluvium.

### 3.5.3 Aquifer Characteristics

Rock core samples obtained in Borings B-3 and B-8 show that the bedrock surface at the site consists of very-soft to soft shale beneath the dike system (borings B-2 through B-5) to hard limestone at the base of the hillside (Boring B-6). With the exception of Boring B-6, these borings also indicate that the top of bedrock is relatively flat, varying from elevation 1491.2 to 1496.7 across the site. Based on the site topography, it is believed that Pond 2 was constructed in the old river valley of Dumps Creek, and that Dumps Creek may have been re-routed as part of construction; thus the reason for the flat bedrock surface.

Porosity / conductivity values were estimated by Arcadis in an October 8, 2015 report titled Groundwater Flow Model and Screening Level Risk Evaluation. Though the Arcadis report was evaluating the Clinch River Pond 1, the hydraulic units found at Pond 1 are found at Pond 2. The hydraulic conductivity was adjusted in that model to represent the two differing bedrock units (the Chattanooga and the Rome formations). The Chattanooga was represented with a 0.2 ft/day (0.00007556 cm,/sec) K value and the Rome (to the south) was represented with a 0.75 ft / day (0.0002645 cm/sec) K value.

Aquifer matrix characteristics for both the Rome and the Chattanooga (as described above in the geology section describe the fractured bedrock units (the aquifer bearing units) in the following ways: Geotechnical or environmental drilling and sampling within the footprint of Pond 2 would be expected to encounter the dark gray to black, fissile Chattanooga Shale (with lesser siltstone and sandstone) and the variegated red and green shale and siltstone (and lesser dolomite and limestone) of the Rome Formation.

Arcadis describes the recharge of the groundwater system to occur from precipitation infiltration that occurs between the topographic highs and valleys. Recharging water infiltrates into thin unconsolidated deposits and shallow bedrock across the basin. Shallow groundwater likely occurs in the unconsolidated deposits and bedrock units in the upland areas. Preferential bedrock groundwater flow is within the fracture system and is also local to the shallow alluvial systems produced by perennial stream flow deposition (American Electric Power Service Corporation, 2015).

#### 3.5.3.1 Seasonal Water Table Variation

**Table 1** below presents water level data collected between December 2016 and May 2017 from piezometers installed in 2012 at the Pond 2 site. There is no clear representation of seasonal variation within the given time period is strongly defined. The static water levels have only slightly decreased since the start of the Pond 2 Closure Project in 2012 as indicated by the Change Column in **Table 1**.

Table 1. VW Piezometer Water Level Elevations

| | Project Start | Monthly Readings 2017 | | | | | | Change Since Project Start |
|---|---|---|---|---|---|---|---|---|
| | June 2012 | Dec 2016 | Jan 2017 | Feb 2017 | Mar 2017 | April 2017 | May 2017 | |
| **L-20** | 1505.53 | 1502.58 | 1502.65 | 1502.40 | 1502.63 | 1502.42 | 1502.59 | **-2.94** |
| **M-20A** | 1520.47 | 1514.14 | 1514.36 | 1514.51 | 1514.63 | 1514.21 | 1514.99 | **-5.48** |
| **U-20A** | 1525.99 | 1517.44 | 1517.39 | 1518.23 | 1518.57 | 1518.44 | 1519.57 | **-6.42** |
| **M-21A** | 1520.23 | 1516.85 | 1517.30 | 1516.71 | 1512.22 | 1513.23 | 1518.06 | **-2.17** |
| **M-22** | 1521.23 | 1517.98 | 1518.00 | 1518.00 | 1518.05 | 1518.06 | 1518.07 | **-3.16** |
| **U-21** | 1528.04 | N/A | N/A | N/A | 1520.64 | 1521.06 | 1523.06 | **-4.98** |
| **L-8** | 1517.39 | N/A | N/A | 1515.20 | 1515.45 | N/A | 1516.92 | **-0.47** |
| **L-5** | 1514.46 | N/A | N/A | Dry | Dry | Dry | Dry | **Dry** |
| **U-4** | 1517.72 | N/A | N/A | 1516.20 | 1516.20 | N/A | 1516.2 | **-1.52** |
| **U-1** | 1520.45 | N/A | N/A | Dry | Dry | Dry | Dry | **Dry** |

XXXX lowest groundwater elevation recorded in each piezometer
XXXX highest groundwater elevation recorded in each piezometer

## 4.0 GROUNDWATER MONITORING NETWORK DESIGN

### 4.1 General

The proposed monitoring well installations will ensure groundwater monitoring compliance with 9VAC20-81-250 and 9VAC20-81-800.

A key component of this Pond 2 site is the Dumps Fault that extends through the middle of the pond (as discussed in Section 3.4 Geology above). The differing rock composition of the two bedrock formations (Rome and Chattanooga) found under Pond 2 may affect the geochemistry of the groundwater. To allow for adequate definition of background for this site, it will be necessary to define background water quality conditions for both of those existing rock formations in which monitoring wells may be installed. The rock formations that are separated by the fault are the Cambrian aged Rome Formation, and the Devonian aged Chattanooga Shale. The background sampling locations defined in this Groundwater Monitoring Plan to evaluate the Chattanooga Formation are traditional upgradient wells. The background well proposed to support water quality assessments within the Chattanooga Formation is proposed as a cross-gradient background well that will provide water quality evaluation of the Chattanooga Formation without being impacted by prior Coal Combustion Residual (CCR) land use, but is not located immediately upgradient of the site as physical characteristics of this site do not allow for that physical location. Two monitoring wells will be installed along the fault contact, one well in a downgradient location to the ponds and a second well in a cross-gradient location, to define any lateral gradient flow that may occur which is independent of other flow gradients defined at the site.

It is proposed that the Pond 2 monitoring network consist of 12 groundwater monitoring wells. Twelve wells will be newly installed as shown on **Figure 9** and described below.

- Four of these wells will be installed in areas determined to be upgradient from the pond and screened within the Rome Formation.
- One background well will be installed cross-gradient from the pond and screened within the Chattanooga formation.
- Six well locations will be installed downgradient of the pond in areas defined to assess any water quality changes that may be attributable to the Pond 2 as follows:
  - Four wells shall intercept the Chattanooga Formation bedrock.
  - One additional well will be located in close proximity to the contact of the Dumps Fault to assess if lateral migration of groundwater may be present along this front.
  - One well will be installed downgradient in the Rome Formation.
- One well will be installed along the Dumps Fault in a non-upgradient background locations to characterize potential offsite lateral migration of groundwater.

Groundwater monitoring wells will not be screened in CCR or in earth that has been disturbed and/or not of native soils. If during the process of installation, it is determined that the wells are installed through CCR or non-native soils or manmade embankments, the screens will be sealed off from groundwater in these zones during both drilling and well installation activities.

Since metals sampling results can be affected by complex solution/dissolution reactions that take place in the capillary fringe zone, the well screens shall be located at least 5 ft below the seasonal low water table, such that they are submerged all year long. Monitoring wells shall be screened entirely in a single lithology (e.g., entirely in bedrock).

All monitoring wells will be installed as soon as possible following approval of plans and permits.

### 4.2 Downgradient Monitoring Wells

Six wells will be installed downgradient of the Pond 2 system (**Figure 9**). The horizontal and vertical locations of the monitoring wells have been selected to detect early entry of contaminants into the subsurface. Wells will be screened with 10 ft long screens, at a depth as to maintain the screen zones in a fully submerged capacity within the bedrock at this site. It is anticipated that this will correlate with a screen depth ranging from approximately from 5 to 15 ft below the top of bedrock.

The proposed compliance monitoring well network will consist of the horizontal and vertical locations of the monitoring wells have been selected to detect early entry of contaminants into the subsurface.

### 4.3 Upgradient Monitoring Wells

Four upgradient monitoring wells are proposed to be installed in the Rome Formation. The horizontal locations of the proposed upgradient monitoring wells have been selected so that the wells are outside of the influence of the facility. Well screens for upgradient wells will be installed as described in Section 4.7.

### 4.4 Special Conditions

One significant special condition for Pond 2 is that it is geologically mapped to be roughly bisected along its long axis by the Dumps Fault. This fault separates the Rome Formation from the Chattanooga Formation. Geotechnical or environmental drilling and sampling within the footprint of Pond 2 will be expected to encounter both the dark gray to black, fissile Chattanooga Shale (with lesser siltstone and sandstone) and the variegated red and green shale and siltstone (and lesser dolomite and limestone) of the Rome Formation depending upon the placement of the wells around the pond (**Figure 6**).

The monitoring well network described above has been designed to account for this condition in the following ways:

- Proposed monitoring wells are located on both sides of the fault;
- Proposed monitoring wells are located topographically and hydraulically upgradient and downgradient of the fault; and,
- Two wells (one cross-gradient and one downgradient) will be installed along the fault contact to define any lateral gradient flow that may exist along the fault contact independent of other flow gradients present at the site.

The second special condition that may affect the site is flooding.  However, the locations of the proposed new wells and the existing well are outside of the 100 year floodplain.  If locations are revised due to existing site conditions and results in a well inside the 100 year floodplain, precautions would be implemented to protect the well during flood events, including:

- Installation of bollards to protect the well from flood debris;
- The riser will be constructed so that the top of the riser will be at an elevation above the 100 year floodplain, as appropriate.  If the top of the riser cannot be constructed to extend above the 100 year floodplain, then the wells will be fitted with a properly fitted compression cap or other type sealing cap to prevent surface water intrusion.

Following a flood event, monitoring wells will be inspected within 90 days of flood water retreat or prior to the next groundwater sampling event to determine if the well was impacted by the flood event.  If impacts to a well or wells is identified as a result of a flood event, the VADEQ will be notified within 7 days to either 1) ask for a one-time extension to the groundwater sampling schedule using an appropriate mechanism to allow flood impact mitigation or 2) replace the well or wells with deeper monitoring points that can act as compliance points until the flood impairment of the aquifer has ended and baseline conditions have returned.  Mitigation of an inundated well would include the full redevelopment of those wells affected by flooding.

### 4.5 Non-Upgradient Background Wells

Due to the location challenges at this site with physically locating wells in the Chattanooga Formation “upgradient” of the pond, it is proposed that an off-gradient well located in the correct bedrock lithology, be installed instead (**Figure 6**).  Monitoring well MW-1707 is proposed as a cross-gradient location to support background evaluations of the groundwater contacting the Chattanooga Formation.

In addition, because faults zones can act as conduits for groundwater migrations, Monitoring Well MW-1708 is proposed as a cross-gradient to support background evaluation of potential lateral migration of groundwater along the Dumps Fault.

It is recommended that these background wells be installed as early in the process as possible. Early installation of a background well will maximize the opportunity to collect multiple background water samples, allowing for the collection of sufficient data to develop a representative statistical dataset of the chemical and hydraulic background conditions for this site.  Background shall be developed using results from no fewer than eight independent sampling events and shall be updated on a regular basis (every 2 years), as directed by the VADEQ.

### 4.6 Monitoring Well Replacement

If a monitoring well fails to perform as designed due to internal or external damage or change in groundwater elevation, it will be replaced (where applicable) prior to the next scheduled sampling event.  Wells will be abandoned as described in Section 4.7.6 and will be replaced using the methods described in Section 4.7.

## 4.7 Monitoring Well Installation

All monitoring well installations shall be completed in accordance with 9VAC20-81-250.A.3.c (well construction) and 9VAC20-81-250.A.d (boring logs).

### 4.7.1 Drilling

Monitoring wells will be installed using a combination of hollow-stem auger, air rotary drilling, sonic, or other similar applicable techniques. The boreholes for the wells will have a minimum annular space that correlates with a diameter of 4-inches larger than the outside diameter of the well casing. Wells will be composed of 2 inch schedule 40 polyvinyl chloride (PVC) flush threaded riser pipe and screen (and end cap), with an outside diameter of 2.375 inches. As such, final borehole will have a minimum diameter of 6.5 inches.

It is the intent of this Groundwater Monitoring Plan is for groundwater monitoring wells to not be screened in CCR or in earth that has been disturbed and/or not of native soils. In such instances, where during the process of installation it is determined that the wells are installed through CCR or non-native soils or manmade embankments, the screens shall be sealed off from groundwater in these other zones during drilling and well installation activities. The borehole shall be continuously sampled from ground surface to final depth. Final diameter of the boring shall be 6.5 inches or larger to support the installation of a 2 inch inside diameter, schedule 40 PVC well. It is anticipated that the installation will be completed using hollow-stem auger drilling utilizing continuous sampling techniques (or equivalent) through the overburden to bedrock refusal. Bedrock borehole installations shall use NQ sized rock coring tooling (or similar approved equivalent continuous sampling method) techniques to collect continuous rock core samples to borehole total depth. All continuous sampling (overburden and rock core) will be logged to document the material being contacted with this well installation.

Drilling fluids will consist of potable water and/or compressed air. Water used during drilling activities will originate from an approved potable water source, identified and recorded in the daily log book.

### 4.7.2 Investigation Derived Waste

IDW shall be handled in accordance with the VSWMR and Department Guidance (LPR-REM-01-1995). Investigation derived waste (IDW) generated during the installation and/or sampling of the monitoring well network will include personal protection equipment (PPE) and other trash, soil cuttings from well installation, and water from decontamination, development, and purging activities. PPE and other trash will be placed into plastic trash bags and disposed of within sanitary trash receptacles.

Soil cuttings will be placed in a location approved by the on-site AEP representative. Water generated during investigation activities will be containerized in 55-gallon drums, 5-gallon buckets, or other appropriate container and discharged into the on-site Reclamation Pond for subsequent treatment and discharge through a VPDES permitted outfall.

### 4.7.3 Soil and Rock Sampling Techniques

Continuous soil/overburden samples will be collected using techniques that allow for full continuous recovery of overburden materials in quantities sufficient to allow for identification and logging of materials. Sampling techniques may include hollow-stem auger drilling utilizing continuous sampling techniques, a 2-inch diameter split spoon sampler, rotosonic coring or other approved alternative. Bedrock sampling shall also be conducted in such a way as to facilitate the continuous sampling and logging of bedrock. Coring may be completed using NQ rock coring techniques (or other equivalent approved) to collect core samples from top of rock to the total depth of each borehole. Soils will be logged and classified in accordance with the Unified Soil Classification System (USCS) and rock cores will be classified in accordance with standard practice such as through ASTM D5434, *Standard Guide for Field Logging of Subsurface Soil and Rock*, and shall include such information as: size, core recovery RQD and fracture frequency.

### 4.7.4 Installation Procedures and Construction

A total of ten monitoring wells will be installed adjacent to Pond 2. Monitoring wells will be installed by a Commonwealth of Virginia certified and licensed driller. Permanent monitoring wells will be constructed using 2-inch inside diameter schedule 40 PVC casing that will be flush threaded and will have a threaded end cap with O-ring seal installed. Well screens will be 2-inch inside diameter factory-cut 0.010-inch slotted pipe with a total length of 10 ft. A filter pack consisting of 20/40 mesh, commercially available, clean silica sand with uniform sorting, or similar size compatible with the well slot size, will be installed in the annulus around the well screen at a minimum of 0.5 ft below the bottom end cap to a minimum height of 2 ft. (maximum height of 3 ft) above the top of screen. During placement of the filter pack and prior to placement of the annular seal, subcontractor personnel shall use a surge block to surge the well to optimize filter pack placement, remove voids and/or bridges that may have developed in the filter pack. The well shall be appropriately designed as to allow for the entire screened zone to fall within one single lithology (as discussed above).

An annular seal will be placed above the filter pack and will consist of a minimum of 2 ft of bentonite. Following bentonite placement, the annular seal will be allowed to hydrate as recommended by the manufacturer's instructions or for a minimum of 12 hours (whichever is greater) prior to grout installation.

After hydration of the annular seal, a Portland-bentonite grout (preferred) or a 30% solids bentonite grout, as applicable, shall be used to fill the annular space between the casing and the borehole wall, from the top of the bentonite seal to within approximately 1 to 2 ft of ground surface. The grout will be allowed to cure for a minimum of 24 hours prior to installation of the concrete pad and vaults.

At ground surface, a locking protective steel casing (stick up/above ground completion) that has a minimum diameter of 3 inches and a minimum length of 5 ft will be placed over the PVC casing. Concrete will be placed above the annular seal and will extend to the surface apron that will consist of a 2-ft by 2-ft by 4-inch thick well pad. Three protective bollards will be installed to protect the well. The preferred installation method shall be the stick-up/above ground completion with protective bollards. As such, all monitoring wells will be located in areas where stick-up completions with protective bollards are possible, unless specifically otherwise directed by the owner operator. A traffic-bearing reinforced road vault will be utilized to protect the integrity of the monitoring well at locations where monitoring wells may be located within a roadway or area where heavy equipment may be reasonably assumed to traverse.

The well pad will be constructed so that surface water will drain away from the protective casing. The top of well casing will be cut using a rotary tool to ensure the top of the riser is smooth, even and parallel to ground surface. The top of riser will be capped with water tight, lockable compression well caps with keyed alike Master locks or equivalent. Weep holes shall be installed to manage potential water influx to the interior of the surface casing.

#### 4.7.5 Monitoring Well Development

Monitoring well shall be developed to remove sediment and other residual materials from the well following installation, and to restore natural hydraulic conditions of the formations. This allows the collection of groundwater samples which are representative of formation water rather than samples with may be impacted by non-representative injected water used during installation or drilling processes, or that may be impacted by some other external impact potentially introduced during well installation activities. Monitoring wells will be developed at a minimum of 24 hours following the installation of the well pad and grouting of the outer protective casing to allow for sufficient time for well materials to cure.

Well development will be conducted using pump and surge techniques until a minimum of three well volumes and the quantity of water injected (and not recovered) during installation, have been removed and water quality parameters [temperature, specific conductance, pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), and turbidity] have stabilized (within 10% over 3 readings). Ideally, turbidity will be less than 10 Nephelometric turbidity units (NTUs), where possible, to insure all extraneous sediments have been removed from the filter pack and well bore to the greatest extent possible.

#### 4.7.6 Monitoring Well Abandonment

When a well or piezometer must be abandoned (decommissioned), the well/borehole must be sealed in such a manner as to ensure that the well/piezometer cannot act as a conduit for migration of potential contaminants into the groundwater. The following abandonment procedures for all piezometers and groundwater monitoring wells will be followed:

1. The depth to water shall be measured and recorded.
2. A probe will be used to measure the depth of the well and note any obstructions within the well.
3. The depth of the well as measured by the probe shall be compared to the recorded depth on the well log.
4. The well shall be pressure grouted with a bentonite-grout slurry (94-pounds of Portland cement plus 3 to 5% bentonite plus 5 to 6 gallons of water) using a positive displacement method (i.e., through installation of the grout through tremie pipe). The monitoring well

will be filled proceeding upward from the bottom of the well screen in a continuous manner to within 2 ft of ground surface. The volume of neat cement will be measured against the anticipated volume of the well (including borehole area) to verify adequate filling.

5. The casing protector and casing will be cut at grade and capped with cement.
6. The date of the well abandonment will be noted on the well log. The well log will be retained on file until the disposal site is released from its post-closure monitoring requirements.

### 4.7.7 Decontamination

During the installation of monitoring wells, decontamination of heavy equipment and sampling/development equipment will be conducted as described in the following subsections. Water generated during decontamination activities will be containerized and disposed at an approved offsite facility.

Decontamination will also occur on all applicable sampling equipment and materials (e.g., water level meters, reusable bailers if applicable, etc.) that have the potential to come in contact with sampled media to prevent potential for false reading related to sampling activities.

#### 4.7.7.1 Heavy Equipment

Heavy equipment (e.g., drill rods, drill bit, casing materials, wrenches, drill rigs, and other heavy equipment) will be steam cleaned prior to drilling at each borehole location using the following procedures:

- Equipment caked with drill cuttings, soil, or other material will be initially scraped or brushed to remove bulk soil;
- Equipment will then be sprayed with potable water using a high pressure steam cleaner/ washer; and,
- The equipment will then be rinsed with potable water.

#### 4.7.7.2 Sampling Equipment Used During Drilling Activities

Sampling equipment (e.g., split spoons samplers, continuous sampler barrels, etc.) used to collect samples during drilling shall be decontaminated between each sample as follows:

- Rinse and scrub sampling equipment in potable water;
- Wash sampling equipment with alconox / liquinox;
- Rinse with distilled or deionized water; and,
- Air dry.

### 4.7.8 Groundwater Monitoring Well Network Operation and Maintenance Requirements

A visual inspection shall be conducted at minimum once per quarter by a designated representative. Any impacts or problems experienced with the wells in this network shall be reported to the Land Environment and Remediation Services representative and the Plant Environmental Coordinator. Any needed repairs or issues identified following sampling or quarterly inspections shall be immediately identified to these representatives. They shall ensure appropriate repairs are completed as required to maintain a fully functional and compliant monitoring network. All maintenance will at minimum follow 9VAC20-81-250.A.3.e (well maintenance) requirements.

### 4.7.9 Surveying

The locations of the new monitoring wells will be surveyed for location to sub-meter accuracy. Well head elevations (e.g., top of casing), as well as the ground elevations, will be surveyed by conventional leveling to an accuracy meeting or exceeding +/-1 centimeter. Elevations will be reported in ft msl. The survey will be conducted by a licensed or otherwise certified land surveyor and will be completed using a permanent and established benchmark and/or a global positioning system.

### 4.7.10 Documentation

All monitoring well installations shall be completed in accordance with 9VAC20-81-250.A.3.c (well construction) and 9VAC20-81-250.A.d (boring logs). The monitoring well certification will be submitted as required by 9VAC20-81-250.A.3.g (monitoring well certification). Monitoring well installation documentation will be recorded in the field by a qualified person and submitted to VADEQ, as required, and will be included as an appendix in the Final Report of Monitoring Well Installation.

### 4.7.11 Certification

As required in 9VAC20-81-250.A.3.g (monitoring well certification), the groundwater monitoring wells will be certified by a qualified professional engineer within 30 days of well installation. The certification will note that all wells have been installed in accordance with the documentation submitted under 9VAC20-81-250.A.3.d (boring logs). The owner or operator shall transmit the certification to the VADEQ within 14 days of completing this certification.

## 5.0 GROUNDWATER SAMPLING AND ANALYSIS PLAN

This Groundwater Sampling and Analysis Plan (SAP is provided to establish and define the groundwater monitoring sampling requirements in accordance with 9VAC20-81-250 and in accordance with those regulations of the U.S. Environmental Protection Agency (USEPA), set forth in 40 CFR 257 Subpart D, wherein they relate to standards for the disposal of CCR in landfills and surface impoundments. This SAP also includes (where applicable) reference to USEPA SW-846 guidance for sampling and analyzing waste and other matrices.

This SAP includes consistent sampling and analysis procedures that are protective of human health, safety, and the environment and are designed to ensure sample results are an accurate representation of groundwater quality.

### 5.1 Potentiometric Surface Monitoring

Water levels (groundwater elevations) shall be measured during each sampling event from the 10 monitoring wells (**Figure 9**) identified in this groundwater monitoring network to evaluate groundwater flow rate and flow direction at the site each time the wells are sampled, pursuant to subsection B or C of 9VAC20-81-250 or 9VAC20-81-260.

Prior to initiating any groundwater sampling activities, the static water level of all monitoring wells in the network will be obtained using an electronic water level indicator. Static water levels will be collected during a 24-hour period at the beginning of each groundwater monitoring event. Depth to groundwater measurements will be to the nearest 0.01 ft and recorded on a static water level data sheet or in the field log.

Potentiometric surface maps and ground water flow directions will be provided in the annual report.

### 5.2 Groundwater Sample Collection

#### 5.2.1 Sampling Equipment

The list of equipment required to conduct groundwater sampling in accordance with this Groundwater Monitoring Plan (GMP) includes, but is not limited to:

- Electronic water level indicator;
- Multi-parameter water quality meter;
- Turbidity Meter;
- Disposable polyethylene tubing;
- Calibrated bucket;
- pump and controller;
- Electric generator;
- Sample containers with preservatives, as necessary;
- Cooler with ice;
- Chain-of-Custody forms;

- Distilled/deionized water; and,
- Field logbook and data sheets.

### 5.2.2 Calibration Procedures

Field equipment and instruments will be calibrated and verified daily prior to use, as applicable. Physical and chemical standards used to calibrate instruments will be traceable to National Institute of Standards and Testing, USEPA, or other recognized standards. Instrument calibration will be performed in accordance with the manufacturer's requirements.

The following information will be recorded in logbooks or equipment calibration logs for all field equipment and instruments:

- Equipment type (i.e., manufacturer, model, and version);
- Serial number or other unique identification;
- Location;
- Frequency of calibration;
- Date of calibration;
- Name of calibration technician;
- Acceptance criteria; and,
- Actions required if results are unsatisfactory.

Factory calibration records, logbooks, and calibration logs documenting field calibration events will be maintained in the project files.

### 5.2.3 Groundwater Purge and Sample Procedures

Monitoring wells will be purged and sampled employing the Low Stress (Low Flow) Purging and Sampling technique. The primary goal of this groundwater sampling procedure is to collect groundwater samples that reflect the total mobile and inorganic loads (dissolved and colloidal-sized fractions) transported through the subsurface under ambient flow conditions with minimal physical and chemical alterations from sampling operations (US EPA Region 1, 2010).

Adjustable rate pumps constructed of stainless steel or Teflon (or other inert non-leaching materials) shall be used with Teflon-lined polyethylene tubing to collect the samples. Where approved and commiserate with site conditions, peristaltic pumps may be used. If peristaltic pumps are utilized for sampling, silicon tubing of 1 foot or less may be used around the rotor head. Tubing will not be reused.

Water purged from the well will discharge into a graduated bucket to determine the total volume of groundwater purged and estimate the rate of pumping. During the purging process, water quality parameters [pH, specific conductance, temperature, ORP, turbidity, and DO] will be measured using a water quality meter with a flow through cell attachment. Measurements of water quality parameters, groundwater level/drawdown rates, and pumping rate will be collected every 5 minutes, or as appropriate. A pump rate will be established that is appropriate for low flow sampling when little or no drawdown is occurring within the water column. The final purge volume must be greater than the stabilized drawdown plus the pumps tubing volume. Calculations will be shown in the log books to verify quantities. Well purging will be considered complete when stabilization of water quality parameters is achieved, as summarized in **Table 2**.

**Table 2. Water Quality Stabilization Requirements**

| Parameter | Units | Requirement |
|---|---|---|
| pH | Standard Units | ± 0.1 |
| Specific Conductivity | Micro-Siemens /centimeter (µS/cm) | ± 3 percent |
| Temperature | Degrees Celsius (ºC) | ± 3 percent |
| Dissolved Oxygen | Milligrams/liter (mg/L) | ± 10 percent (when DO is greater than 0.5 mg/L) |
| Turbidity | Nephelometric Turbidity Units (NTUs) | ± 10 percent (when turbidity is greater than 5 NTUs; if three turbidity values are less than 5, consider the values as stabilized) |
| Oxidation-Reduction Potential | Millivolts (mV) | ± 10 millivolts |

**Notes:** Requirements obtained from United States Environmental Protection Agency Region 1, 2010 (USEPA, 2010)

After achieving stabilization, the appropriate sample containers will be filled using direct fill sampling techniques. As required in accordance with 9VAC20-81-250 B or C, groundwater samples will not be filtered prior to laboratory analyses. The sampling, analyses and quality assurance (QA)/quality control (QC) methods set forth in USEPA document SW-846, as amended, will be used. Purge water generated during sampling activities will be containerized and managed as detailed in Section 4.7.2.

### 5.2.4 Sampling Event and Applicable Parameters

#### 5.2.4.1 Background Sampling

Eight (8) to ten (10) individual background samples will be collected from the monitoring network to provide adequate data set to define background. The wells in the Pond 2 groundwater monitoring network will complete the required independent sampling events to establish background data in 18 months. Within 30 days of completing background calculations (250.C.3.b.(2), a Phase II Background Report will be submitted. 9VAC20-81-250.C.3.c.(1) requires that GPS be proposed within 30 days of submitting the Phase II background Report. It is anticipated that Pond 2 will enter a modified Phase II Sampling Program (9VAC20-81-250) upon permit issuance for proposed compliance wells.

The 12 compliance wells for the Pond 2 network will begin under the modified Phase II Sampling Program as they are installed. No delay is anticipated.

Background sampling shall consist at a minimum of the USEPA Appendix III and IV Analyte list provided within the CCR Rule 40 CFR Part 257 Subpart D regulations and the additional VADEQ analyte list as provided in accordance with 9VAC20-81.

**Table 3** provides the full combined list of required analyses to be conducted.

**Table 3. Sample Analytes**

| Combined Constituent List | EPA CCR[5] Appendix III | EPA CCR[5] Appendix IV | 9 VAC 25[3]-280-40[1] | 9 VAC 25[3]-280-70[2] | 9 VAC 20[4]-81-250 Table 3.1 Col A | 9 VAC 20[4]-81-250 Table 3.1 Col B |
|---|---|---|---|---|---|---|
| Antimony | | ✓ | | | ✓ | ✓ |
| Arsenic | | ✓ | ✓ | | ✓ | ✓ |
| Barium | | ✓ | ✓ | | ✓ | ✓ |
| Beryllium | | ✓ | | | ✓ | ✓ |
| Boron | ✓ | | | | | |
| Cadmium | | ✓ | ✓ | | ✓ | ✓ |
| Calcium | ✓ | | | | | |
| Chloride | ✓ | | | ✓ | | |
| Chromium (Total) | | ✓ | ✓ | | ✓ | ✓ |
| Hexavalent Chromium | | | | | | |
| Cobalt | | ✓ | | | ✓ | ✓ |
| Copper | | | ✓ | | ✓ | ✓ |
| Cyanide | | | | | | |
| Fluoride | ✓ | ✓ | | ✓ | | |
| Lead | | ✓ | ✓ | | ✓ | ✓ |
| Lithium | | ✓ | | | | |
| Mercury | | ✓ | ✓ | | | ✓ |
| Nickel | | | | | ✓ | ✓ |
| Molybdenum | | ✓ | | | | |
| pH | ✓ | | | | | |
| Radium 226/228 | | ✓ | ✓ | | | |
| Selenium | | ✓ | ✓ | | ✓ | ✓ |
| Silver | | | ✓ | | ✓ | ✓ |
| Sulfate | ✓ | | | ✓ | | |
| Sulfide | | | | | | ✓ |
| Total Dissolved Solids (TDS) | ✓ | | | ✓ | | |
| Thallium | | ✓ | | | ✓ | ✓ |
| Tin | | | | | | ✓ |
| Vanadium | | | | | ✓ | ✓ |
| Zinc | | | ✓ | | ✓ | ✓ |

**Notes:**

[1]**9 VAC 25-280-40 =** Ground water standards applicable statewide
[2]**9 VAC 25-280-70 =** Ground water criteria by providence
[3]**9 VAC 25** = State Water Control Board
[4]**9 VAC 20** = Virginia Waste Management Board
[5]**EPA CCR =** CCR Rule 40 CFR Part 257 Subpart D

#### 5.2.4.2 Sampling

Groundwater monitoring/sampling for this site will follow 9 VAC 20-81-250.C with the inclusion of CCR parameters, per direction from VADEQ. The VADEQ has determined that no CCR ponds will undergo the 9VAC20-81-250.B.2 defined, “Detection monitoring program” and instead the 1st semi-annual sampling event for Pond 2 will be under Phase II monitoring (9VAC20-81-250.C.3).

Pond 2 will collect 8-10 background samples in the first 18 months. Within 30 days of completing background calculations (250.C.3.b.(2)), a Phase II Background Report will be submitted. Within 30 days submitting the Phase II Background Report, the Groundwater Protection Standards (GWPS) will be proposed for the parameters listed in **Table 6** below.

The 1st semi-annual sampling event for Pond 2 will be under Phase II monitoring (9VAC20-81-250.C.3) and will continue until termination of PCC. The semi-annual sampling event will be comprised of the full list of constituents for **Table 4**, including constituents derived from the following sources:

- The EPA CCR Appendix 3 list;
- The EPA CCR Appendix 4 list; and,
- VSWMR appropriate constituents.

The order of parameter sample collection will be as follows: pH, sodium, sulfate, sulfide, radium 226/228, fluoride, total dissolved solids, and metals.

Groundwater sample results will be evaluated against the CCR Groundwater Protection Standards (GWPSs) as listed in the last column of **Table 6** and discussed in Section 5.2.9.10 (Groundwater Protection Standards). Groundwater sample results will be presented in the semi-annual and annual groundwater reports.

During each groundwater sampling event, monitoring wells will be sampled in the following order: 1) upgradient background wells, 2) cross-gradient background wells, and 3) downgradient wells. Because the monitoring well network consists of new monitoring wells, several groundwater events will need to be conducted to evaluate the relative concentrations within each well. Thereafter, downgradient wells will be sampled in order of lowest constituent concentrations to highest concentrations.

#### 5.2.4.3 Alternate Source Determinations

As a result of any statistically significant increase identified while monitoring groundwater under subdivision B2 or C2 of 9VAC 20-81-250 or at any time with in the Corrective action process under 9VAC20-81-260, the owner or operator has the option of submitting an Alternate Source Demonstration report, certified by a qualified groundwater scientist, demonstrating:

(1) A source other than the Pond caused the statistical exceedance

(2) The exceedance resulted from error in sampling, analysis or evaluation

(3) The exceedance resulted from a natural variation in groundwater quality

A successful demonstration must be made within 90 days of noting a statistically significant increase. The director may approve a longer timeframe for submittal and approval of the Alternate Source Demonstration with appropriate justification.

Alternate Source Determinations will follow 9VAC20-81-250.C.3.e.(3).(a).(ii) and 9VAC20-81-250.A.5 guidance.

#### 5.2.4.4 Assessment of Corrective Measures

Within 90 days of confirming that any GPS constituent listed in **Table 6** has exceeded the Groundwater Protection Standards, the owner or operator must initiate an assessment of corrective measures to prevent further releases per 9VAC20-81-260.

### 5.2.5 Quality Assurance/Quality Control Samples

QA/QC samples will be collected to assess the quality of sampling efforts and reported analytical data. QA/QC samples will be collected at a sampling rate of 10% (1 out of every 10 samples) and shall consist of the following:

- Field duplicate samples;
- Equipment rinsate samples;
- Matrix spike/matrix spike duplicate samples (ms/msd); and,
- Trip blanks (1 per shipment).

### 5.2.6 Equipment Decontamination

Groundwater sampling equipment will be decontaminated prior to activities at the first well and then following the sampling of each well. The pump, support cabling, and electrical wires, as well as the water level meter and any other materials that may come into contact with sampled media will be decontaminated as follows:

- Flush equipment/pump with potable water;
- Flush with non-phosphate detergent solution (e.g., Liquinox);
- Flush with potable water; and,
- Final flush with distilled/deionized water.

### 5.2.7 Sample Containers, Preservation, and Handling/ Shipment

#### 5.2.7.1 Sample Containers and Preservation

Sample containers and the required types and volumes of preservatives for each of the required analytes shall be supplied by the laboratory prior to sample activities. Anticipated container types, preservation requirements, methods, and hold times are detailed in **Table 4**.

Temperature preservation will consist of cooling the samples with ice immediately following collection to <4°C. Once received by the laboratory, the samples will be maintained at 4°C as required, until the samples are analyzed.

**Table 4. Sample Containers, Preservation, and Hold Times***

| Combined Constituent List | Method | Amount Needed | Preservative | Holding times |
|---|---|---|---|---|
| Antimony | 6020 | Total (1 L) | HNO3 | 180 days from collection |
| Arsenic | 6020 | Total (1 L) | HNO3 | 180 days from collection |
| Barium | 6020 | Total (1 L) | HNO3 | 180 days from collection |
| Beryllium | 6020 | Total (1 L) | HNO3 | 180 days from collection |
| Boron | 6010 | Total (1 L) | HNO3 | 180 days from collection |
| Cadmium | 6020 | Total (1 L) | HNO3 | 180 days from collection |
| Calcium | 6010 | Total (1 L) | HNO3 | 180 days from collection |
| Chloride | 9056 | Total (1 L) Poly | Cool to 4°C | 28 days |
| Hexavalent Chromium | 7195 | 125 mL | Cool to ≤ 6°C | 24-hour |
| Chromium | 6020 | Total (1 L) | HNO3 | 180 days from collection |
| Cobalt | 6020 | Total (1 L) | HNO3 | 180 days from collection |
| Copper | 6020 | Total (1 L) | HNO3 | 180 days from collection |
| Cyanide | 9012B | 500 mL Poly | NaOH to pH>12 | 14 days |
| Fluoride | 9056 | Total (1 L) Poly | None | TBD |
| Lead | 6020 | Total (1 L) | HNO3 | 180 days from collection |
| Lithium | 6010 | Total (1 L) | HNO3 | 180 days from collection |
| Mercury | 7470 | Total (1 L) | HNO3 | 28 days for mercury |
| Nickel | 6020 | Total (1 L) | HNO3 | 180 days from collection |
| Molybdenum | 6020 | Total (1 L) | HNO3 | 180 days from collection |
| pH | 9040 | 125 mL | None | Analyze immediately |
| Radium 226/228 | 9315/9320 | Total (1 L) Poly | N HNO3 | 16 Hours |
| Selenium | 6020 | Total (1 L) | HNO3 | 180 days from collection |
| Silver | 6020 | Total (1 L) | HNO3 | 180 days from collection |
| Sulfate | 9056A | Total (1 L) Poly | Cool to 4°C | 28 days |
| Sulfide | 9034 | 500 mL Poly | Cool to 4°C | Analyze immediately |
| Total Dissolved Solids | 2540 C | 1 L Poly | None | TBD |
| Thallium | 6020 | Total (1 L) | HNO3 | 180 days from collection |

| Combined Constituent List | Method | Amount Needed | Preservative | Holding times |
|---|---|---|---|---|
| Tin | 6020 | Total (1 L) | HNO3 | 180 days from collection |
| Vanadium | 6020 | Total (1 L) | HNO3 | 180 days from collection |
| Zinc | 6020 | Total (1 L) | HNO3 | 180 days from collection |

**Notes:**
*The data in this table shall be validated by the analyzing lab prior to initiation of field work
mL – milliliter
HNO3 – nitric acid
NaOH – Sodium Hydroxide
TBD – to be determined (by the lab prior to sampling)
L – liter
H2SO4 – sulfuric acid
°C – Celsius

#### 5.2.7.2 Chain-of-Custody Record

Chain-of-custody forms will be used to document the integrity of all samples. To maintain a record of sample collection, transfer of samples between personnel, shipment of samples, and receipt of samples at the laboratory, chain-of-custody forms will be filled out for each sample/analysis at each sampling location. The chain-of-custody forms shall include the following information:

- Project name and project number if applicable;
- Name and address of laboratory to receive the samples;
- Chain-of-custody control number;
- Sample type and sample method;
- Location ID and/or sample ID;
- Matrix code;
- Analyses requested;
- Field QC for matrix spike (MS)/matrix spike duplicate (MSD) samples, if applicable;
- Container type, size and number;
- Preservatives used;
- Turn-around-time for laboratory analysis; and,
- Comments to Laboratory or sample collector, if applicable.

The sample collector will enter the following information using indelible black or blue ink:

- Sampler's initials;
- Date of collection;
- Time of collection (24-hour format);
- Depths, if applicable;
- Pump/equipment number, if applicable; and,
- Void reason, if applicable.

The sample collector shall verify the chain-of-custody record is complete, accurate in all aspects, and consistent with all other sample documentation (e.g., number of samples, sample labels, field logs). The sample collector will sign the "Sampled By" and "Relinquished By" fields on the chain-of-custody record, marking the date and time custody is transferred to the sample shipper or other authorized person.

The sample shipper will perform the following duties:

- Obtain the signature of the sample collector to transfer sample custody;
- Record the carrier service and air bill number on the chain-of-custody;
- Sign and enter the date and time relinquished to the shipper; and,
- Prepare the samples for shipment from the field to the laboratory.

The sample shipper or sample custodian will sign the "Received By" box, marking the date and time of receipt of the samples from the sample collector or other sample custodian. Every transfer of physical custody shall be documented on the chain-of-custody record.

Any corrections to the chain-of-custody form entries will be made by a single-line strike mark through the incorrect item, and then entering the correct entry adjacent to the strikeout item. Corrections will be initialed and dated by the person making the change. After the form has been inspected and determined to be complete, the sample shipper will sign, date, and note the time of transfer and will reference a shipper tracking number on the form. The chain of custody form will be placed in a Ziploc plastic bag and placed inside the cooler after the sample packer has detached or made an appropriate copy of the form. Field copies of the completed chain of custody forms will be maintained in project files.

#### 5.2.7.3 Sample Chain of Custody Control

Sample custody procedures are designed to ensure that sample integrity is maintained from collection to final disposition. A critical aspect of sound sample collection and analysis protocols is the maintenance of strict chain-of-custody procedures as described in this technical procedure. Chain-of-custody procedures include tracking and documentation during sample collection, shipment, and laboratory processing. A sample is considered to be in an individual's custody if it is:

(1) In the physical possession of the responsible party;
(2) In view of the responsible party after being in their possession
(3) Secured to prevent tampering; or,
(4) Placed in a designated, secure area that is controlled and restricted by the responsible party.

Custody will be documented throughout all sampling activities on the chain-of-custody record for each day of sampling. This record will accompany the samples from the site to the laboratory. All personnel with sample custody are required to sign, date, and note on the record the time when receiving and relinquishing samples from their immediate custody. Any discrepancies will be noted at this time. Samples will be shipped to subcontractor laboratories via overnight air courier. Bills of lading will be used as custody documentation during this time and will be retained as part of the permanent sample custody documentation. In some cases, samples may be hand delivered to the laboratory; hand delivery will be noted on the chain-of-custody form. The subcontractor laboratory is responsible for sample custody once samples are received.

#### 5.2.7.4 Sample Labels

A label will be attached to all sample containers at the time of sample collection. The label will contain the following information:

- Site name;
- Well number;
- Sample collection date and time;
- Sampler's initials;
- Parameters to be analyzed;
- Whether the sample was filtered; and,
- Type of preservative, if any.

Labels will be attached to sample containers securely to ensure the label does not become detached during transport. The information above must be legible and written with an indelible pen.

#### 5.2.7.5 Sample Packing and Shipping

The instructions contained in this section are to be used by field personnel when collecting and handling samples for packing and shipping. On the occasion that field personnel determine that any of the instructions described in this section are inappropriate, inadequate or impractical and that another procedure must be used, the variance must be documented in the field log book, along with a description of the circumstances requiring its use. At a minimum, the following items are necessary to complete the actions required by this section:

- Indelible black-ink pens;
- Field logbook;
- Ziploc® bags;
- Sample containers;
- Coolers;
- Blue Ice® (or equivalent);
- Strapping tape or duct tape;
- Bubble wrap;
- Garbage bags;
- Sample labels;
- Chain-of-custody forms; and,
- Custody seals.

- Custody seals will be placed on each individual sample as well as in a configuration to provide evidence if the cooler being used to transport the shipment was tampered with.

### 5.2.8 Laboratory Analytical Procedures

#### 5.2.8.1 Analytical Methods

Samples will be analyzed by a Virginia Environmental Laboratory Accreditation Program (VELAP) accredited lab, using the following SW-846 methods defined in **Table 5**, or other SW-846 approved methods appropriate for the specific constituents.

**Table 5. Analytical Methods**

| Combined Constituent List | Chemical Abstracts Service (CAS)-RN from 9VAC20-81-250 | Method SOP |
|---|---|---|
| Antimony | Total | 6020 |
| Arsenic | Total | 6020 |
| Barium | Total | 6020 |
| Beryllium | Total | 6020 |
| Boron | | 6010 |
| Cadmium | Total | 6020 |
| Calcium | | 6010 |
| Chloride | | 9056 |
| Chromium | Total | 6020 |
| Chromium | Hexavalent | 7195 |
| Cobalt | Total | 6020 |
| Copper | Total | 6020 |
| Cyanide | 57-12-5 | 9012B |
| Fluoride | | 9056 |
| Lead | Total | 6020 |
| Lithium | | 6010 |
| Mercury | Total | 7470 |
| Nickel | Total | 6020 |
| Molybdenum | | 6020 |
| pH | | 9040 |
| Radium 226/228 | | 9315/9320 |
| Selenium | Total | 6020 |
| Silver | | 6020 |
| Sulfate | | 9056A |
| Sulfide | 18496-25-8 | 9034 |
| Total Dissolved Solids (TDS) | | 2540C |
| Thallium | Total | 6020 |
| Tin | Total | 6020 |
| Vanadium | Total | 6020 |
| Zinc | Total | 6020 |

#### 5.2.8.2 Laboratory Quality Assurance/Quality Control

Laboratory QA/QC procedures consist of those specified in SW-846 "*Test Methods for Evaluating Solid Waste*", 3rd Edition, Section 4.4 (Laboratory QA/QC Procedures) as well as the QA/QC requirements specified in the individual test procedures. Laboratory QC measures are specified by the test method and may include reagent blanks, MS/MSDs, calibration blanks, calibration standards, and laboratory control standards. Although matrix interference and equipment/instrument malfunctions are potential sources of error, analytical interferences are not anticipated.

#### 5.2.9 Evaluating Groundwater Quality Data

##### 5.2.9.1 Reporting of Low and Zero Values

Most extremely low concentrations are reported as being less than the reporting limit of the analytical procedure. These numbers cannot be used in statistical testing to determine if a statistically significant difference is present. To complete statistical analyses, the laboratory results must be assigned a value. For data where the percentage of data below the laboratory limit of detection or laboratory limit of quantitation is less than 25 percent, the non-detects or non-quantified values will be replaced with half the laboratory limit of detection or quantitation. When the percentage of non-detects or non-quantified values is greater than 25 percent and less than 50 percent, the mean and standard deviation will be adjusted using either Aitchison's adjustment or Cohen's adjustment. When the percentage of non-detects or non-quantified values is greater than 50%, a non-parametric statistical test method will be applied.

##### 5.2.9.2 Missing Data Values

If missing data values are identified before the end of the compliance period, a resample will be collected. Missing data values that are identified after the end of the compliance period will be treated as data that does not exist. No actual value will be assigned to these missing data values and; therefore, the total number of data points will be reduced due to missing data. Missing data will be reported in the evaluation report.

##### 5.2.9.3 Outliers

When an outlier is identified in the background dataset, a review of the result will be conducted. If an outlier is identified before the end of the compliance period, verification sampling will be conducted within the compliance period to identify if the result is in error. Errors that are identified will be excluded from the dataset to preserve the power of the test to detect an actual release from the facility, and statistical analysis will be performed without outliers that are identified from the background dataset. If verification sampling confirms the initial sample, the results will be reported. Results, reviews, and actions taken regarding outliers will be reported to VADEQ.

##### 5.2.9.4 Verification Sampling

If a statistically significant difference is discovered in a downgradient groundwater monitoring well prior to the end of the "30 day statistically significant increases determination period" (9VAC20-81-250-A.4i), repeated independent verification samples may be analyzed for the affected parameter in the specified downgradient well within the compliance period. Undertaking verification sampling will not alter the timeframes associated with determining or reporting a statistically significant increase as defined under subdivision A.4.h(2), B2, C2 or 3 of 9VAC20-81-250.

#### 5.2.9.5 Data Validation

AEP may at any time within the 30-day statistically significant increases determination period defined under subdivision A 4 h (2) of this subsection, undertake third-party data validation of the analytical data received from the laboratory. Undertaking such validation efforts is a voluntary action on the part of the owner or operator and shall not alter the timeframes associated with determining or reporting a statistically significant increase as otherwise defined under subdivision A 4 h (2), B 2 or 3, or C 2 or 3 of this section.

#### 5.2.9.6 Statistical Tests

The statistical analysis of groundwater data will be based upon a determination of whether a single parameter datum from a downgradient monitoring well for a specific sampling period shows a statistically significant difference from data collected from applicable background wells. A single parameter datum is defined as:

- The numerical concentration of a substance determined from a single groundwater sample obtained from a monitoring well during a single sampling event; or,
- The average of the concentrations of a substance determined from a number of dependent groundwater samples obtained from a monitoring well during a single sampling event.

Interval statistical testing is a robust examination in comparing one single datum from a specific sampling period to a group of independent data. Interwell testing (e.g., prediction limits, tolerance limits, or a combination of the two for verification purposes) will be utilized unless another statistical test method is determined to be more appropriate. In addition, outlier testing, distribution determinations, and non-detect adjustments (Aitchison's or Cohen's adjustments) will be utilized as appropriate. The Shapiro-Wilk test will be used to evaluate the normality of the background data sets equal to or less than 50 and the Shapiro-Francia Test for data greater than 50. If an alternative statistical method other than the Shapiro-Wilk or the Shapiro-Francia test is utilized, it must demonstrated that the other method has similar power to detect deviations from the normal distribution as the above tests. The statistical test methods employed will comply with the pertinent performance standards shown in 9VAC20-81-250 of the Virginia Solid Waste Management Regulations (VSWMRs).

Statistical interval methods (prediction or tolerance) will be applied for groundwater data. For all interval methods, the normality or log normality of the background dataset will be checked and the percentage of non-detects in the background dataset. If the background dataset is normally or log-normally distributed, and there are less than 50% non-detects, then a parametric interval will be calculated. If a distribution cannot be established for the background dataset or 50% or more of the data are non-detects, a non-parametric statistical limit will be calculated. Prediction interval or tolerance interval parameter values will include an alpha value no less than 0.01 and the coverage for tolerance intervals will not be greater than 95%, unless it is demonstrated that a lower false positive rate (or higher coverage for tolerance intervals) will provide at least 50% power to detect a 3 standard deviation increase above background levels and 80% power to detect a 4 standard deviation increase above background levels for an individual constituent/well comparison. If a statistical comparison of mean/median constituent concentrations in background to mean/median constituent concentrations in the downgradient wells is applied during the compliance period, a minimum of four independent samples will be collected from compliance wells during the compliance period.

#### 5.2.9.7 Comparison with Subsequent Well Data

Based on data distributions and the presence of non-detect values for each well/analyte combination, statistically appropriate inter well testing (e.g., prediction limits, tolerance limits) will be utilized unless another statistical test method is determined to be more appropriate.

#### 5.2.9.8 Comparison with Groundwater Protection Standards

Initially, a value-to-value comparison of all groundwater monitoring data to GWPSs will be conducted. If a GWPS exceedance is noted during the value-to-value comparison for a parameter(s), a verification sample may be collected and results from the verification sample will be compared to the GWPS in a value-to-value comparison as long as the comparison is completed within 30 days of the initial sampling event. If the GPS is derived from a MCL, three additional independent groundwater samples for the suspect constituent(s) may be collected in order to perform a statistical comparison to GWPSs. A lower normal confidence limit will be calculated to compare the results to the standard. An 80% level of confidence of the interval will be used for a sample size of 4-7 and 90% for a sample size of 8-10.

#### 5.2.9.9 Required Response Actions

If analyses of the background monitoring well data shows a statistically significant increase (or decrease in the case of pH) the result will be reported in the semi-annual/annual groundwater monitoring report as required.

If the downgradient monitoring well data shows a statistically significant increase (or decrease in the case of pH), as a result of statistical analyses, but does not exceed any groundwater protection standard, then the result will be reported in the semi-annual and annual groundwater monitoring reports. (Note that the groundwater protection standards are defined below in section 5.2.9.10).

If the downgradient monitoring well data show a statistically significant increase (or decrease in the case of pH), that exceeds the groundwater protection standard, then the agency will be notified within 14 days of the exceedance. Verification sampling will occur within the 30-day statistically significant increases determination period in accordance with 9VAC20-81-250.A.4.i. If verification sampling verifies the presence of a statistically significant increase, Alternate Source Demonstration may be conducted to identify an alternate source area that may be contributing to statistically significant increases. The Alternate Source Demonstration must be conducted within 90 days of noting a statistically significant increase and in accordance with 9VAC20-81-250.A.5. If an alternate source cannot be demonstrated, then corrective actions will be conducted in accordance with 9VAC20-81-260.

#### 5.2.9.10 Groundwater Protection Standards

Virginia Administrative Code 9VAC20-81-250.A.6 (Establishment of groundwater protection standards) states that upon recognition of a statistically significant increase over background and while monitoring in the assessment or Phase II monitoring programs defined under 9VAC20-81-250 subdivision B3 or C3, the owner or operator shall propose a groundwater protection standard for all detected constituents. **Table 6** (State of Virginia Regulatory Values) below provides the Groundwater Protection Standards (GWPS) that shall be used to assess groundwater compliance for this site. USEPA MCLs are included as well in this table for information and to provide reference for the defined values. In instances where a site specific background concentration is greater than the MCL associated with that constituent under 9VAC20-81-250.A.6b(1), the background value may be substituted for use as the groundwater protection standard in lieu of the MCL upon receiving written department approval for that constituent.

In instances where the regulatory values are defined by background values (BKG) in the table below, approved background wells will be utilized to determine applicable concentrations. Groundwater monitoring data will be compared with the background values that are derived from the analyses of data from the background well which is installed in the same bedrock unit as the monitoring well being evaluated. For this site, there will be background GWPSs defined for wells installed within the Rome Formation as well as separate GWPSs for wells installed within the Chattanooga Formation and along the Dumps Fault. This separation of wells installed in different bedrock units, will prevent potential false positives that may be attributable only to groundwater interactions with varying bedrock geochemistry and not from other Pond related inputs.

Regulatory values which are defined with a numerical value (as shown in the "CCR Groundwater Protection Standards" column from **Table 6** below, shall be evaluated against that defined regulatory value only. Statistical variation will not be used to define exceedances.

**Table 6. State of Virginia Regulatory Values**

| Combined Constituent List | USEPA Maximum Contaminant Levels | CCR related Groundwater Protection Standards |
|---|---|---|
| **Antimony** | 6ppb | 6ppb |
| **Arsenic** | 10ppb | 10ppb |
| **Barium** | 2,000ppb | 2,000ppb |
| **Beryllium** | 4ppb | 4ppb |
| **Boron** | | BKG |
| **Cadmium** | 5ppb | 5ppb |
| **Calcium** | | n/a |
| **Chloride** | | n/a |
| **Chromium (Total)** | 100ppb | 100ppb |
| **Cobalt** | | BKG |
| **Copper** | 1,300ppb | 1,300ppb |
| **Cyanide** | 200ppb | 200ppb |
| **Fluoride** | 4,000ppb | 4,000ppb |
| **Lead** | 15ppb | 15ppb |
| **Lithium** | | BKG |
| **Mercury** | 2ppb | 2ppb |
| **Nickel** | | BKG |
| **Molybdenum** | | BKG |
| **pH** | | n/a |
| **Radium 226/228** | 5pCi/L | 5pCi/L |
| **Selenium** | 50ppb | 50ppb |

| Combined Constituent List | USEPA Maximum Contaminant Levels | CCR related Groundwater Protection Standards |
|---|---|---|
| **Silver** | | BKG |
| **Sulfate** | | n/a |
| **Sulfide** | | BKG |
| **Total Dissolved Solids** | | n/a |
| **Thallium** | 2ppb | 2ppb |
| **Tin** | | BKG |
| **Vanadium** | | BKG |
| **Zinc** | | BKG |

**Notes:**
n/a – not applicable. Constituents will be compared to background and used as indicator parameters.

#### 5.2.10 Sampling Records and Reports

Records pertaining to groundwater monitoring (sampling) activities shall be retained at the Plant throughout the post-closure care period of Pond 2 and shall include at a minimum:

- Groundwater surface elevation data obtained from wells installed;
- Cross-sections depicting revised site geology knowledge based upon additional soil boring advancement and logging at the site.
- Laboratory analytical results for groundwater sampling events required under the groundwater monitoring programs;
- Records of well installation, repair, or abandonment actions;
- Department correspondence etc.; and,
- Approved variances, well subsets, wetlands, or other such director/department approvals.

Copies of actual laboratory data sheets and chain-of-custody forms and original field log notes shall remain on file at the Clinch River Plant throughout the post-closure period. Records may be transferred to another location in the event that the Clinch River Plant would close and groundwater sampling and analysis would continue during the post-closure period.

Reports documenting groundwater monitoring activities will include:

- An Annual Groundwater Monitoring Report that will be submitted to VADEQ no later than 120 days from the completion of sampling and analysis conducted. The report will be accompanied by the specified items listed in 9 VAC 20-81-250.E.2.a.
- A semi-annual sampling report will be submitted to VADEQ no later than 120 days from the completion of sampling and analysis. The report will be accompanied by the specified items listed in 9 VAC 20-81-250.E.2.b.
- All other reporting and recordkeeping will be performed in accordance with the regulations.

All reports listed above will include, but not limited to, a summary of field activities conducted at the site, field logs, analytical reports, and revised cross-sections.

#### 5.2.11 Groundwater Elevation Evaluation

In conjunction with each sampling event, the groundwater elevation data will be evaluated to determine the direction and rate of groundwater flow. This information will be reported with the groundwater annual report. If a well is determined to no longer function, based upon the results of this evaluation, proposed actions to rectify the situation will be presented to VDEQ. The proposed actions will be implemented prior to next regularly scheduled groundwater sampling event and they will fulfill the regulatory requirements of the groundwater monitoring system.

#### 5.2.12 Groundwater Monitoring Plan Revisions

Should revisions to the groundwater monitoring plan be required, due to changes in the monitoring well network, sampling actions, revisions to the Virginia Solid Waste Management Regulations (VSWMR) or at the request of the permittee, revisions will be submitted in accordance with 9VAC20-81-600 Modification of Permits.

## 6.0 REFERENCES

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United States Environmental Protection Agency (USEPA), 40 Code of Federal Regulations (CFR) §257 Subpart D: Standards *for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments*.

Virginia Tourisim Corporation. (2016). *Virginia climate*. Retrieved from Official Tourism Website of the Commonwealth of Virginia: http://www.virginia.org/Climate/.

Virginia Administrative Code (VAC), Title 9: *Environment*, Agency 20: *Virginia Waste Management Board*, Chapter 81: *Solid Waste Management Regulations*, Section 250: *Groundwater Monitoring Program* (9VAC20-81-250).

Virginia Administrative Code (VAC), Title 9: *Environment*, Agency 20: *Virginia Waste Management Board*, Chapter 81: *Solid Waste Management* Regulations, Section 800: Part VIII Requirements for the Management of Coal Combustion Residuals (9VAC20-81-800).

**Figures**

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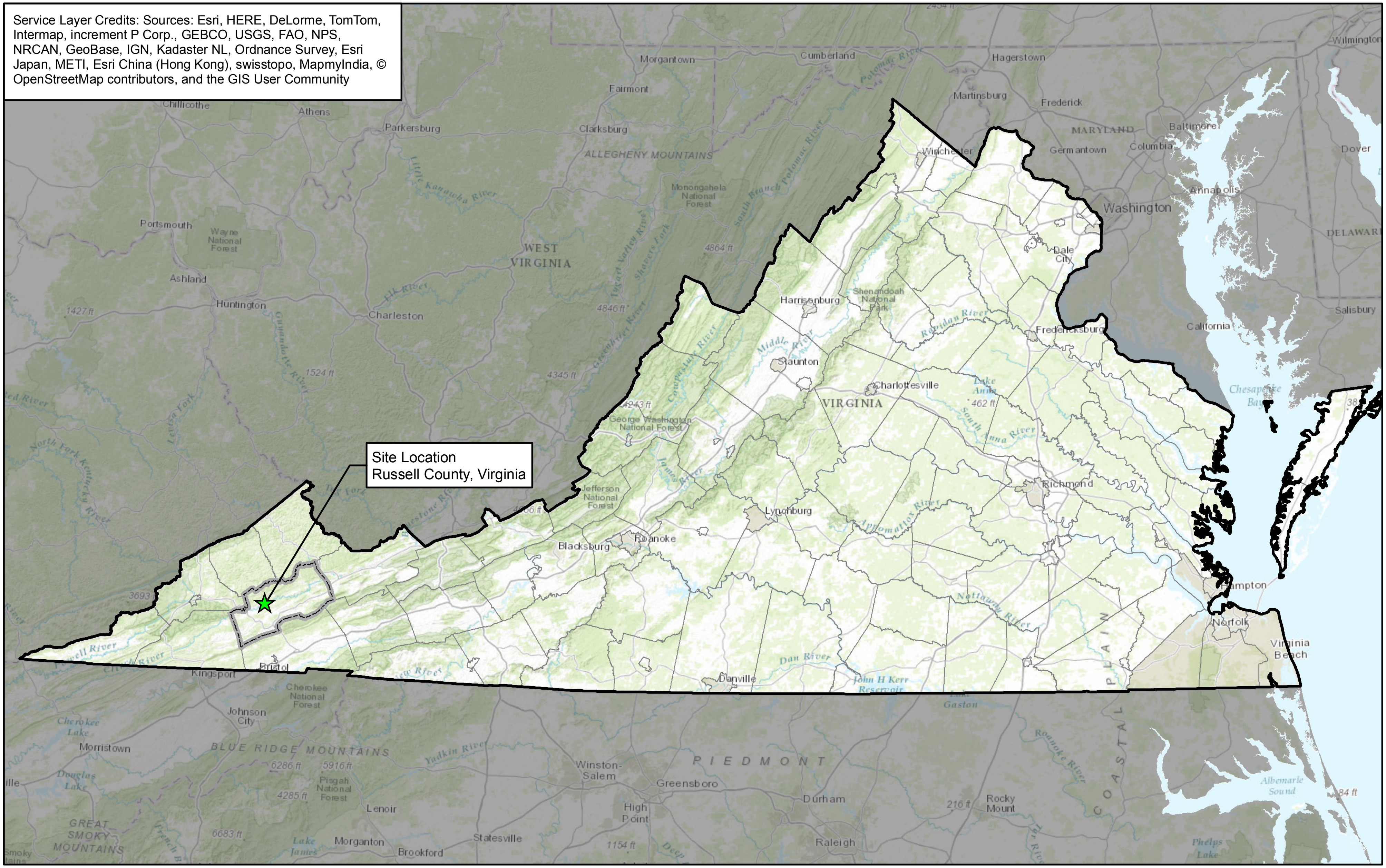



| SYMBOL KEY |
|---|
| ★ Site Location |

AMERICAN ELECTRIC POWER

amec foster wheeler

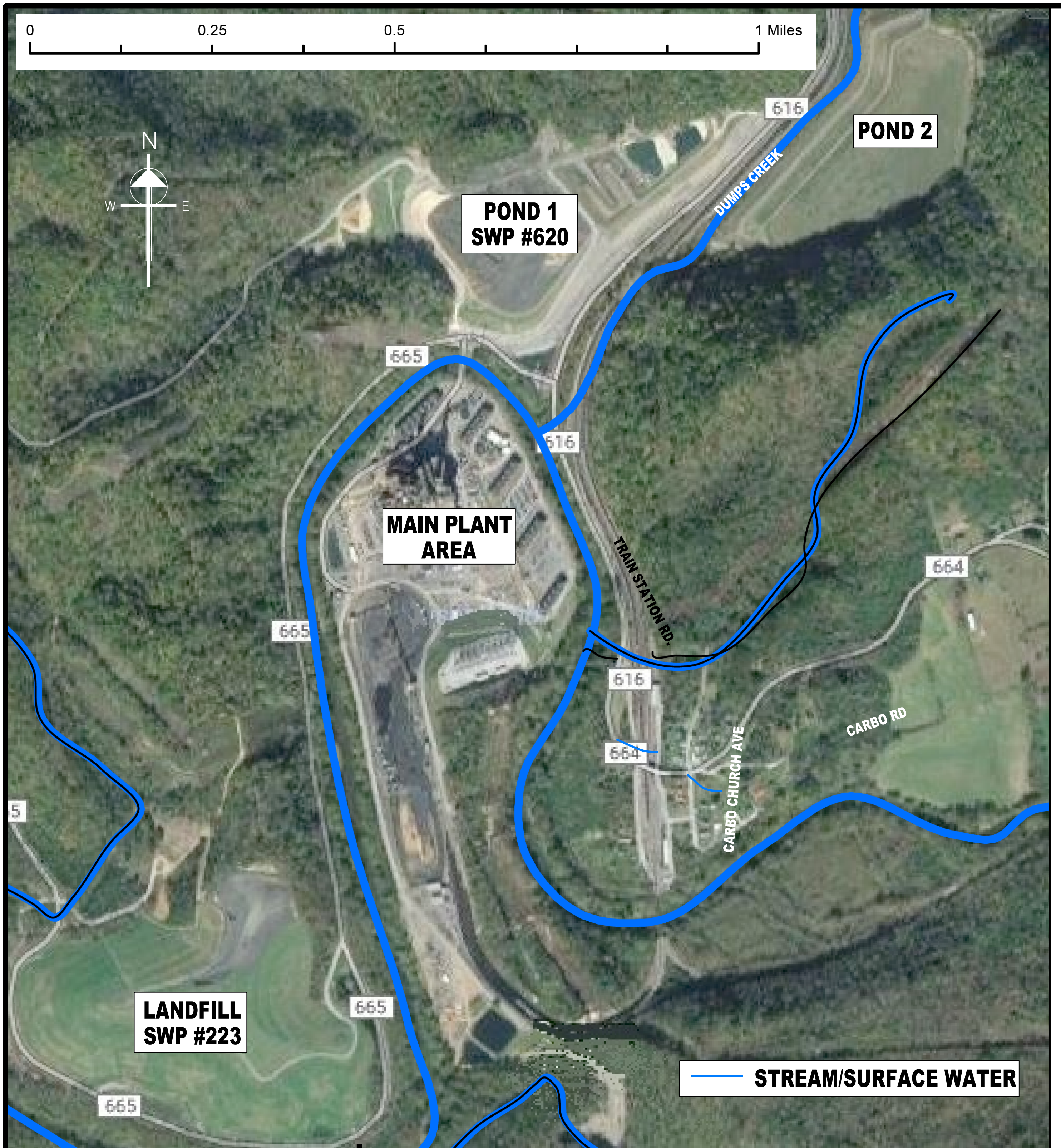
N

**FIGURE 1**
**Site Location Map**
American Electric Power, Clinch River Plant
Carbo, Virginia

0 25 50 100 150 200 250 Kilometers

0 25 50 75 100 125 150 Miles

| 04/01/2016 | AEP_Carbo_Site_Location_Map_GWMP |
|---|---|
| PROJ: 3050150294 | Drawn: JBO |




REVISIONS

THIS DRAWING IS CLASSIFIED AS:

**AEP PUBLIC**

REFERENCE AEP's CORPORATE INFORMATION SECURITY POLICY

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APPALACHIAN POWER COMPANY

**CLINCH RIVER PLANT**

CARBO VIRGINIA

SITE LAYOUT MAP

UNIT:

DRAWING NUMBER: FIGURE 2

REV:

SCALE:

DR:

CH:

SUP:

ENG:

DATE:

APPROVED BY

AMERICAN ELECTRIC POWER

*AEP SERVICE CORP.*
*1 RIVERSIDE PLAZA*
*COLUMBUS, OH 43215*

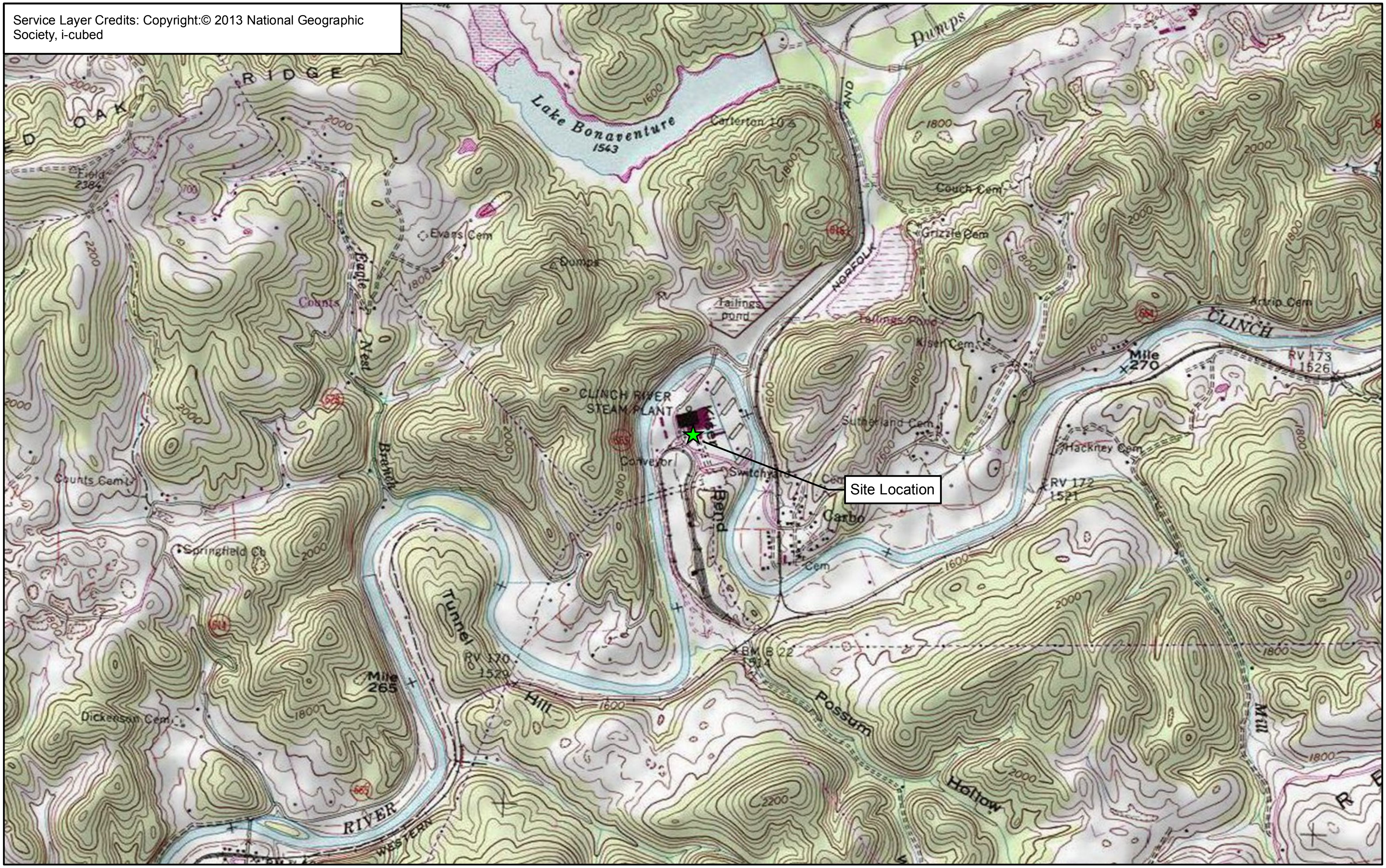
BY: s145543

PLOT TIME: 1:47:46 PM

PLOT DATE: 8/17/2017

CROSS REFS:

A (8.5"x11")




**SYMBOL KEY**

★ Site Location

AEP AMERICAN ELECTRIC POWER

amec foster wheeler

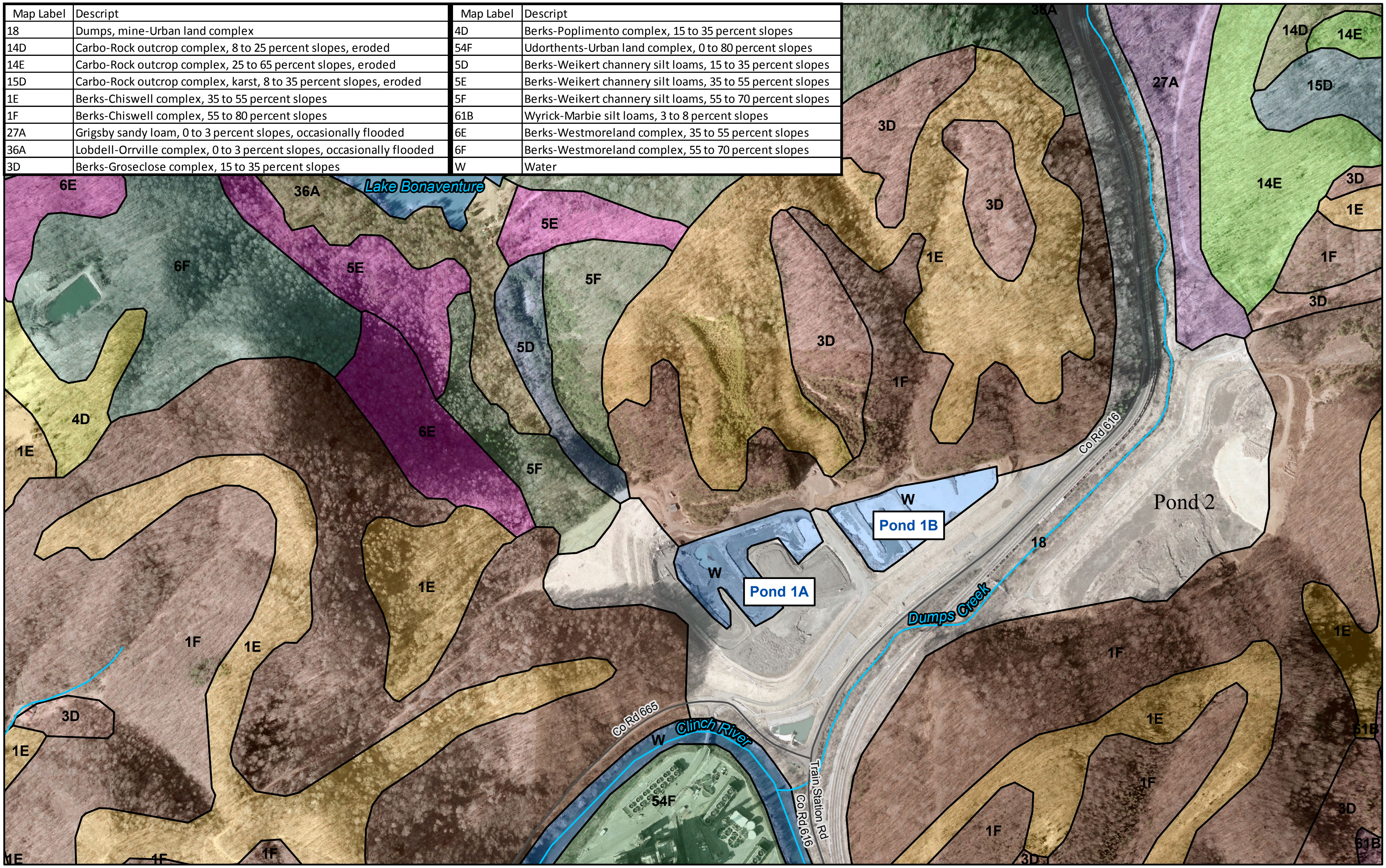
N

Scale: 0, 250, 500, 1,000, 1,500, 2,000, 2,500 Meters; 0, 2,000, 4,000, 6,000, 8,000 Feet

**FIGURE 4**
**Topographic Map**
American Electric Power, Clinch River Plant
Carbo, Virginia

| | |
|---|---|
| 04/01/2016 | AEP_Carbo_Topographic_Map_GWMP |
| PROJ: 3050150293 | Drawn: JBO |

| Map Label | Descript | Map Label | Descript |
|---|---|---|---|
| 18 | Dumps, mine-Urban land complex | 4D | Berks-Poplimento complex, 15 to 35 percent slopes |
| 14D | Carbo-Rock outcrop complex, 8 to 25 percent slopes, eroded | 54F | Udorthents-Urban land complex, 0 to 80 percent slopes |
| 14E | Carbo-Rock outcrop complex, 25 to 65 percent slopes, eroded | 5D | Berks-Weikert channery silt loams, 15 to 35 percent slopes |
| 15D | Carbo-Rock outcrop complex, karst, 8 to 35 percent slopes, eroded | 5E | Berks-Weikert channery silt loams, 35 to 55 percent slopes |
| 1E | Berks-Chiswell complex, 35 to 55 percent slopes | 5F | Berks-Weikert channery silt loams, 55 to 70 percent slopes |
| 1F | Berks-Chiswell complex, 55 to 80 percent slopes | 61B | Wyrick-Marbie silt loams, 3 to 8 percent slopes |
| 27A | Grigsby sandy loam, 0 to 3 percent slopes, occasionally flooded | 6E | Berks-Westmoreland complex, 35 to 55 percent slopes |
| 36A | Lobdell-Orrville complex, 0 to 3 percent slopes, occasionally flooded | 6F | Berks-Westmoreland complex, 55 to 70 percent slopes |
| 3D | Berks-Groseclose complex, 15 to 35 percent slopes | W | Water |




**SYMBOL KEY**

Road

Stream/Surface Water

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N

0 100 200 400 600 800 Meters

0 350 700 1,400 2,100 2,800 Feet

**FIGURE 5**
**Local Soil Survey Map**
American Electric Power, Clinch River Plant
Carbo, Virginia

| | |
|---|---|
| 04/01/2016 | AEP_Carbo_Soil_Survey_GWMP |
| PROJ: 3050150293 | Drawn: JBO |

DWG. NO. 13-30225-02-0


## SOIL BORING INFORMATION

| NUMBER | NORTHING | EASTING | ELEVATION |
|---|---|---|---|
| B-1 | 3521957.20 | 10404206.58 | 1558.36 |
| B-2 | 3522090.54 | 10404660.72 | 1559.62 |
| B-3 | 3522639.70 | 10404557.48 | 1534.06 |
| B-4 | 3522561.00 | 10404636.87 | 1560.27 |
| B-5 | 3522491.17 | 10404707.72 | 1555.65 |
| B-6 | 3522248.22 | 10405163.61 | 1566.69 |
| B-7 | 3522654.09 | 10405203.14 | 1578.33 |
| B-8 | 3523040.68 | 10405041.75 | 1556.37 |

## PIEZOMETER INFORMATION

| NUMBER | NORTHING | EASTING | ELEVATION |
|---|---|---|---|
| U-1 | 3523088.08 | 10404928.48 | 1562.77 |
| U-2 | 3522800.00 | 10404841.59 | 1561.97 |
| U-3 | 3522379.56 | 10404451.15 | 1563.26 |
| U-4 | 3522061.74 | 10404145.45 | 1562.96 |
| L5 | 3522103.82 | 10404089.43 | 1534.30 |
| L7 | 3522848.82 | 10404735.63 | 1537.44 |
| L8 | 3523172.89 | 10404878.74 | 1536.18 |

NOTE: COORDINATE INFORMATION SHOWN IS BASED ON FIELD SURVEY BY D.R. PRICE ENGINEERING & LAND SURVEYING INC., PC ON AUGUST 14 AND 15, 2008.

NOTE: EXISTING TOPOGRAPHY SHOWN IS FROM AERIAL FLYOVER BY AERO-METRIC ON MARCH 6, 2006 AND UPDATED ON MAY 3, 2010.

## LEGEND

- BORING PERFORMED BY AEP JULY-AUGUST 2008
- EXISTING PIEZOMETER
- EXISTING CATCH BASIN
- WATER
- PIPE FLOW DIRECTION
- TREE LINE
- RR TRACKS
- ACCESS ROAD
- UTILITY POLE
- EXISTING CONTOURS (2-Ft. INTERVAL)

COMMONWEALTH OF VIRGINIA
MICHAEL G. ROWLAND
Lic. No. 49494
PROFESSIONAL ENGINEER
7/16/12

| | | | |
|---|---|---|---|
| PROJECT NUMBER: | 011-11497-044 | DRAWN BY: | EDV |
| DRAWING DATE: | 12/14/11 | ENGINEER: | AJS |
| LAST UPDATED: | 12/14/11 | APPROVED BY: | MGR |
| | | SCALE: | AS NOTED |

S&ME

| DATE | NO. | DESCRIPTION | APPD. |
|---|---|---|---|
| 7/16/12 | 0 | ISSUED FOR CONSTRUCTION | |
| 5/12/12 | C | REVISED PER AGENCY COMMENTS | |
| 4/27/12 | B | REVISED PER AGENCY COMMENTS | |
| 3/14/12 | A | ISSUED FOR PERMIT | |
| | | REVISIONS | |



APPALACHIAN POWER CO.

CLINCH RIVER PLANT

CARBO VIRGINIA

POND 2 CLOSURE

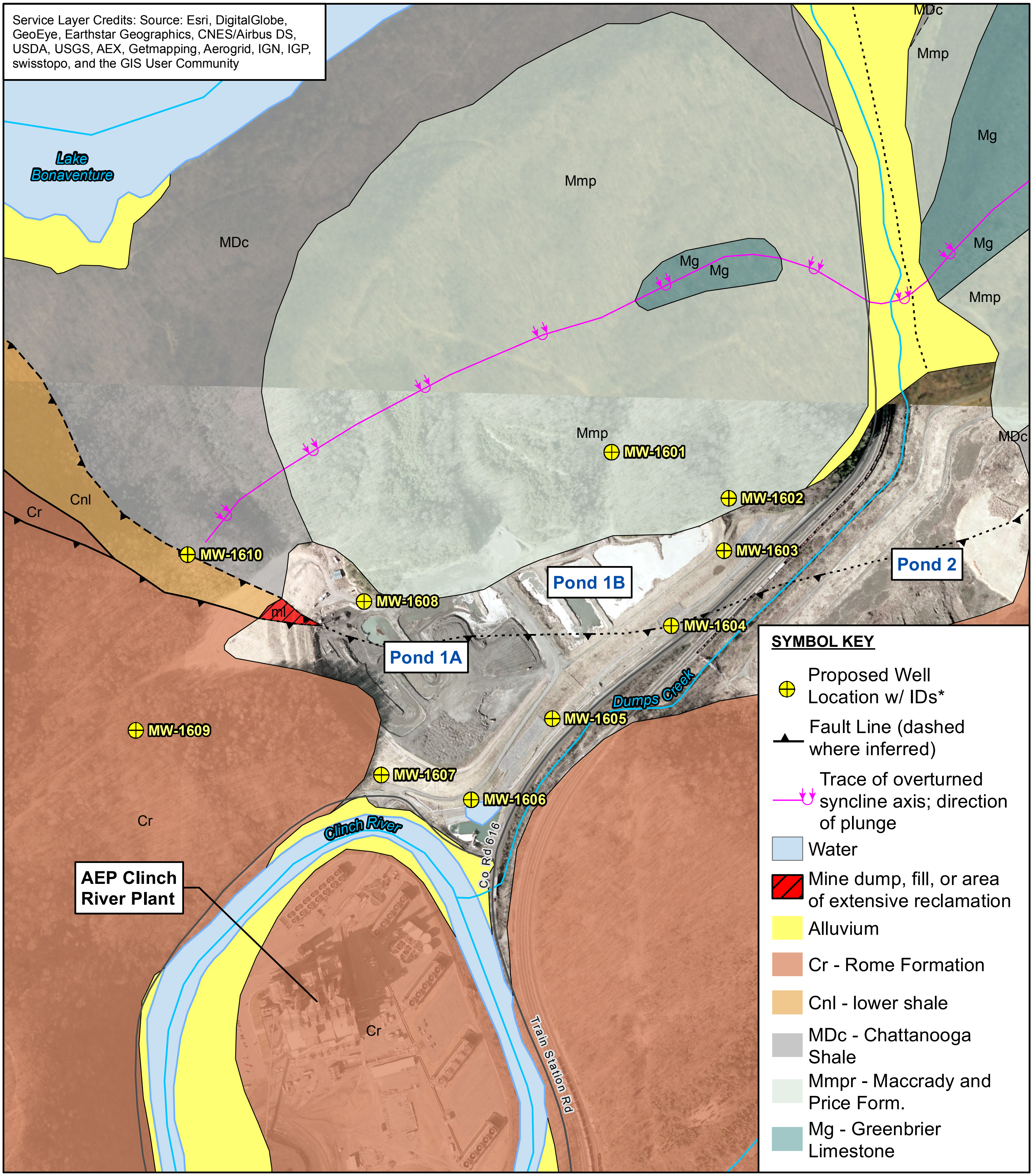
# EXISTING SITE CONDITIONS

DWG. NO. 13-30225-02-0

SCALE:
DR:
CH:
ENGR:
PROJ ENGR:
DATE:
APPROVED BY
CIVIL ENGINEERING

AEP AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215




AMERICAN ELECTRIC POWER

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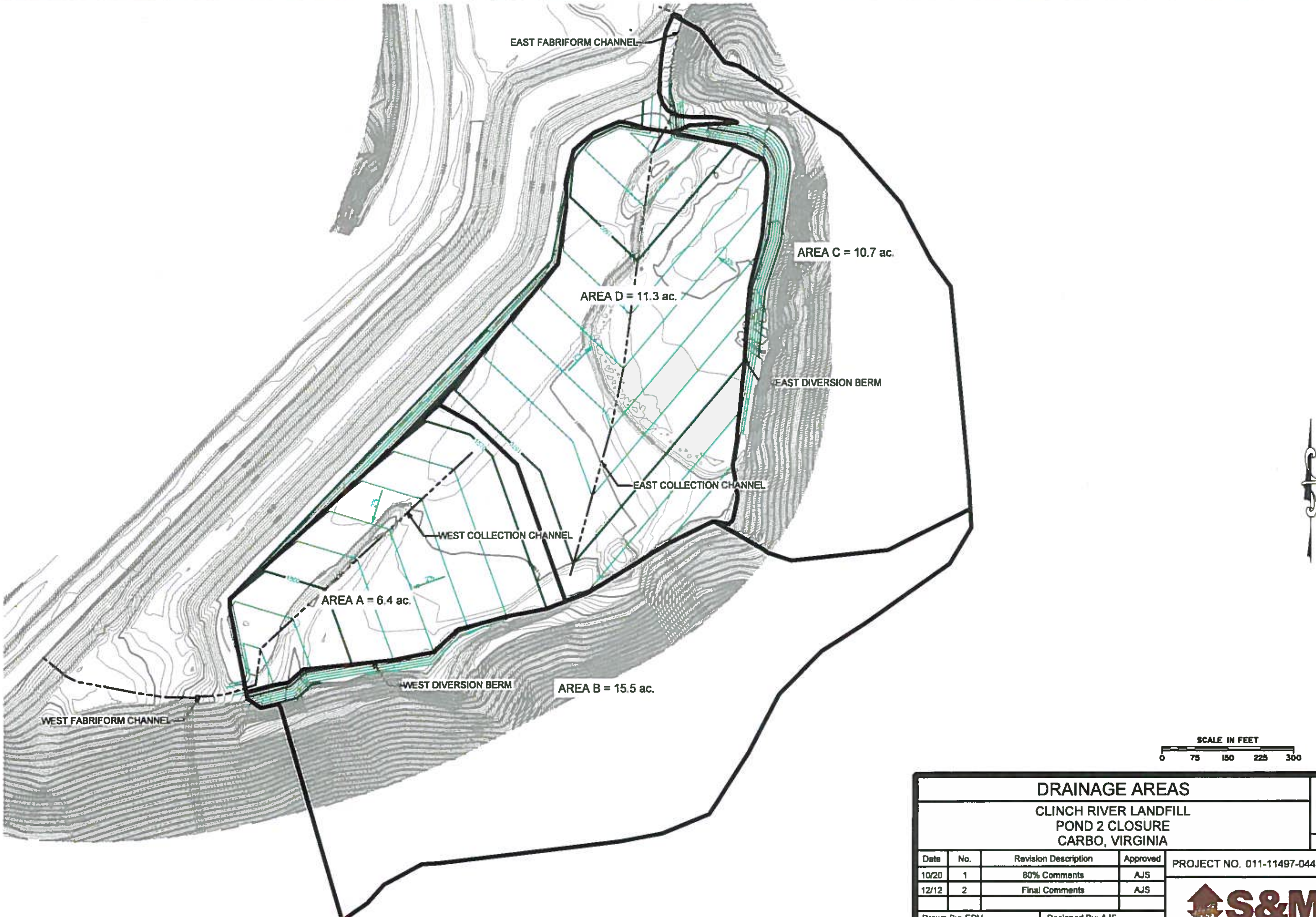
**FIGURE 6**
**Site Specific Geology Map**
American Electric Power, Clinch River Plant
Carbo, Virginia

| | |
|---|---|
| 08/01/2016 | AEP_Carbo_Prop_Sampling_March2016 |
| PROJ: 3050150293 | Drawn: JBO |




# DRAINAGE AREAS

CLINCH RIVER LANDFILL
POND 2 CLOSURE
CARBO, VIRGINIA

| Date | No. | Revision Description | Approved |
|---|---|---|---|
| 10/20 | 1 | 80% Comments | AJS |
| 12/12 | 2 | Final Comments | AJS |

Drawn By: EDV | Designed By: AJS
Approved By: MGR | Date: 9/12/08
Scale: 1" = 300'

PROJECT NO. 011-11497-044

S&ME
WWW.SMEINC.COM

FIGURE 8

13-GSK-CR-13-082817SH3

DRAWING NUMBER

N

W E

HORIZONTAL DATUM:NAD83 VIRGINIA SOUTH ZONE
VERTICAL DATUM: NGVD29


## GENERAL NOTES

1. DUMPS FAULT OUTLINE IS REFERENCED FROM APPENDIX B OF THE POND 2 CLOSURE PLAN GEOTECHNICAL ANALYSIS BY S&ME, INC.
2. 100 YEAR FLOOD STAGE REFERENCE FROM ANALYSIS BY AEP/GEOTECHNICAL DEPARTMENT.

## LEGEND

| Symbol | Description |
| --- | --- |
| x509.5 | SPOT ELEVATION |
| | INTERMEDIATE CONTOUR |
| 500 | INDEX CONTOUR |
| | DEPRESSION CONTOUR |
| | TREES AND TREELINE |
| | STRUCTURE AND BUILDING |
| — x — x — | FENCE |
| | POLE |
| | ROADS |
| | EDGE OF WATER |
| | MANHOLES / CATCH BASIN |
| | POWER POLE |
| | PIPES |
| | TOWER |
| | FAULT LINE |
| 1515 | 100 YEAR FLOOD STAGE (see note 2) |
| M-22 | PIEZOMETER OPOSED) |
| 1500 | CONTOUR LINE |
| | FLOW DIRECTION |

## LEGEND

POND 2 CLOSURE DRAWINGS

30225-14 SITE PLAN

30225-15 GROUNDWATER MONITORING PLAN WELL LOCATION MAP

30225-16 BEDROCK POTENTIOMETRIC MAP

| DATE | NO. | DESCRIPTION | APPD. |
| --- | --- | --- | --- |
| | A | STATIC WATER LEVELS FOR PIEZOMETERS ARE TAKEN FROM MAY, 2017. | |

**REVISIONS**

THIS DRAWING IS CLASSIFIED AS:

**AEP CONFIDENTIAL**

REFERENCE AEP's CORPORATE INFORMATION SECURITY POLICY



APPALACHIAN POWER COMPANY

**CLINCH RIVER PLANT**

CARBO VIRGINIA

SKETCH

**POND 2 CLOSURE**
**ALLUVIUM POTENTIOMETRIC MAP**

| UNIT: | DRAWING NUMBER: | REV: |
| --- | --- | --- |
| 13 | GSK-CR-13-082817SH3 | A |

SCALE: | CIVIL ENGINEERING
DR:
CH:
SUP:
ENG:
DATE: SEE REV 0
APPROVED BY

AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

PLOT DATE: 8/28/2017
PLOT TIME: 2:07:20 PM
BY: s145543

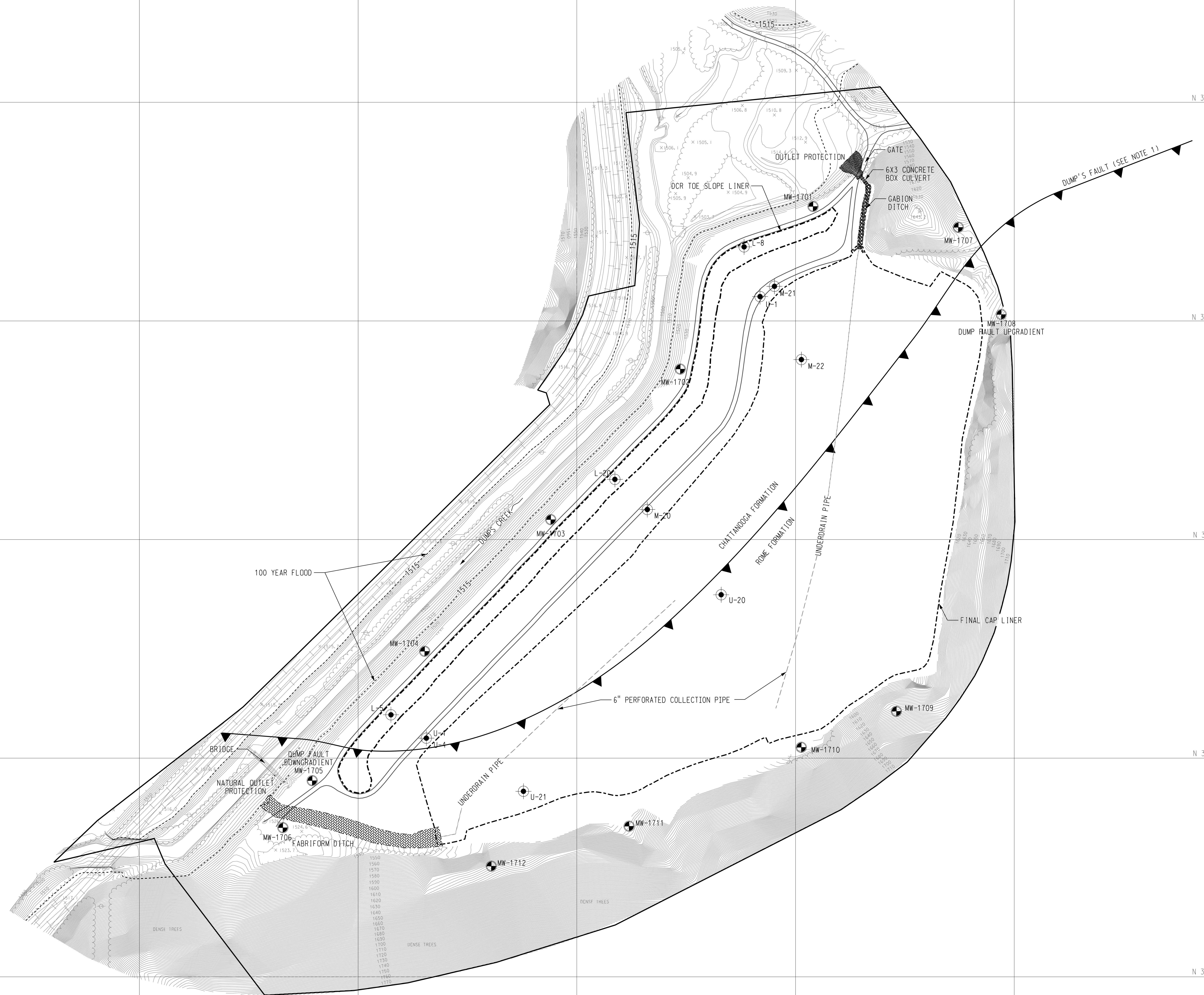
CROSS REFS:

FIGURE 8

13-GSK-CR-13-082817SH3

HORIZONTAL DATUM:NAD83 VIRGINIA SOUTH ZONE
VERTICAL DATUM: NGVD29

| WELL | EASTING | NORTHING |
|---|---|---|
| | Virginia South NAD83/29 | |
| L-8 | 10404882.43 | 3523169.39 |
| M-21 | 10404951.8 | 3523079.15 |
| U-1 | 10404918.81 | 3523055.73 |
| M-22 | 10405013.44 | 3522911.61 |
| L-20 | 10404587.07 | 3522637.68 |
| M-20 | 10404661.17 | 3522568.71 |
| U-20 | 10404830.03 | 3522373.78 |
| U-21 | 10404378.01 | 3521924.27 |
| L-5 | 10404075.09 | 3522099.18 |
| U-4 | 10404155.99 | 3522045.78 |
| MW-1701 | | |
| MW-1702 | | |
| MW-1703 | | |
| MW-1704 | | |
| MW-1705 | | |
| MW-1712 | | |
| MW-1710 | | |
| MW-1709 | | |
| MW-1706 | | |
| MW-1711 | | |
| MW-1708 | | |
| MW-1707 | | |




0 50 100 200 300
Scale: 1"=100'

## GENERAL NOTES

1. DUMPS FAULT OUTLINE IS REFERENCED FROM APPENDIX B OF THE POND 2 CLOSURE PLAN GEOTECHNICAL ANALYSIS BY S&ME, INC.
2. 100 YEAR FLOOD STAGE REFERENCE FROM ANALYSIS BY AEP/GEOTECHNICAL DEPARTMENT.

## LEGEND

- x509.5 SPOT ELEVATION
- INTERMEDIATE CONTOUR
- 500 INDEX CONTOUR
- DEPRESSION CONTOUR
- TREES AND TREELINE
- STRUCTURE AND BUILDING
- FENCE
- POLE
- ROADS
- EDGE OF WATER
- MANHOLES / CATCH BASIN
- POWER POLE
- PIPES
- TOWER
- FAULT LINE
- 1515 100 YEAR FLOOD STAGE (see note 2)
- MW-1707 MONITORING WELL (PROPOSED)
- M-22 PIEZOMETER
- LINER
- FACILITY BOUNDARY

## REFERENCES

POND 2 CLOSURE DRAWINGS:

SERIES 13-30225-1 THRU 13-30225-13

| | |
|---|---|
| GSK-CR-13-082817 | SITE PLAN |
| GSK-CR-13-082817SH2 | POTENTIOMETRIC MAP |
| GSK-CR-13-082817SH3 | ALLUVIUM POTENTIOMETRIC MAP |

ADDITIONAL POND 2 DRAWINGS:

| | |
|---|---|
| 13-30300 | SITE GRADING AND DRAINAGE |
| 13-30302 | EROSION & SEDIMENT CONTROL SITE PLAN AND DETAILS |

| DATE | NO. | DESCRIPTION | APPD. |
|---|---|---|---|
| | A | ISSUED TO SHOW PROPOSED MONITORING WELL LOCATIONS & BOUNDARIES. | |

**REVISIONS**



APPALACHIAN POWER COMPANY

**CLINCH RIVER PLANT**

CARBO VIRGINIA

SKETCH

# POND 2 CLOSURE GROUNDWATER MONITORING PLAN WELL LOCATION MAP

UNIT: 13
DRAWING NUMBER: GSK-CR-13-082817SH1
REV: A

SCALE: 1" =100'
CIVIL ENGINEERING
DR:
CH:
SUP:
ENG:
DATE: SEE REV 0
APPROVED BY

AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

PLOT DATE: 3/12/2018
PLOT TIME: 3:30:07 PM
BY: s279452

CROSS REFS:

13-GSK-CR-13-082817SH1

## Appendix A

## Borehole Logs / Monitoring Well Installation Logs

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