Prepared for

American Electric Power

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Columbus, Ohio 43215

GROUNDWATER MONITORING NETWORK EVALUATION

BIG SANDY BOTTOM ASH PONDS

LOUISA, KENTUCKY

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LIST OF ACRONYMS

AEP	American Electric Power
BAC	Bottom Ash Complex
BAP	Bottom Ash Pond
bgs	below ground surface
BSFAP	Big Sandy Fly Ash Pond
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
cfs	cubic feet per second
CWP	Clear Water Pond
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
ft, MSL	Feet above mean sea level
gpm	gallons per minute
KAR	Kentucky Administrative Regulation
KRS	Kentucky Revised Statutes
KPDES	Kentucky Pollutant Discharge Elimination System
KYDEP - DWM	Kentucky Department for Environmental Protection – Division of Waste Management
KYPCo	Kentucky Power Company
MCL	Maximum Contaminant Level
MW	Megawatt
NAD83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
PE	Professional Engineer
PG	Professional Geologist
PVC	Polyvinyl Chloride
RWP	Reclaim Water Pond
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

1. OBJECTIVE

1.1 Purpose

The purpose of this report is to provide an assessment of the groundwater monitoring network associated with the Bottom Ash Ponds (BAPs) at the American Electric Power (AEP) Big Sandy Power Plant with respect to compliance with the United States Environmental Protection Agency's (USEPA's) Coal Combustion Residual (CCR) Rule (Title 40 Code of Federal Regulations (CFR) Section (§) 257.91.

This report was prepared by Mr. Dawit Yifru, geologist. The geology and hydrogeology information evaluated and discussed in this report was prepared under the direction of Mr. Jimmy Whitmer, PG (Kentucky licensed professional geologist (PG) No. 2287). The overall groundwater monitoring network evaluation contained herein was performed by Mr. Scott M. Graves, PE (Kentucky licensed professional engineer (PE) No. 21274). The report was reviewed by Mr. John Seymour, PE (Illinois), in accordance with Geosyntec's senior peer review policies.

1.2 Organization of Report

This report is organized as follows:

- Section 2 presents background information on the power plant and the CCR unit;
- Section 3 presents an evaluation of the existing monitoring well network; and
- Section 4 provides a certification from a qualified PE.

A list of references that are cited in this report is provided in Appendix A. Supporting documentation is provided in Appendices B through D.

1.3 Coordinate System and Datum

The horizontal coordinate values provided in this report are based upon the North American Datum of 1983 (NAD83), Kentucky North Zone. The vertical datum utilized for reporting the elevations within this report is North American Vertical Datum of 1988 (NAVD 88).

2. BACKGROUND INFORMATION

2.1 Facility Location Description

The Kentucky Power Company (KYPCo), a business unit of AEP, operates the Big Sandy Plant – a former 1,060 megawatt (MW) coal-fired power generating station located in Lawrence County, Kentucky, approximately 4.5 miles north of Louisa, Kentucky (Figure 2-1). The Big Sandy Plant is located along the Kentucky side of the Big Sandy River that forms the border with West Virginia.

AEP permanently ceased burning coal at the Big Sandy Plant in November 2015 and transitioned to a 278 MW natural-gas-fired power plant facility. The Bottom Ash Pond is currently in service for wastewater management for the natural gas operations. The Bottom Ash Pond will be closed by removal of CCR and a liner system installed and the pond repurposed as a non-CCR wastewater pond. The closure by removal and repurposing as a non-CCR wastewater pond is scheduled to be completed by the end of 2018. AEP has indicated that they plan to excavate the bottom ash from these ponds and dispose of the ash in the Big Sandy Plant Fly Ash Pond (BSFAP) located approximately 1.5 miles north-northwest of the main plant area (see Figure 2-2), followed by closure of the BSFAP.

2.2 Description of CCR Unit

The CCRs formerly generated by the Big Sandy Plant include bottom ash that is placed in two identical side-by-side existing surface impoundments – the Bottom Ash Ponds (BAPs) – which are the CCR unit that is the subject of this groundwater monitoring network evaluation report. The location of the BAPs in relation to the main plant area is shown on Figure 2-2. As shown, the BAPs are located just west of the main plant area, and located approximately 500-ft north from the Big Sandy River.

The Bottom Ash Complex (BAC), shown in more detail on Figure 2-3, consists of the:

- North and South Bottom Ash Ponds (collectively, the "BAPs" that together are the CCR unit that is subject of this report);
- North and South Clear Water Ponds (CWPs); and
- Reclaim Water Pond (RWP).

The BAPs formerly received wet-sluiced bottom ash generated from the coal burning process. The BAPs continue to receive other non-CCR wastewater flows from the plant. Solids in the BAPs were periodically reclaimed from the pond and used as a construction material, or transferred to the BSFAP for disposal. Each BAP is equipped with a 24-inch diameter outlet pipe that conveys decanted water through the divider embankment from the BAPs to the CWPs. The CWPs also each have outlet structures to regulate the maximum water level in those ponds. When water rises to the elevation of those outlet structures, water is conveyed from the CWPs to the RWP. From the RWP, water is pumped to the BSFAP (AEP, 2015), which eventually discharges water at a Kentucky Pollutant Discharge Elimination System (KPDES)-permitted outfall (KPDES Permit No. KY0000221). The

CWPs and RWP contain only "de minimis" levels of CCR and thus, in accordance with the Final CCR Rule, do not meet the definition of a CCR surface impoundment. Therefore, the CWPs and RWP are not the subject of this monitoring network evaluation report and the CCR unit comprises only the North and South BAPs.

2.2.1 Embankment Configuration

The design and configuration of the BAPs and overall BAC is shown in plan and cross-sectional view on DWG No. 12-3642-6 (Bottom Ash Storage Area) within Appendix B. The design drawing shows that the BAPs are symmetrical and have an identical size and shape. The perimeter embankment of the BAPs is constructed of compacted fill with 2 horizontal to 1 vertical (2H:1V) exterior side slopes. The design drawing also shows that the BAPs were originally constructed with 1.75H:1V interior side slopes; however according to AEP (2014), as a result of a 2009 pond inspection, the interior slopes of the BAPs were regraded to a 2H:1V slope during the 2009-2010 timeframe. An interior splitter (separator) dike, also constructed of compacted earthen fill and having 1.75H:1V slopes, separates the North BAP and South BAP. Another separator dike constructed of compacted earthen fill and having 2H:1V slopes, separates the west end of the BAPs from the CWPs.

The interior slopes of the BAPs are lined with an 18-inch thick layer of grouted riprap erosion protection, underlain by a geotextile fabric. The exterior slopes of the BAPs are vegetated with grass. The crests of the perimeter BAP embankments serve as access roadways; they have an aggregate road surface, and vary in width from 20 to 30 feet (AEP, 2014). Borings completed in 2009 (Stantec, 2010) and 2016 (Geosyntec, 2016) indicate that the embankment fill consists of a medium stiff to stiff, yellowish brown to brown lean clay, silt with sand, and sandy lean clay with sand. Stantec (2010) further described the embankment fill as having an average moisture content that is 3 to 5 percent above standard Proctor optimum moisture content, and with a density on the order of 90 to 95 percent of the standard Proctor maximum density.

The perimeter embankment around the north, east, and south sides of the BAPs has a top-of-berm elevation of 580 ft above mean sea level (ft, MSL), as does the interior splitter dike between the BAPs. The separator dike on the west end of the BAPs is at elevation 578 ft, MSL. The design drawings indicate that the bottoms of the pond are at elevation 565 ft, MSL at the high end (east end) of the BAPs, and approximately elevation 560 ft, MSL on the low end (west end) of the BAPs. Thus, the interior slopes are between approximately 15 and 20-ft tall. From the design drawings, the BAPs appear to be partially incised (i.e., they appear to have been constructed with a portion of the bottom grades being excavated below the natural ground surface). However, the perimeter embankments and separator dikes are composed of above-grade compacted fill constructed to elevations higher than the surrounding natural ground surface. The existing ground surrounding the BAPs is relatively flat, with a shallow grade sloping downward in a general north to south direction toward the river. Because of this, the northern perimeter embankment of the North BAP has an exterior height of only a few feet. The existing ground south of the BAPs has a ground elevation of approximately 568 ft, MSL.

Therefore, the southern perimeter embankment of the South BAP (where exterior-facing slopes are the tallest) has an exterior embankment slope height of approximately 12 ft.

2.2.2 Area and Volume of CCR Units

The North and South Bottom Ash Ponds are identical in storage size and configuration, each having an area of about 1.5 acres. The combined maximum storage volume that can be held in the bottom ash ponds is about 48,000 cubic yards, assuming they are both completely filled to the top of the west separator dike with no freeboard (elevation 578 ft, MSL). AEP has indicated to Geosyntec (as confirmed by observations during Geosyntec's 2015 and 2016 site visits) that when ponds are in operation they alternate pond filling operations between the two BAPs (i.e., they only fill one pond at a time with bottom ash).

2.2.3 Construction and Operational History

The Big Sandy Power Plant began operation in 1963, and the BAC was constructed in 1968. In 2009-2010, an engineering study and subsequent maintenance/repair activities were completed on the BAPs (AEP, 2014). Specifically, repair activities were performed on the interior slopes and interior splitter dike. The interior slopes were stripped of existing vegetation and slope protection, graded to a 2H:1V slope, and stabilized with grouted riprap to enhance stability and provide erosion protection. Also, in conjunction with these repairs the access roadways that form the perimeter of the BAPs were graded and paved using aggregate.

2.2.4 Surface Water Control

The BAPs are surrounded by above-grade perimeter embankments which prevent surface water runoff from entering them. The existing topography surrounding the BAPs is relatively flat, with a shallow grade sloping down from north to south. A riprap-lined drainage ditch is situated along the north toe of the perimeter embankment to divert storm water drainage around the BAC area. Therefore, the only surface water added to the BAPs is precipitation that falls within their footprint (within the interior crest of slopes). Each BAP is equipped with a 24-inch diameter outlet pipe that conveys decanted water through the divider embankment from the BAPs to the CWPs, which in turn discharge to the RWP. From the RWP, water is pumped to the BSFAP (AEP, 2015).

2.3 Previous Investigations

In 2009, Stantec conducted a geotechnical site investigation of the BAPs as part of a seepage and stability evaluation of the embankment system (Stantec, 2010). Stantec's investigation included drilling of six (6) soil borings (B-1 through B-6) with depths ranging between 31.5 and 61.5 ft below ground surface (bgs) and installation of three (3) shallow piezometers (PZ-1, PZ-2, and PZ-6) in borings (B-1, B-2, and B-6) with depths ranging from 15 to 20 ft bgs. The boring and piezometer locations are shown on Figure 2-3. Five of the six borings were advanced from the tops of the

embankments and one boring (B-2) was advanced at the toe of the slope of a perimeter BAP embankment. Two of the three piezometers (PZ-1 and PZ-6) were dry in January 2010 and April 2016. One piezometer (PZ-2) contained approximately 0.4 ft and 2 ft of water during the January 2010 and April 2016 measurements, respectively.

In 2016 Geosyntec installed nine monitoring wells (MW-1612 through MW-1620) at the locations shown on Figure 2-3 to supplement the existing geologic and hydrogeologic information (Geosyntec, 2016). The monitoring wells were installed at depths ranging from 27 ft to 74 ft bgs. Monitoring wells MW-1612 and MW-1613 were screened in residual soil north of the BAPs. The remaining monitoring wells were screened in sand and gravel alluvium deposited by the Big Sandy River, which represents the uppermost aquifer at the site. These monitoring wells are discussed further in Section 3.

2.4 Hydrogeologic Setting

2.4.1 Climate and Water Budget

The average annual precipitation at the site is approximately 44 inches, with monthly totals averaging between about 3.0 inches in the driest months (October and January) to about 5.5 inches in the wettest month (July). Temperatures range from highs in the mid to upper 80s Fahrenheit in July to highs in the low to mid 40s Fahrenheit in January (Lloyd and Lyke, 1955).

Prior to changing from coal to natural gas fuel, the Big Sandy Power Plant used water to sluice bottom ash to the BAPs. Currently, the BAPs receive and hold precipitation that falls within their footprint (within the interior crest of slopes), and also receive other non-CCR wastewaters from the plant. Water from the BAPs flows into the adjacent CWPs, and then into the RWP from which it is pumped to the BSFAP (AEP, 2015). Water detained in the BSFAP is released through the principal spillway structure at the main dam, where it is discharged to Blaine Creek at a KPDES-permitted outfall.

2.4.2 Regional and Local Geologic Setting

The regional geology of the site consists of relatively flat-lying Pennsylvanian-age rocks of the Monongahela, Conemaugh, and Breathitt Formations in the upland areas and relatively thin Quaternary-age alluvial deposits in the stream valleys (Lloyd and Lyke, 1995). A regional geology map is presented on Figure 2-4. The Monongahela, Conemaugh, and Breathitt Formations are the result of sedimentary deposition in a fluvial-deltaic environment, and consist of cyclic sequences of sandstones, siltstones, shales and coals. The alluvial material in the region is present along present-day streams and consists of unconsolidated deposits of silt, sand, and gravel derived from present-day stream processes (Lloyd and Lyke, 1995). The alluvial deposits may be up to 50 ft thick in some areas, with the greatest thicknesses present in the major stream valleys with generally lesser amounts present in the tributary valleys. A relatively thin layer of residual soils (residuum) generally consisting of clay derived from the weathering of underlying bedrock is often present at the ground surface at higher elevations.

The local site subsurface in and around the BAC includes compacted fill soil used to construct the embankments. Underlying the fill material, the local geology includes alluvium and residual soil. In particular, alluvial deposits were encountered at locations beneath the fill soil associated with the BAPs and at locations south of the BAPs towards the Big Sandy River. The upper alluvial deposits consist of a low hydraulic conductivity sandy lean clay, lean clay, and silt to a depth of approximately 540 ft, MSL in the vicinity of the BAPs. Below approximately 540 ft, MSL, lower alluvial deposits were encountered consisting of sand and gravel with occasional thin clay lenses. In areas north of the BAPs, a residual soil consisting of primarily silts, along with clays and sand/gravel zones at greater depths was encountered beneath the fill. Weathered shale was encountered beneath the residual soil north of the BAPs. Based on elevation, the weathered shale is likely part of the Breathitt Formation. Geologic cross sections illustrating the subsurface lithologic units at the site in relation to the BAPs are presented in Appendix C.

2.4.3 Regional and Local Hydrogeologic Setting

The near-surface hydrogeology of the region is generally categorized into two systems: (i) an alluvial aquifer system of unconsolidated deposits; and (ii) an aquifer system in the fractures of the bedrock (Lloyd and Lyke, 1995). The unconsolidated aquifer system, which consists of sand and gravel overlying the consolidated rocks, occurs in present-day stream valleys. The bedrock mostly consists of repeating sequences of fractured sandstone, shale, coal and limestone deposited during multiple sedimentary cycles. The two aquifer systems are directly recharged by precipitation where exposed at land surface and groundwater generally flows parallel to the topographic slope.

The lower alluvial deposits (below approximately elevation 540 ft, MSL) are composed of sand and gravel composites that form the uppermost aquifer, with the water bearing portion of the uppermost aquifer in the vicinity of the BAPs being located below approximately elevation 524 ft, MSL. It is noted that on the western side of the BAC area of the site and upgradient from the BAPs, a groundwater elevation of approximately elevation 535 ft, MSL was measured in the alluvium. The upper alluvial deposits (above approximate elevation 540 ft, MSL) are composed of low hydraulic conductivity clay and silt (with vertical hydraulic conductivities varying between 7.6×10^{-8} cm/sec and 5.2×10^{-6} cm/sec) (Geosyntec, 2016) .

Piezometers (PZ-1, PZ-2 and PZ-6) installed within the lean clay material during the 2009 geotechnical investigation are consistently dry (PZ-1 and PZ-6) or have a small amount of water that collects over time in the end cap (PZ-2). Borings drilled through the clay/silt upper alluvium in 2016 indicated dry to moist soil, not saturated, and boreholes left open during drilling did not accumulate groundwater. Deeper borings installed during the 2016 monitoring well installation activities indicated saturated conditions within the sand and gravel of the lower alluvial deposits. These saturated alluvial deposits represent the uppermost aquifer and occur at approximately 60 ft bgs in the vicinity of the BAPs. Water levels measured in monitoring wells installed within the sand and gravel lower alluvium in the vicinity of the BAPs range in elevation from approximately 523 to 524 ft, MSL.

Groundwater flow in the sand and gravel alluvium generally follows the surface topography towards the Big Sandy River. Two soil borings/monitoring wells (MW-1612 and MW-1613) installed directly upgradient and north of the BAPs during the 2016 investigation did not encounter the alluvial deposits. These borings/wells were installed into the residual soil and encountered shallow bedrock before encountering the alluvial aquifer. Borings/wells MW-1612 and MW-1613 encountered bedrock at elevations of approximately 537 and 552 ft, MSL, respectively. Monitoring well MW-1613 remained dry for several days and eventually only accumulated approximately 1.9 ft of water. Monitoring well MW-1612 encountered a very localized shallow perched water zone not representative of the uppermost alluvial aquifer. As a result, monitoring well MW-1619 and MW-1620 were added to Geosyntec's 2016 drilling program to provide upgradient hydrogeologic information for the alluvial aquifer.

2.4.4 Surface Water and Surface Water-Groundwater Interactions

The BAPs formerly received waters associated with the wet-sluiced bottom ash and currently receive only non-CCR wastewaters from other Big Sandy Plant operations, as well as any precipitation that falls on them. As described in Section 2.4.1, water from the BAPs flows into the adjacent CWPs, and then to the RWP, where it is pumped to the BSFAP. Water detained in the BSFAP is released through the principal spillway structure at the Main Dam, where it is discharged to Blaine Creek from a KPDES-permitted outfall downstream of the dam. During the time that water is held in the BAPs, some of the water evaporates and some water probably infiltrates into the subsurface since there is no constructed pond liner system. Stantec (2010) indicates that the normal operating pool of the BAPs is elevation 575 ft, MSL.

FEMA's Flood Insurance Rate Map (FIRM) that includes the site area (FIRM Number 54099C0165C, January 2, 2013) shows that the BAPs are not in the 100-year floodplain. The FEMA map also indicates that the 100-year base flood elevations in the Big Sandy River are between elevation 567 and 568 ft, MSL where the river is closest to the BAPs. During normal river stage conditions, the water level in the Big Sandy River is much lower.

Based on groundwater elevation data collected from the monitoring wells installed in 2016, the groundwater flow direction in the sand and gravel alluvium is to the south towards the Big Sandy River. The measured groundwater elevation in the alluvium at monitoring wells in the vicinity of the BAPs ranged from elevation 523 to 524 ft, MSL. Not only is this elevation well below the normal operating pool of the BAPs at elevation 575 ft, MSL, but it is also much lower than the base of the BAPs (elevation 560 to 565 ft, MSL). Furthermore, the clay/silt zone between the base of the BAPs and the upper limit of the uppermost aquifer was not saturated, and no evidence of a hydraulic connection between the groundwater in the alluvium and the surface water in the BAPs was observed.

2.4.5 Water Users

Location and description of groundwater withdrawal wells were obtained from the Kentucky Groundwater Data Repository, Water Well and Spring Location Map (http://kgs.uky.edu/kgsmap/KGSWater/viewer.asp). The location of these wells is shown on Figure 2-5. As shown, ten (10) water wells were identified in the search area in Kentucky within approximately three (3) miles from the BAPs. Additional information on these wells is provided in Table 2-1. As shown on Table 2-1, six (6) of these wells are used for domestic use, one (1) for industrial use, one (1) for mining, and two (2) water wells for unknown use. The water withdrawal wells in the area are all upgradient of, and/or in different alluvial valleys than, the BAPs.

3. MONITORING NETWORK EVALUATION

3.1 Hydrostratigraphic Units

3.1.1 Horizontal and Vertical Position Relative to CCR Unit

The hydrogeology within the BAPs area is characterized by a sand and gravel alluvial deposit associated with the floodplain of the Big Sandy River. The upper limit of the sand and gravel alluvium aquifer is located at an approximate elevation of 540 ft, MSL (20 to 25 ft below the bottom of the BAPs). The aquifer is not in direct hydraulic connection with the surface water in the BAPs or with the CCR due to the presence of a low-permeability zone of clay/silt located between the base of the BAPs and the upper limit of the uppermost aquifer (i.e., the sands and gravels in the lower alluvium).

3.1.2 Overall Flow Conditions

Groundwater elevations in the alluvium monitoring wells in the vicinity of the BAPs (523 to 524 ft, MSL on July 14, 2016) are higher than surface water elevation in the Big Sandy River (approximately 519 ft, MSL on July 14, 2016; obtained from the USGS Stream gauge data, USGS Big Sandy River at Louisa, KY). A potentiometric surface map generated based on the July 2016 water level measurements indicated that the groundwater flow direction in the sand and gravel alluvium aquifer is parallel to the topographic slope to the south towards the Big Sandy River (Figure 3-1).

Laboratory vertical hydraulic conductivity testing was conducted using undisturbed Shelby tube soil samples collected from the clay/silt zone at four borings around the BAPs, from elevations corresponding to the interval below the base of the BAPs and above the uppermost aquifer. The measured vertical hydraulic conductivity of the clay/silt zone ranged from 7.6×10^{-8} cm/sec to 5.2×10^{-6} cm/sec (Geosyntec, 2016). Borings drilled for the associated four hydraulic conductivity specimens indicated dry to moist soil, not saturated, and boreholes left open during drilling did not accumulate groundwater. Additionally, piezometers drilled during the 2010 investigation within the clay and silt zone are consistently dry (PZ-1 and PZ-6) or have a small amount of water that collects over time in the end caps (PZ-2). From May 2016 through July 2016, groundwater elevations in monitoring wells in the vicinity of the BAPs screened in the sand and gravel alluvium ranged between 523 and 524 ft, MSL while surface water elevations in the BAPs ranged between approximately 565 ft, MSL (when water levels were near the bottom of the BAPs) and approximately 575 ft, MSL (when the ponds were full). The difference in groundwater and surface water elevations near the BAPs demonstrates the lack of a hydraulic connection between the groundwater in the alluvium and the surface water in the BAPs.

Slug testing results of seven monitoring wells screened in the lower alluvial sands and gravels show that the aquifer has an average measured horizontal hydraulic conductivity of approximately 9.3×10^{-3} cm/sec. Recharge to the sand and gravel alluvium aquifer can be attributed to infiltration of

precipitation in areas where the low permeability clay layer is thin or not present. Recharge is also likely from surface water draining from the sandstone outcrops north of the BAPs.

3.2 Uppermost Aquifer

3.2.1 CCR Rule Definition

The term "uppermost aquifer" referred to in §257.91 of the groundwater monitoring systems rule for CCR units is defined in 40 CFR §257.53 as: "the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural ground surface to which the aquifer rises during the wet season." Aquifer is defined as "a geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs." Per the preamble that accompanies the CCR Rule, this includes a shallow, deep, perched, confined, or unconfined aquifer, provided that it yields usable water. "Usable water" is not defined in the CCR Rule nor in Kentucky regulations.

For reference, Kentucky environmental regulations for water wells (401 KAR 6:001(3)) defines an aquifer as "a water-bearing formation that transmits water in sufficient quantity to supply a well."

3.2.2 Identified Onsite Hydrostratigraphic Unit

The sand and gravel alluvium deposited by the Big Sandy River meets the definition of the uppermost aquifer in the CCR Rule. Based on boring log and monitoring well data around the BAPs, the upper limit of the sand and gravel alluvium aquifer is located at an approximate elevation of 540 ft, MSL (20 to 25 ft below the bottom of the BAPs). Based on the July 14, 2016 water level measurements, groundwater elevations in the alluvium aquifer in monitoring wells in the vicinity of the BAPs was between 523.23 ft, MSL and 524.21 ft, MSL. Slug testing data from wells screened in the lower alluvial sands and gravels show that the aquifer has an average measured horizontal hydraulic conductivity of approximately 9.3×10^{-3} cm/sec (Geosyntec, 2016). The direction of groundwater flow is generally to the south towards the Big Sandy River. A potentiometric surface map depicting groundwater elevations and the general direction of flow in the uppermost aquifer is presented on Figure 3-1.

The aquifer is not in direct hydraulic connection with the surface water in the BAPs or with the CCR due to the presence of a low hydraulic conductivity zone of clay/silt located between the base of the BAPs and the upper limit of the uppermost aquifer (i.e., the sands and gravels in the lower alluvium).

3.3 Overview of Groundwater Monitoring System Regulatory Requirements

The preamble that accompanies the CCR Rule concisely summarizes the groundwater monitoring system regulatory requirements of Rule 40 CFR §257.91 by stating that "all groundwater monitoring

systems must consist of a sufficient number of appropriately located wells (at least one upgradient and three downgradient wells) in order to yield groundwater samples from the uppermost aquifer that represent the quality of background groundwater and the quality of groundwater passing the CCR waste boundary." The upgradient background wells must be located beyond the upgradient extent of CCR-derived contamination whereas the downgradient wells will monitor the quality of groundwater passing the waste boundary of the CCR unit and must be located at the downgradient perimeter of the CCR unit or at the closest practical distance from this location. Although the rule requires a minimum of one upgradient and three downgradient monitoring wells, the number, spacing and depths of the monitoring wells must be determined based on hydrogeology of the site including aquifer thickness, groundwater flow rates and direction.

3.4 Review of Existing Monitoring Network

3.4.1 Overview

The groundwater monitoring network is shown on Figure 3-2 and consists of a total of five groundwater monitoring wells to provide detection monitoring in the uppermost aquifer, with two wells located upgradient of the BAPs and three wells located downgradient of the BAPs. The number, depth and spacing of groundwater monitoring wells included in the groundwater monitoring network are based on site-specific geologic and hydrogeologic information. Two monitoring wells MW-1619 and MW-1620 located upgradient of the BAPs will serve for background monitoring. The remaining three monitoring wells MW-1614, MW-1615, and MW-1618 will be used for downgradient monitoring. Also as indicated on Figure 3-2, two additional wells MW-1616 and MW-1617 will be used for water level measurement only, to help confirm groundwater flow directions as needed. The monitoring wells were installed in an eight-inch borehole and have four-inch diameter Polyvinyl Chloride (PVC) casings, 10-ft long screens with 0.01-inch slot size in the uppermost aquifer. Well construction details for the five wells in the monitoring network are summarized in Table 3-1 and boring logs and well construction diagrams for all of Geosyntec's 2016 well installations are provided in Appendix D.

3.4.2 Compliance Assessment

Review of the groundwater monitoring well network in relation to the geologic and hydrogeologic conditions in the area of the BAPs indicates that it consists of a sufficient number of wells installed at the appropriate locations and depths to yield groundwater samples from the uppermost aquifer that accurately represent the quality of background groundwater and groundwater passing the waste boundary of the BAPs. The groundwater monitoring well network is also capable of providing a system for detection of potential groundwater contamination in the uppermost aquifer nearest the waste boundary. In particular, the three downgradient groundwater monitoring wells are appropriately positioned based on their close proximity to downgradient waste boundary of the BAPs, the close lateral spacing for the relatively small size of the BAPs, and the documented groundwater flow

direction to the south towards the Big Sandy River. Based on the above review, the groundwater monitoring network around the Big Sandy BAPs meets the requirements of 40 CFR §257.91.

4. CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

I have reviewed the groundwater monitoring network and well construction details in the vicinity of the Bottom Ash Ponds at the Big Sandy Plant and based on the evaluation presented in Section 3 of this report, I certify that the groundwater monitoring system has been designed and constructed to meet the requirements of Section 40 CFR §257.91.

Scott M. Graves

Printed Name of Licensed Professional Engineer

12/16/2016

Seal and Signature | Date

21274 | Kentucky

License No. | State

TABLES

Table 2-1. Summary of Nearby Groundwater Withdrawal Wells

Bottom Ash Ponds Groundwater Monitoring Network, AEP - Big Sandy Plant
Louisa, Kentucky

AKGWA Number	Primary Use	Latitude[1]	Longitude[1]	Construction Date	Elevation (ft)	Total Depth (ft)	Static Water Level (ft)	Approximate Static Water Level Elevation (ft)	Well Yield (gpm)
00011523	Domestic - Single Household	38.189	-82.638	5/23/1988	580	67	50	530	35
00006915	Domestic - Single Household	38.194	-82.653	5/15/1988	580	120	60	520	8
00006916	Domestic - Single Household	38.193	-82.651	5/31/1988	580	105	70	510	20
00002933	Domestic - Single Household	38.192	-82.629	3/3/1987	640	100	50	590	10
30002996	Not Available	38.189	-82.625	NA	NA	NA	NA	NA	NA
00006922	Domestic - Single Household	38.188	-82.615	8/10/1988	810	380	250	560	0.83
00060898	Industrial - General	38.178	-82.613	7/18/2011	576	64	55	521	5-10
00056935	Mining	38.171	-82.645	8/24/2001	680	200	51	629	60
00008075	Domestic - Single Household	38.188	-82.664	2/22/1990	680	80	25	655	20
00051043	Not Available	38.170	-82.644	5/26/1999	580	140	25	555	15

Notes:

1. Latitude and Longitude are based on NAD 83 Geographic Coordinate System.
2. Vertical datum is based on NAVD 88.
3. Groundwater supply well data obtained from Kentucky Groundwater Data Repository, Water Well and Spring Location Map (http://kgs.uky.edu/kgsmap/KGSWater/viewer.asp).
4. NA: Not Available

Table 3-1. Monitoring Network Well Construction Summary

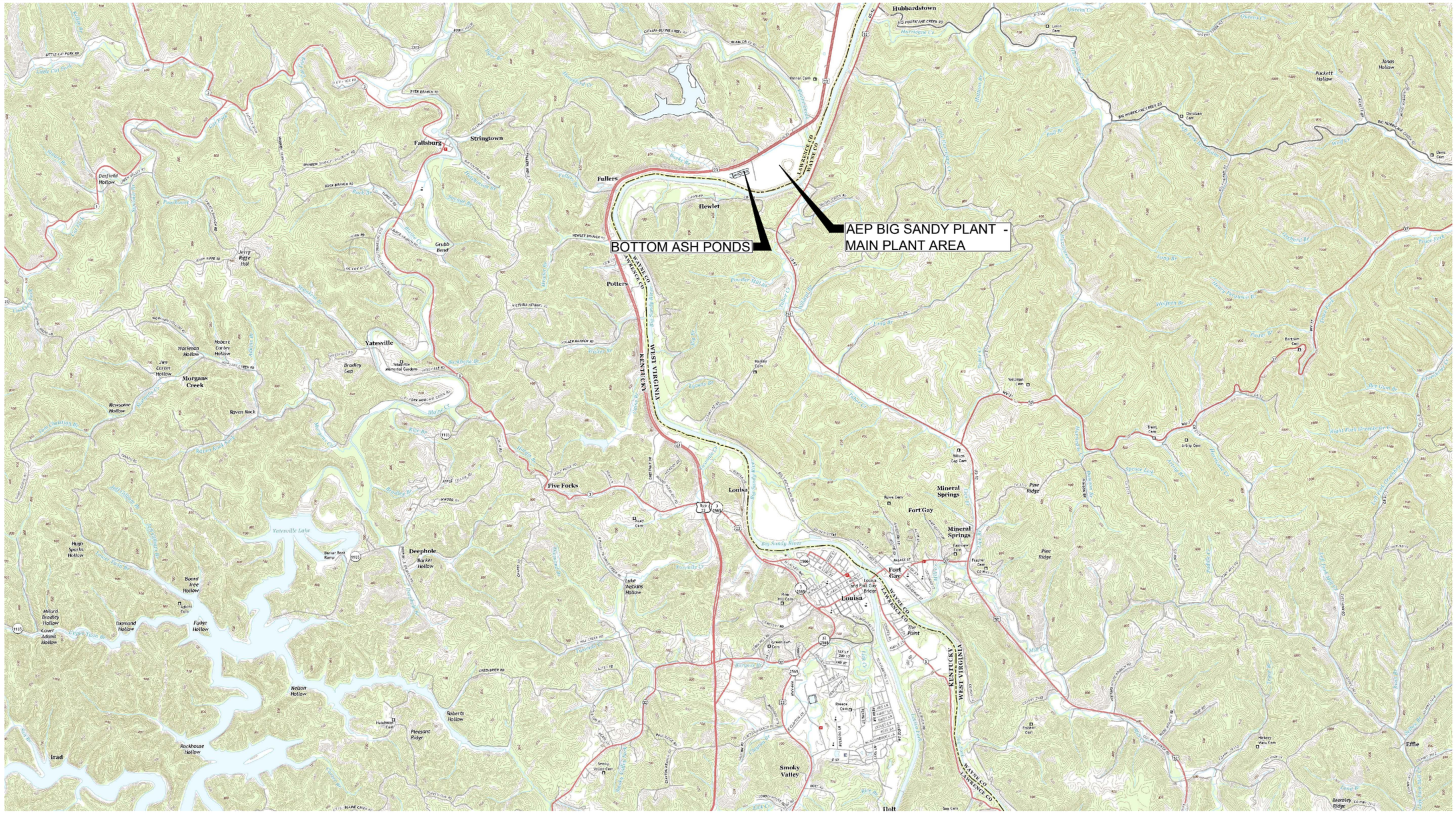
Bottom Ash Ponds Groundwater Monitoring Network, AEP - Big Sandy Plant
Louisa, Kentucky

Monitoring Well ID	Northing	Easting	TOC Elevation (ft, MSL)	Ground Surface Elevation (ft, MSL)	Stickup Length* (ft)	Well Purpose & Location	Screen Zone Geology	Screen Top BTOC (ft)	Screen Bottom BTOC (ft)	Screen Bottom Elevation (ft, MSL)
MW-1614	248536.83	2108469.48	582.95	580.39	2.56	Sampling (Downgradient)	Sand Alluvium	66.1	76.1	506.9
MW-1615	248596.46	2108637.78	583.22	580.42	2.80	Sampling (Downgradient)	Sand Alluvium	66.3	76.3	506.9
MW-1618	248659.65	2108783.48	584.19	581.17	3.01	Sampling (Downgradient)	Sand Alluvium	66.0	76.0	508.2
MW-1619	250527.53	2111325.37	562.95	561.10	1.85	Sampling (Upgradient)	Sand Alluvium	41.4	51.4	511.6
MW-1620	248456.53	2107233.10	571.95	569.20	2.75	Sampling (Upgradient)	Sand Alluvium	45.7	55.7	516.2

Notes:

1. Northing and Easting are in NAD83 State Plane KY North. Elevations are in based on NAVD88.
2. The Northing and Easting measurements were taken at the top of casing (TOC).
3. ft = Feet
   MSL = Mean Sea Level
   *: Casing length above ground surface
   BTOC = Below Top Of Casing

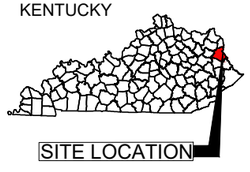
FIGURES



0 5,000'

SCALE IN FEET

LAWRENCE COUNTY
KENTUCKY



BASE MAP SOURCE: UNITED STATES GEOLOGICAL SURVEY (USGS) 7.5 MINUTE QUADRANGLE MAPS FOR PRICHARD WEST VIRGINIA (DATED 2014), LOUISA KENTUCKY (2013), ADAMS KENTUCKY (2013), AND FALLSBURG KENTUCKY (2013).

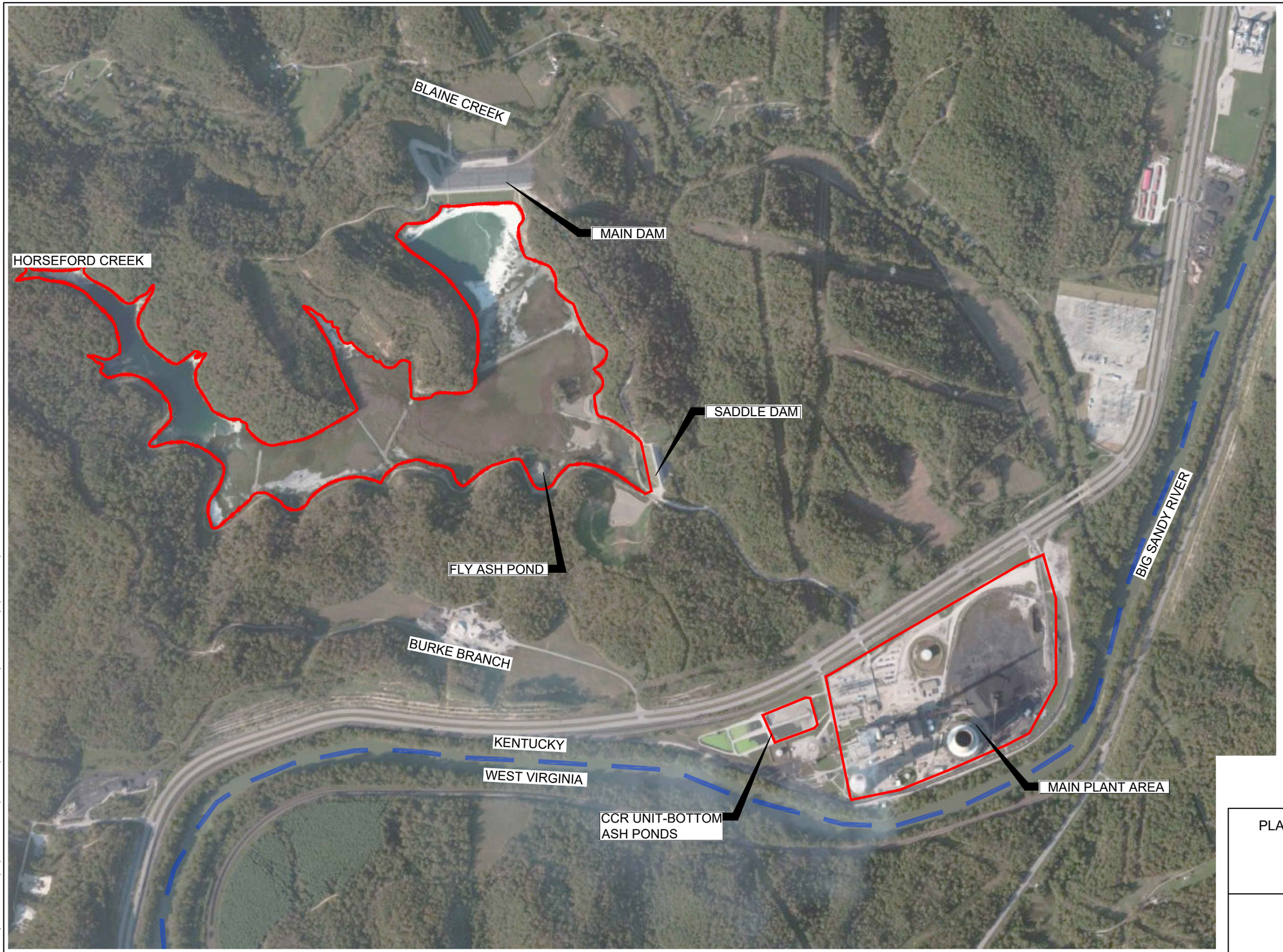
SITE LOCATION MAP
BOTTOM ASH PONDS
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

Geosyntec consultants

AUSTIN, TX | DECEMBER 2016

FIGURE 2-1

P:\CADD\PROJECTS\B\BIG SANDY\PERMIT\CCR COMPLIANCE (TXL0510.02)\FIGURES\TXL051002F01A



N

BASE MAP SOURCE: AERIAL IMAGERY ACCESSED VIA ArcGIS ONLINE IN JULY 2015 AND PROVIDED BY MICROSOFT. IMAGE IS DATED 17 AUGUST 2011.

0 1,000'

SCALE IN FEET

PLANT AND CCR UNIT LOCATION MAP
BOTTOM ASH PONDS
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

Geosyntec consultants

AUSTIN, TX | DECEMBER 2016

FIGURE 2-2

P:\CADD\PROJECTS\B\BIG SANDY\PERMIT\CCR COMPLIANCE (TXL0510.02)\FIGURES\TXL051002F02-2

Legend

- Monitoring Well (Installed in 2016)
- Piezometer (Installed in 2009)
- Soil Boring (Installed in 2009)
- CCR Unit - Bottom Ash Ponds (Approximate Limits)

N

MW-1619

MW-1612

MW-1613

B-3

NORTH BOTTOM ASH POND

NORTH CLEAR WATER POND

SOUTH BOTTOM ASH POND

B-4

MW-1616

MW-1618

B-1

B-5

PZ-1

MW-1615

PZ-2

B-2

RECLAIM POND

MW-1620

MW-1617

MW-1614

PZ-6

B-6

SOUTH CLEAR WATER POND

Big Sandy River

Big Sandy River

0 150 300 600 900 1,200 Feet

N:\AEP\GIS\MXDs\Bottom Ash Pond\August 2016\2016 Boringand Wells.mxd\DY\14 November 2016

CCR UNIT LAYOUT AND BORING, PIEZOMETER, AND MONITORING WELL LOCATIONS

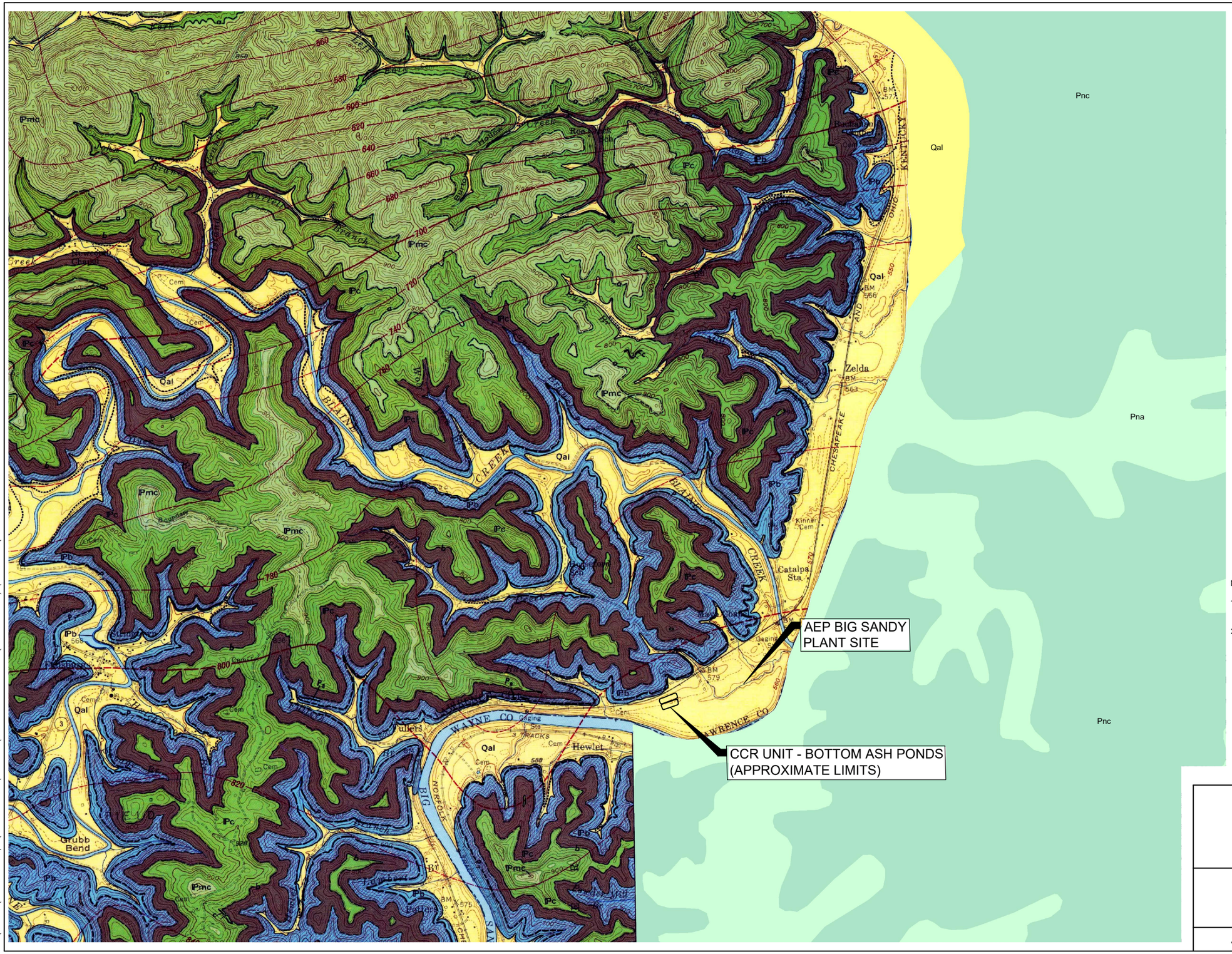
BOTTOM ASH PONDS
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

Geosyntec consultants

AUSTIN, TX

DECEMBER 2016

FIGURE 2-3



N

LEGEND

KENTUCKY

Qal

Alluvium

Monongahela and Conemaugh Formations

Pmc, *Monongahela Formation and upper part of Conemaugh Formation*
Pc, *Conemaugh Formation*
a, *Ames Limestone Member*
c, *unnamed coal bed*
b, *Brush Creek Limestone Member*
bc, *Brush Creek coal bed*

Breathitt Formation

P8, *Princess No. 8 coal bed*
P7, *Princess No. 7 coal bed*
P6, *Princess No. 6 coal bed*
P5, *Princess No. 5 coal bed*

WEST VIRGINIA

Qal	ALLUVIUM
Pna	ALLEGHENY FORMATION
Pnc	CONEMAUGH GROUP

NOTE:

1. GEOLOGIC MAP OF KENTUCKY OBTAINED FROM THE USGS/AASG NATIONAL GEOLOGIC MAP DATABASE.
2. GEOLOGIC MAP OF WEST VIRGINIA OBTAINED FROM THE WEST VIRGINIA DEPARTMENT OF ENVIRONMENTAL PROTECTION (WVDEP) GIS RESOURCES AND SOURCED FROM THE 1968 STATE GEOLOGIC MAP OF WEST VIRGINIA, PUBLISHED BY THE WILLIAMS & HEINTZ MAP CORPORATION.

0 2,500'

SCALE IN FEET

SURFACE GEOLOGY MAP
BOTTOM ASH PONDS
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

Geosyntec consultants

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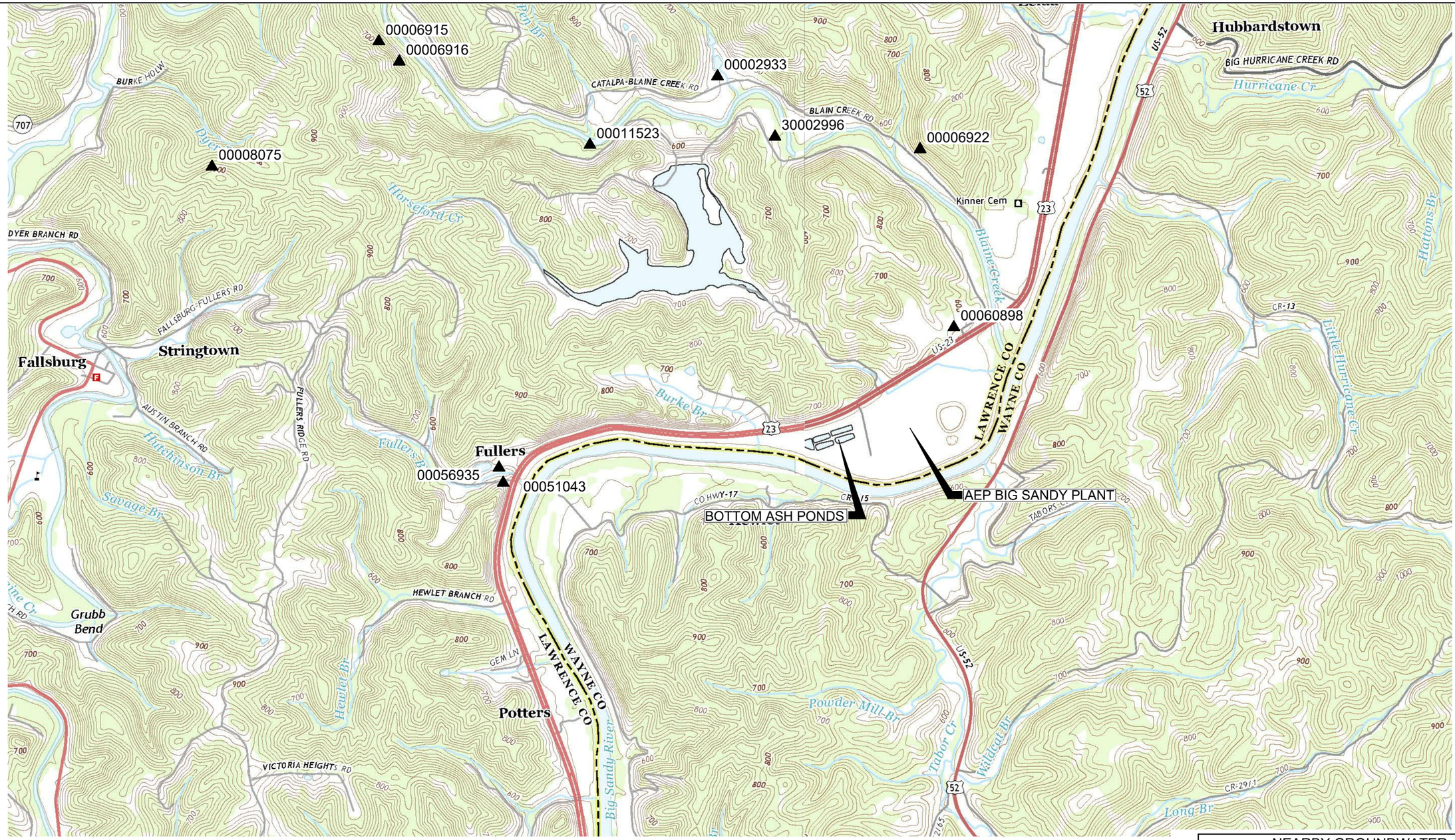
FIGURE 2-4

P:\CADD\PROJECTS\B\BIG SANDY\PERMIT\CCR COMPLIANCE (TXL0510.02)\FIGURES\TXL051002F15



LEGEND

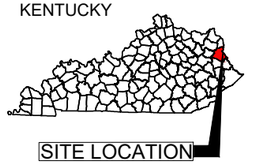
▲ EXISTING GROUNDWATER SUPPLY WELL

NOTES:

1. NUMERICAL CODE NEXT TO EACH WATER WELL SYMBOL REFERS TO THE KENTUCKY WATER WELL I.D. NUMBER.
2. LOCATION AND DESCRIPTION OF GROUNDWATER WITHDRAWAL WELLS WERE OBTAINED FROM KENTUCKY GEOLOGIC MAP INFORMATION SERVICE (KENTUCKY GEOLOGICAL SURVEY, HTTP://KGS.UKY.EDU/KGSMAP/KGSWATER/VIEWER.ASP).

MAP SOURCE: UNITED STATES GEOLOGICAL SURVEY (USGS) 7.5 MINUTE QUADRANGLE MAPS FOR PRICHARD WEST VIRGINIA (2014) AND FALLSBURG KENTUCKY (2013).

LAWRENCE COUNTY
KENTUCKY



0 2,000'
SCALE IN FEET

NEARBY GROUNDWATER WITHDRAWAL WELLS BOTTOM ASH PONDS AEP BIG SANDY PLANT LOUISA, KENTUCKY

Geosyntec consultants

AUSTIN, TX | DECEMBER 2016

FIGURE 2-5

P:\CADD\PROJECTS\B\BIG SANDY\PERMIT\CCR COMPLIANCE (TXL0510.02)\FIGURES\TXL0510002F11

Legend

- Monitoring Well
- 14 July 2016 Groundwater Elevation Contour (ft, MSL)
- Groundwater Flow Direction (Approximate)

Note:
Groundwater elevation contour is dashed where inferred.

N

MW-1619
525.90

526

524

MW-1620
535.12

534

532

530

528

526

524

MW-1616
523.76

MW-1617
523.41

MW-1614
523.63

MW-1615
524.08

MW-1618
524.21

Big Sandy River

Big Sandy River

0 150 300 600 900 1,200
Feet

POTENTIOMETRIC SURFACE MAP - UPPERMOST AQUIFER
14 JULY 2016

BOTTOM ASH PONDS
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

Geosyntec consultants

AUSTIN, TX

DECEMBER 2016

FIGURE
3-1

N:\AEP\GIS\MXDs\Bottom Ash Pond\July 2016\July 2016 Potmap.mxd\DY\14 November 2016

Legend

- Monitoring Well (Sampling)
- Monitoring Well (Water Level Measurement Only)
- CCR Unit - Bottom Ash Ponds (Approximate Limits)

N

MW-1619

NORTH BOTTOM ASH POND

SOUTH BOTTOM ASH POND

MW-1618

MW-1616

MW-1615

MW-1614

MW-1617

MW-1620

Big Sandy River

Big Sandy River

0 150 300 600 900 1,200 Feet

N:\AEP\GIS\MXDs\Bottom Ash Pond\July 2016\August 2016 MW Network.mxd\DY\14 November 2016

GROUNDWATER MONITORING WELL NETWORK

BOTTOM ASH PONDS
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

Geosyntec consultants

AUSTIN, TX

DECEMBER 2016

FIGURE
3-2

APPENDIX A

REFERENCES

AEP (American Electric Power), 1975. *Drawing 12-3642-6 Bottom Ash Storage Area*, Kentucky Power Company Big Sandy Plant, November, 2014.

AEP (American Electric Power), 2014. *Dam & Dike Inspection Report: Bottom Ash Pond Complex, Saddle Dam, Horseford Dam*, GERS-14-024, November, 2014.

AEP (American Electric Power), 2015. *Big Sandy Plant: Post-Conversion and Decommissioning Water Balance Flow Diagram (Interim and Final)*, May, 2015.

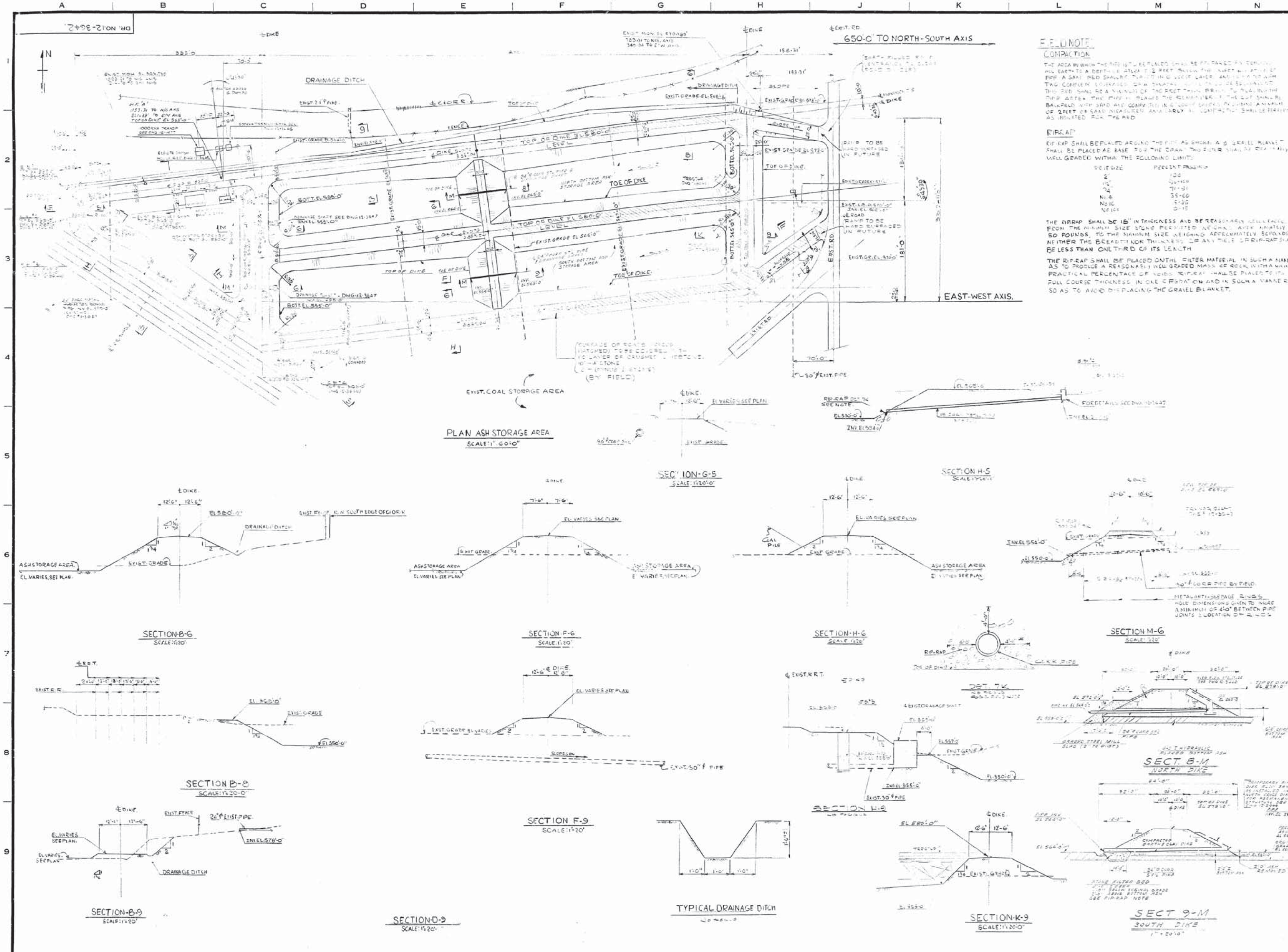
Geosyntec (Geosyntec Consultants, Inc.), 2016. Monitoring Well Installation Report: Bottom Ash Ponds, AEP Big Sandy Plant, October 2016.

Lloyd, Jr., O.B., and Lyke, W.L., 1995. *Ground Water Atlas of the United States, Segment 10: Illinois, Indiana, Kentucky, Ohio, Tennessee. Hydrologic Investigations Atlas 730-K. U. S. Geological Survey, Reston, VA.*

Stantec (Stantec Consulting Services, Inc.), 2010. *Report on Geotechnical Exploration – AEP Big Sandy Power Plan Unit 1-2 Bottom Ash Pond*. June, 2010.

APPENDIX B

SUPPLEMENTAL DOCUMENTATION



FIELD NOTES

COMPACTION

THE AREA IN WHICH THE PIPE IS TO BE PLACED SHALL BE PREPARED BY REMOVING ALL EARTH TO A DEPTH OF AT LEAST 2 FEET BELOW THE INVERT [illegible] PIPE. A SAND BED SHALL BE PLACED IN [illegible] LAYERS AND [illegible] WITH TWO COMPLETE COVERAGES OF A [illegible] THIS BED SHALL BE A MINIMUM OF TWO FEET THICK PRIOR TO PLACING THE PIPE. AFTER THE PIPE IS PLACED THE REMAINDER OF THE CUT SHALL BE BACKFILLED WITH SAND AND COMPACTED IN [illegible] PROVIDING A MINIMUM OF 2 FEET OF SAND MEASURED [illegible] COMPACTION SHALL BE PERFORMED AS INDICATED FOR THE BED.

RIPRAP

RIP-RAP SHALL BE PLACED AROUND THE PIPE AS SHOWN. A 3" GRAVEL BLANKET SHALL BE PLACED AS BASE FOR THE RIPRAP. THIS FILTER SHALL BE [illegible] WELL GRADED WITHIN THE FOLLOWING LIMITS:

SIEVE SIZE	PERCENT PASSING
2"	100
1½"	90-100
¾"	70-95
No. 4	35-60
No. 16	5-35
No. 100	0-15

THE RIPRAP SHALL BE 18" IN THICKNESS AND BE REASONABLY WELL GRADED FROM THE MINIMUM SIZE STONE PERMITTED WEIGHING APPROXIMATELY 50 POUNDS, TO THE MAXIMUM SIZE WEIGHING APPROXIMATELY 500 POUNDS. NEITHER THE BREADTH NOR THICKNESS OF ANY PIECE OF RIP-RAP SHALL BE LESS THAN ONE THIRD OF ITS LENGTH.

THE RIP-RAP SHALL BE PLACED ON THE FILTER MATERIAL IN SUCH A MANNER AS TO PRODUCE A REASONABLY WELL GRADED MASS OF ROCK WITH A MINIMUM PRACTICAL PERCENTAGE OF VOIDS. RIP-RAP SHALL BE PLACED TO ITS FULL COURSE THICKNESS IN ONE OPERATION AND IN SUCH A MANNER SO AS TO AVOID DISPLACING THE GRAVEL BLANKET.

GENERAL NOTES

NOTES:

MATERIALS

REFERENCE DRAWINGS

DATE	NO.	DESCRIPTION	APPD.
	6	ADDED 1000 KVA [illegible] ASH STORAGE AREA	
	5	[illegible]	
	4	REVISED [illegible] ADD SECT. 9-M	
	3	ADDED 24" Φ [illegible] REVISED SECT. M-8	
	2	DIKES ADDED	
	1	REVISED [illegible]	

REVISIONS

KENTUCKY POWER CO.
BIG SANDY PLANT
BIG SANDY, KENTUCKY

BOTTOM ASH STORAGE AREA

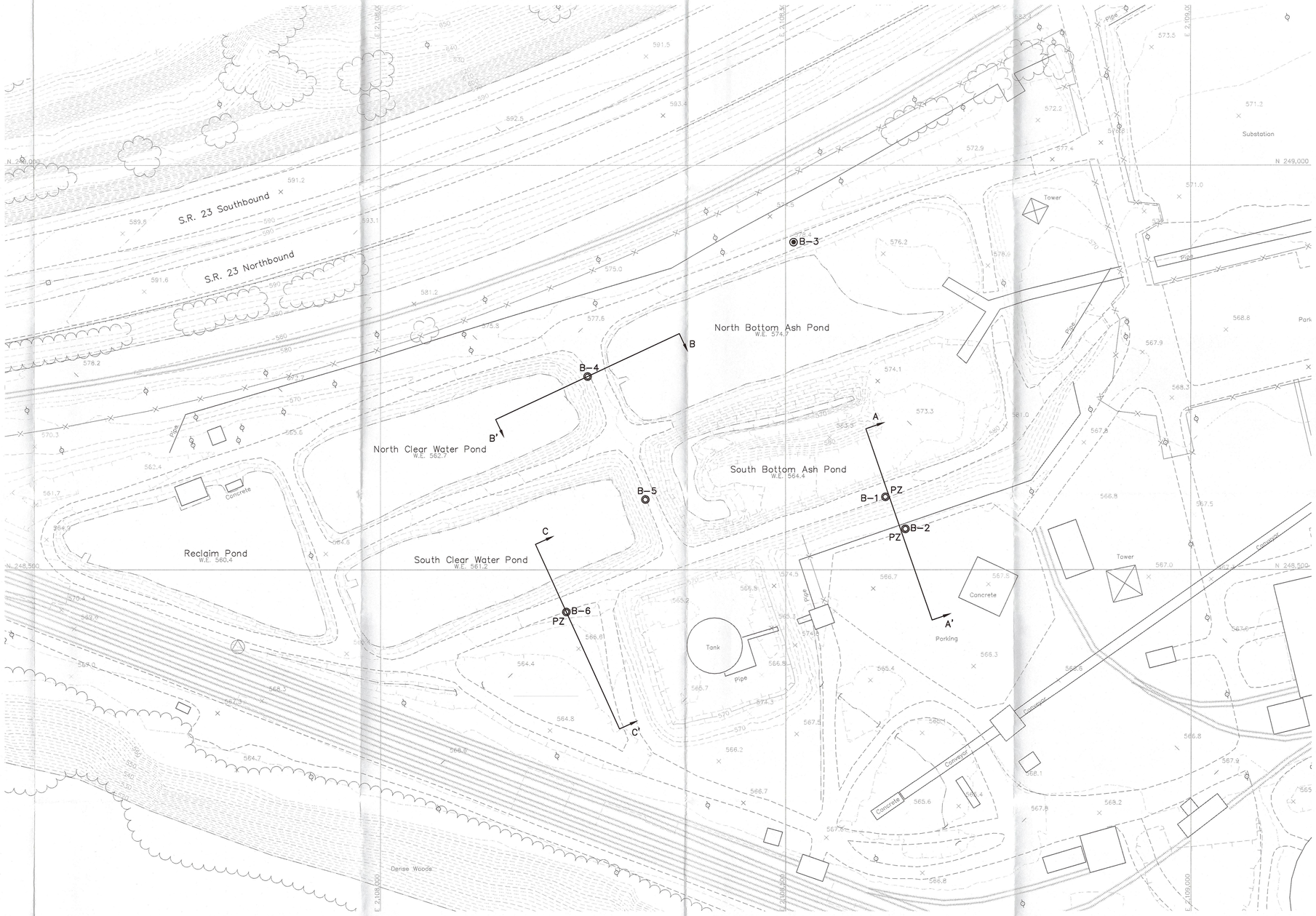
DR. NO. 12-3642-6

ARCH.	ELEC.	MECH.	STR.

SCALE: 1" = 60'
DR. RBA
CH. F.V.
APPROVED BY

AMERICAN ELECTRIC POWER SERVICE CORP.
2 BROADWAY NEW YORK

DWG. NO.



BORING LAYOUT
SCALE: 1"=50'

LEGEND

- ◎ Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests
- ◉ Soil Boring with Undisturbed (Shelby) Tube Samples and/or Standard Penetration Tests and Rock Core
- PZ Piezometer Installed in Borehole
- X–X' Stability Analysis Cross Section

NOTES

REFERENCE DRAWINGS

DATE	NO.	DESCRIPTION	APPD.

REVISIONS

INDIANA – KENTUCKY ELECTRIC CO.

BIG SANDY

LOUISA KENTUCKY

GEOTECHNICAL EXPLORATION
BORING LAYOUT

DWG. NO.

SCALE:	CIVIL ENGINEERING DIVISION
DR:	
CH:	
ARCH:	
ENGR:	
DATE:	

APPROVED BY

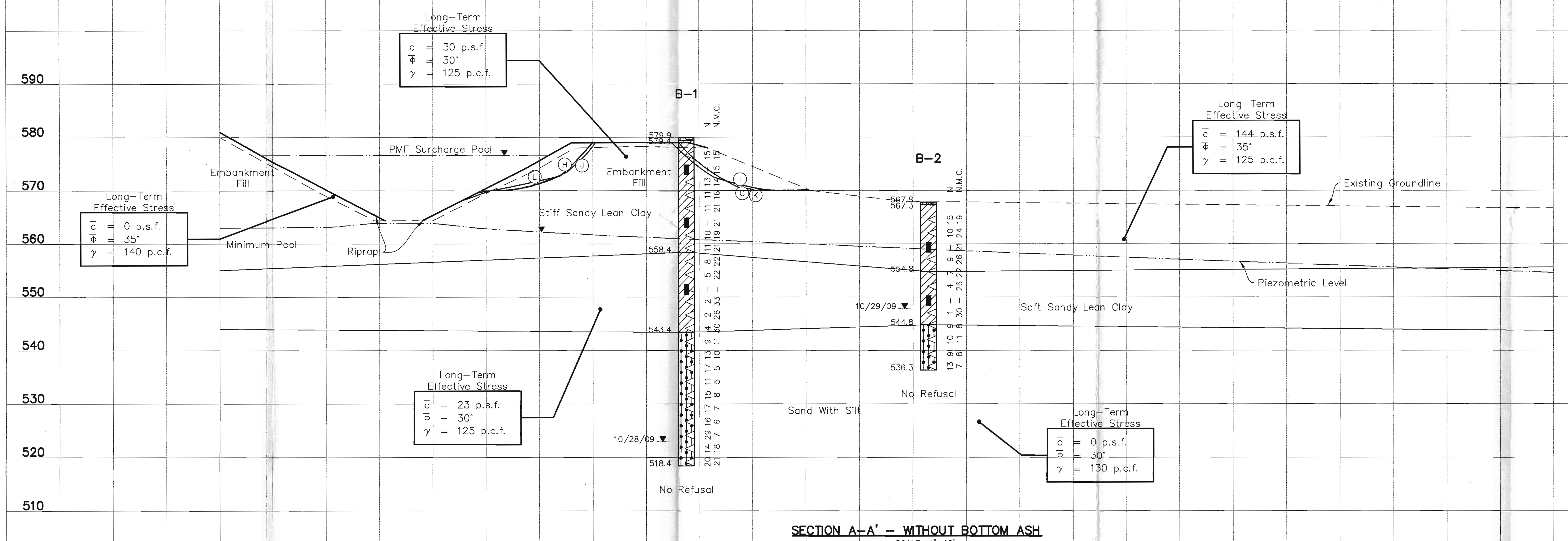
AEP AMERICAN ELECTRIC POWER
AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

SCALE: AS SHOWN	Stantec Consulting Services Inc. 11687 Lebanon Rd. Cincinnati, Ohio 45241 513-842-8200 www.stantec.com
DR: CW	
CH: EMK	
ENGR: CN	
DATE: JUNE, 2010	

Stantec

PLOT DATE: 06/17/2010 - USER: WHERL, GWYDINE
K:\1705\ACTIVE\170500012\GEOTECHNICAL\DRAWING\050618-101-R0.DWG

1050694



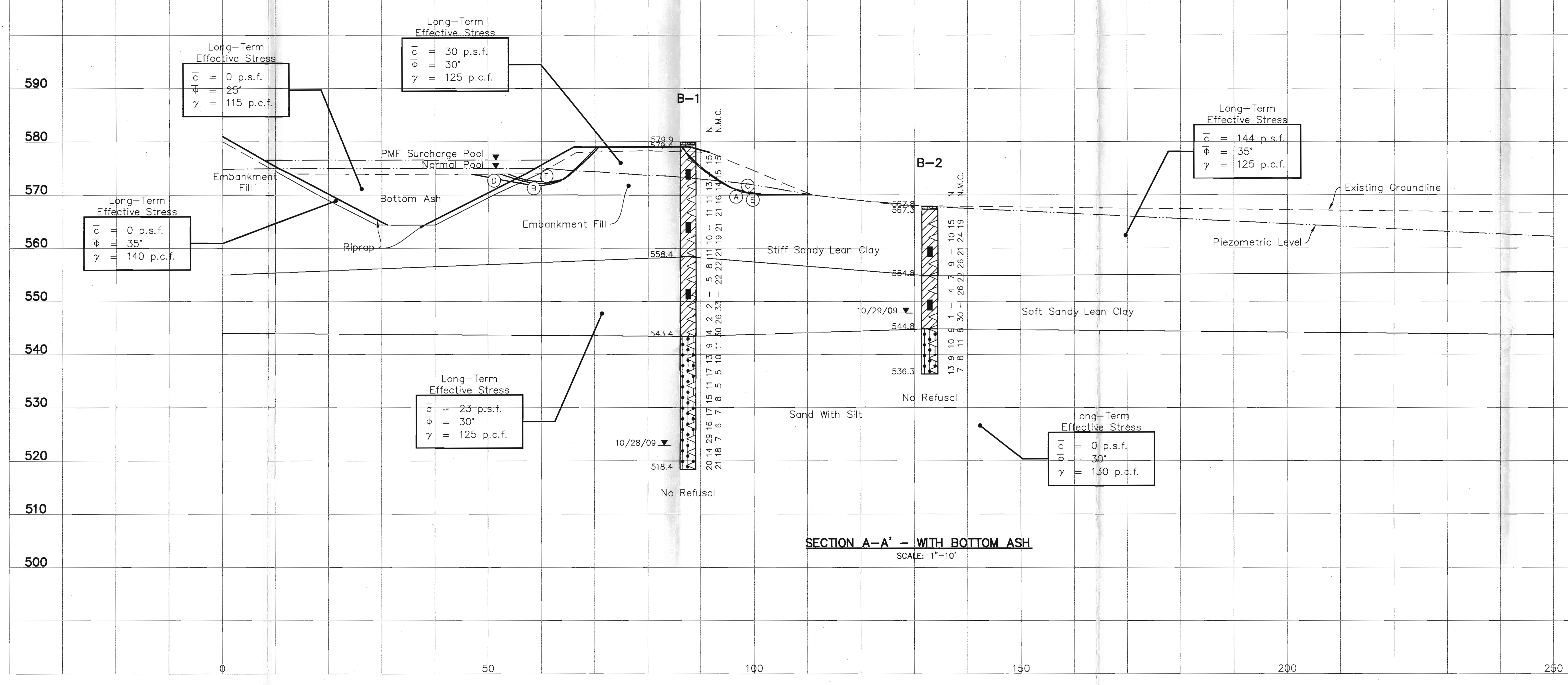
SECTION A-A' – WITHOUT BOTTOM ASH
SCALE: 1"=10'

SUMMARY OF GLOBAL STABILITY ANALYSES		
STATIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
G	Spencer's Method (Optimized)	2.0
H	Spencer's Method (Optimized)	1.7
SEISMIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
I	Spencer's Method (Optimized)	1.7
J	Spencer's Method (Optimized)	1.4
PMF EVENT		
Failure Surface	Failure Mode	Factor of Safety
K	Spencer's Method (Optimized)	2.0
L	Spencer's Method (Optimized)	1.9

LEGEND

- Sandy Lean Clay
- Silty Clay with Sand
- Silt with Sand
- Silty Clay
- Well-Graded Sand with Silt
- Shale
- Sandstone
- Rock/Gravel

- ◁ Standard Penetration Test Interval
- ▪ Undisturbed Thin-Walled (Shelby) Tube Sample
- N Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
- N.M.C. Natural Moisture Content (%)
- 03/31/09 ▼ Water Level and Date Recorded
- T.O.R.– Top of Rock (Indicates the beginning of rock-like resistance to the advancement of the augers. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)
- B.C.– Begin Rock Core
- R.Q.D. Rock Quality Designation (%)
- REC. Recovery (%)
- Refusal Auger Refusal using a carbide-tipped tooth auger bit
- No Refusal No Refusal Encountered



SECTION A-A' – WITH BOTTOM ASH
SCALE: 1"=10'

SUMMARY OF GLOBAL STABILITY ANALYSES		
STATIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
A	Spencer's Method (Optimized)	1.9
B	Spencer's Method (Optimized)	1.9
SEISMIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
C	Spencer's Method (Optimized)	1.6
D	Spencer's Method (Optimized)	1.6
PMF EVENT		
Failure Surface	Failure Mode	Factor of Safety
E	Spencer's Method (Optimized)	1.9
F	Spencer's Method (Optimized)	2.4

NOTES

REFERENCE DRAWINGS

DATE	NO.	DESCRIPTION	APPD.

REVISIONS

INDIANA – KENTUCKY ELECTRIC CO.
BIG SANDY
LOUISA KENTUCKY

GEOTECHNICAL EXPLORATION
STABILITY SEC. A-A'
WITH AND WITHOUT
BOTTOM ASH

DWG. NO.

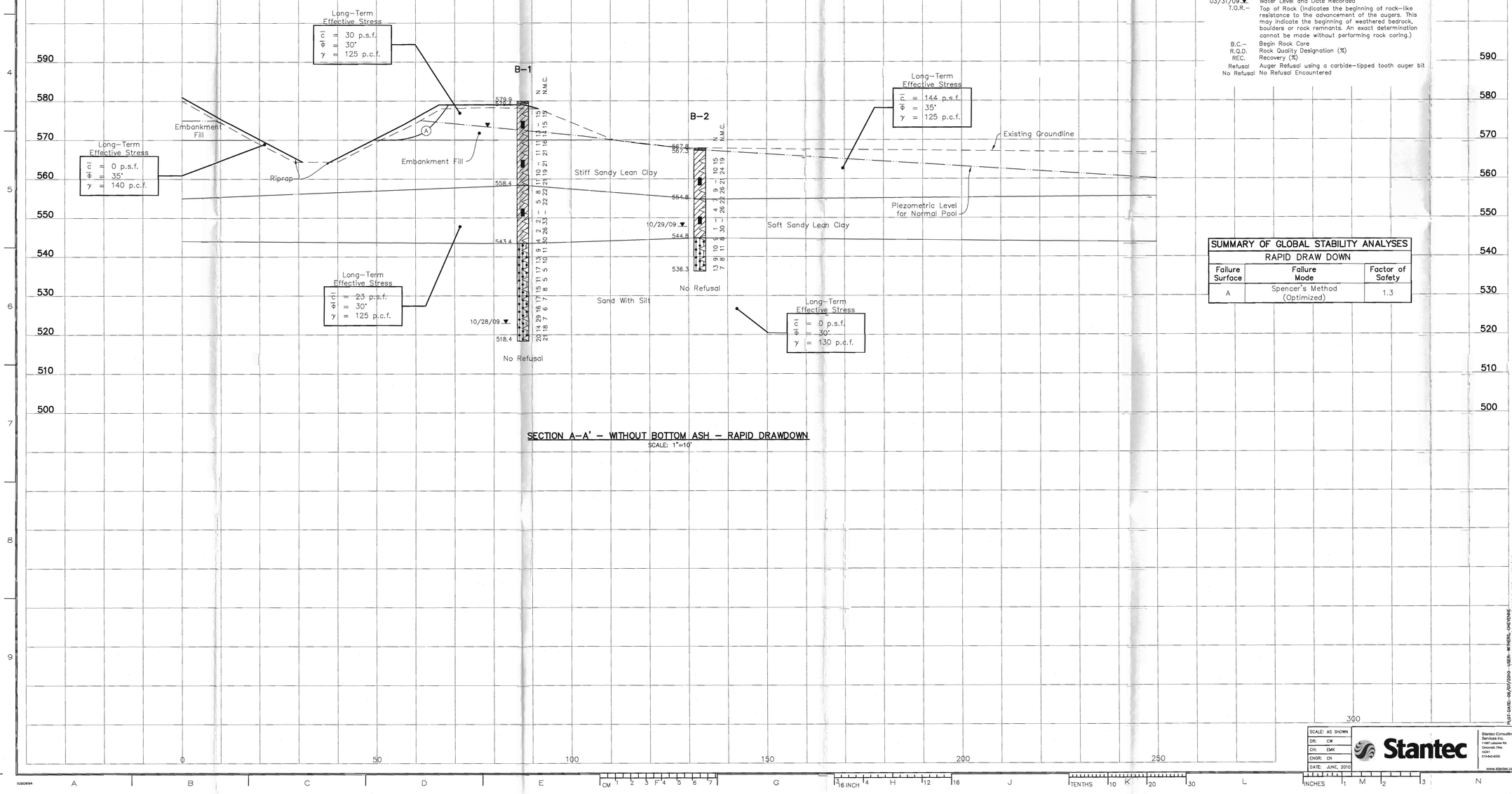
SCALE: CIVIL ENGINEERING DIVISION
DR:
CH:
ARCH:
ENGR:
DATE:
APPROVED BY

SCALE: AS SHOWN
DR: CW
CH: EMK
ENGR: ON
DATE: JUNE, 2010

Stantec

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

DWG. NO.



SECTION A–A' – WITHOUT BOTTOM ASH – RAPID DRAWDOWN
SCALE: 1"=10'

LEGEND

- Sandy Lean Clay
- Silty Clay with Sand
- Silt with Sand
- Silty Clay
- Well–Graded Sand with Silt
- Shale
- Sandstone
- Rock/Gravel

- ◁ Standard Penetration Test Interval
- ■ Undisturbed Thin–Walled (Shelby) Tube Sample
- N Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
- N.M.C. Natural Moisture Content (%)
- 03/31/09 ▼ Water Level and Date Recorded
- T.O.R.– Top of Rock (indicates the beginning of rock–like resistance to the advancement of the augers. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)
- B.C.– Begin Rock Core
- R.Q.D. Rock Quality Designation (%)
- REC. Recovery (%)
- Refusal Auger Refusal using a carbide–tipped tooth auger bit
- No Refusal No Refusal Encountered

SUMMARY OF GLOBAL STABILITY ANALYSES

RAPID DRAW DOWN

Failure Surface	Failure Mode	Factor of Safety
A	Spencer's Method (Optimized)	1.3

NOTES

REFERENCE DRAWINGS

DATE	NO.	DESCRIPTION	APPD.

REVISIONS

INDIANA – KENTUCKY ELECTRIC CO.

BIG SANDY

LOUISA KENTUCKY

GEOTECHNICAL EXPLORATION
STABILITY SEC. A–A'
RAPID DRAWDOWN

DWG. NO.

SCALE:	CIVIL ENGINEERING DIVISION
DR:	APPROVED BY
CH:	
ARCH:	
ENGR:	
DATE:	

AEP AMERICAN ELECTRIC POWER — AEP SERVICE CORP. 1 RIVERSIDE PLAZA COLUMBUS, OH 43215

SCALE:	AS SHOWN
DR:	CW
CH:	EMK
ENGR:	CN
DATE:	JUNE, 2010

Stantec

Stantec Consulting Services Inc. 11687 Lebanon Rd. Cincinnati, Ohio 45241 513-842-8200 www.stantec.com

PLOT DATE: 08/07/2009 - USER: MITHERS, CHRISTIANA, 302218-303-A-001.DWG
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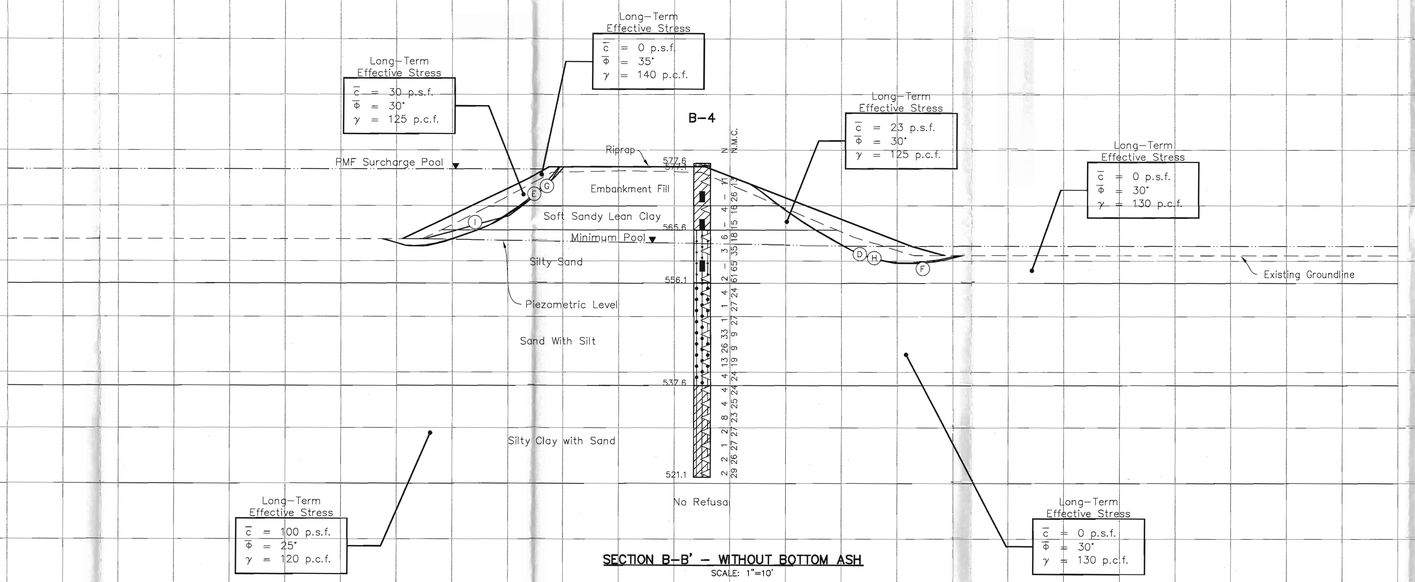
IGS0894

DWG. NO.



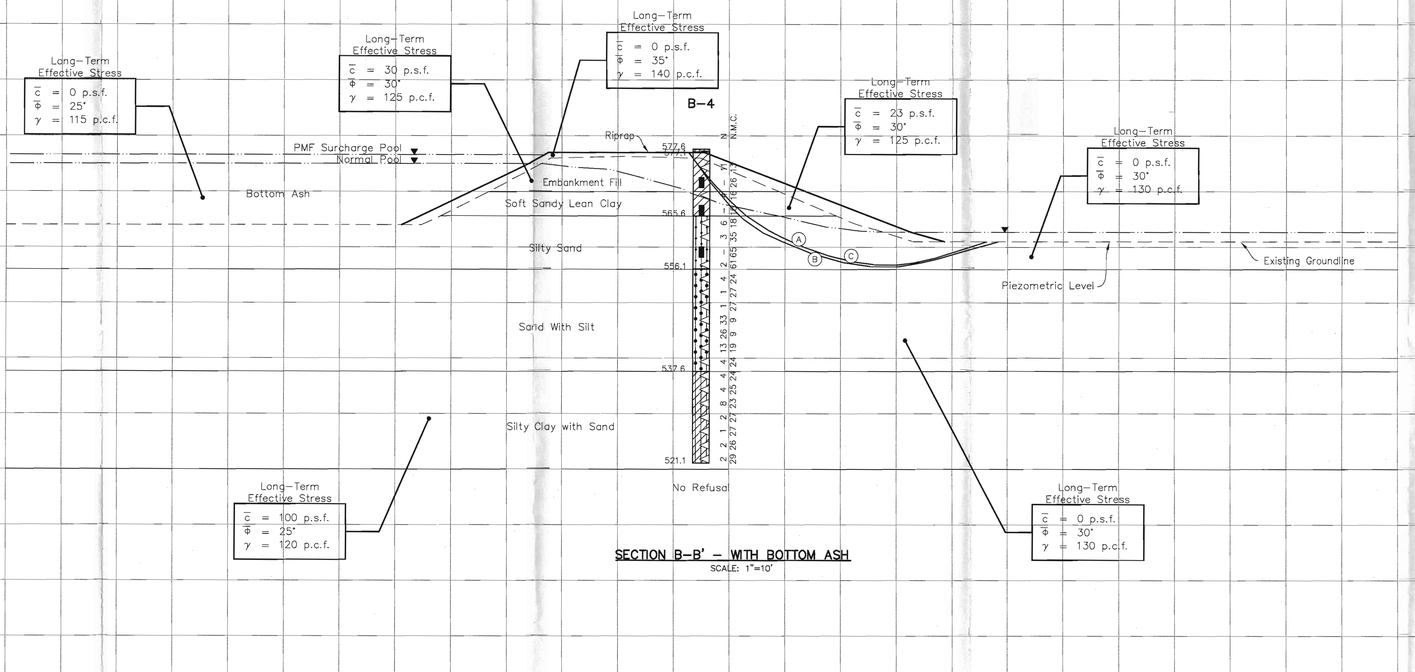
SECTION B-B' – WITHOUT BOTTOM ASH
SCALE: 1"=10'

SUMMARY OF GLOBAL STABILITY ANALYSES		
STATIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
D	Spencer's Method (Optimized)	1.6
E	Spencer's Method (Optimized)	1.4
SEISMIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
F	Spencer's Method (Optimized)	1.3
G	Spencer's Method (Optimized)	1.2
PMF EVENT		
Failure Surface	Failure Mode	Factor of Safety
H	Spencer's Method (Optimized)	1.6
I	Spencer's Method (Optimized)	1.9

LEGEND

- Sandy Lean Clay
- Silty Clay with Sand
- Silt with Sand
- Silty Clay
- Well-Graded Sand with Silt
- Shale
- Sandstone
- Rock/Gravel

- ◁ Standard Penetration Test Interval
- ■ Undisturbed Thin-Walled (Shelby) Tube Sample
- N Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
- N.M.C. Natural Moisture Content (%)
- 03/31/09 ▼ Water Level and Date Recorded
- T.O.R.– Top of Rock (Indicates the beginning of rock-like resistance to the advancement of the augers. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)
- B.C.– Begin Rock Core
- R.Q.D. Rock Quality Designation (%)
- REC. Recovery (%)
- Refusal Auger Refusal using a carbide-tipped tooth auger bit
- No Refusal No Refusal Encountered



SECTION B-B' – WITH BOTTOM ASH
SCALE: 1"=10'

SUMMARY OF GLOBAL STABILITY ANALYSES		
STATIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
A	Spencer's Method (Optimized)	1.4
SEISMIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
B	Spencer's Method (Optimized)	1.2
PMF EVENT		
Failure Surface	Failure Mode	Factor of Safety
C	Spencer's Method (Optimized)	1.4

NOTES

REFERENCE DRAWINGS

DATE	NO.	DESCRIPTION	APPD.

REVISIONS

INDIANA – KENTUCKY ELECTRIC CO.

BIG SANDY

LOUISA KENTUCKY

GEOTECHNICAL EXPLORATION
STABILITY SEC. B-B'
WITH AND WITHOUT
BOTTOM ASH

DWG. NO.

SCALE:	CIVIL ENGINEERING DIVISION
DR:	
CH:	
ARCH:	
ENGR:	
DATE:	

APPROVED BY

AEP AMERICAN ELECTRIC POWER
AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

SCALE: AS SHOWN	Stantec Consulting Services Inc. 11687 Lebanon Rd. Cincinnati, Ohio 45241 513-842-8200 www.stantec.com
DR: CW	
CH: EMK	
ENGR: CN	
DATE: JUNE, 2010	

Stantec

PLOT DATE: 09/10/2010 - USER: MITHERS, CHEYENNE
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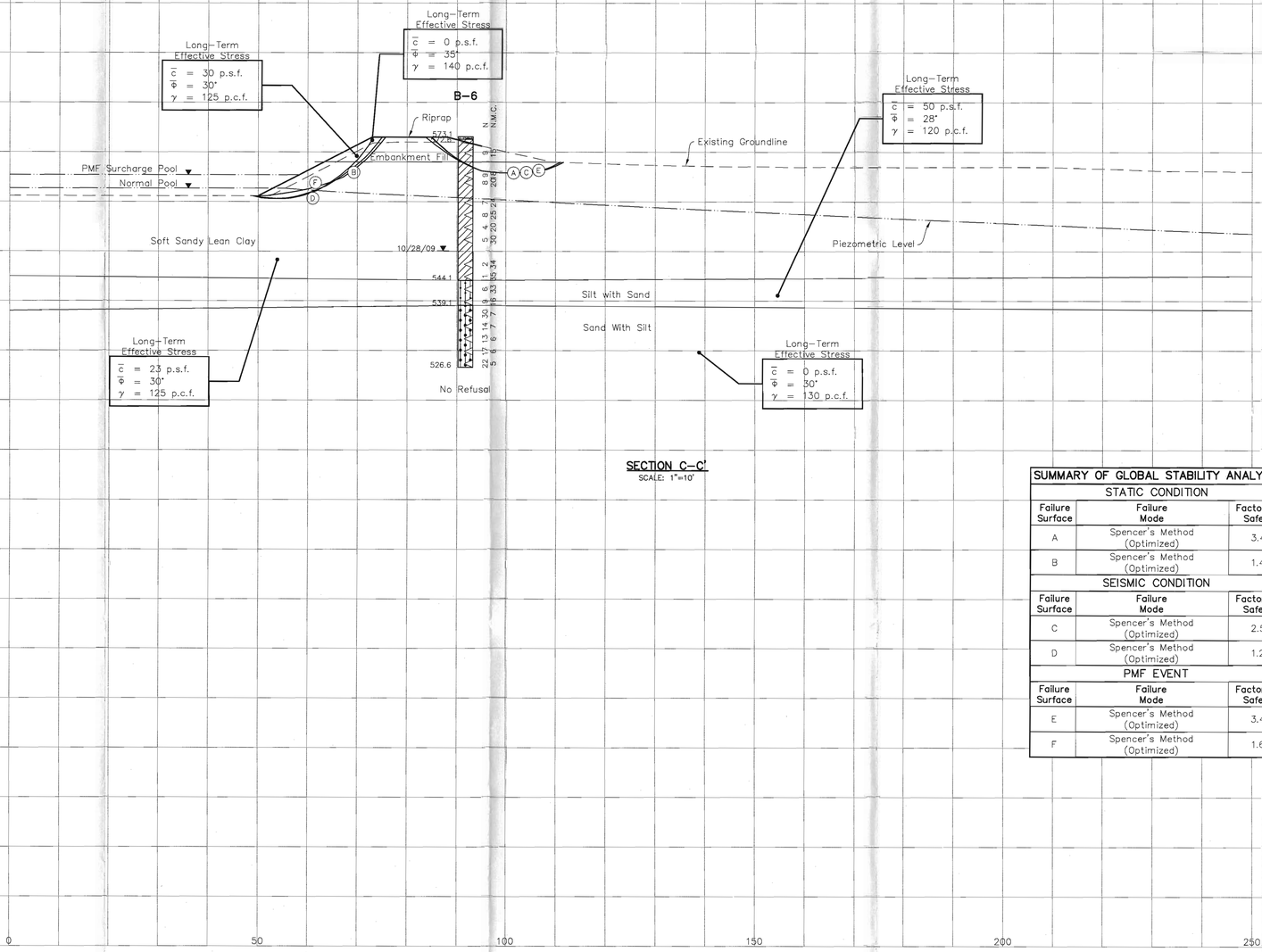
IGS0694



SECTION C-C'
SCALE: 1"=10'

SUMMARY OF GLOBAL STABILITY ANALYSES		
STATIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
A	Spencer's Method (Optimized)	3.4
B	Spencer's Method (Optimized)	1.4
SEISMIC CONDITION		
Failure Surface	Failure Mode	Factor of Safety
C	Spencer's Method (Optimized)	2.5
D	Spencer's Method (Optimized)	1.2
PMF EVENT		
Failure Surface	Failure Mode	Factor of Safety
E	Spencer's Method (Optimized)	3.4
F	Spencer's Method (Optimized)	1.6

LEGEND

- Sandy Lean Clay
- Silty Clay with Sand
- Silt with Sand
- Silty Clay
- Well-Graded Sand with Silt
- Shale
- Sandstone
- Rock/Gravel
- Standard Penetration Test Interval
- Undisturbed Thin-Walled (Shelby) Tube Sample
- N — Standard Penetration Test Blow Count with a 140 lb Safety Hammer (blows/ft.)
- N.M.C. — Natural Moisture Content (%)
- 03/31/09 ▼ — Water Level and Date Recorded
- T.O.R. — Top of Rock (indicates the beginning of rock-like resistance to the advancement of the augers. This may indicate the beginning of weathered bedrock, boulders or rock remnants. An exact determination cannot be made without performing rock coring.)
- B.C. — Begin Rock Core
- R.Q.D. — Rock Quality Designation (%)
- REC. — Recovery (%)
- Refusal — Auger Refusal using a carbide-tipped tooth auger bit
- No Refusal — No Refusal Encountered

NOTES

REFERENCE DRAWINGS

DATE	NO.	DESCRIPTION	APPD.

REVISIONS

INDIANA - KENTUCKY ELECTRIC CO.

BIG SANDY

LOUISA KENTUCKY

GEOTECHNICAL EXPLORATION
STABILITY SEC. C-C'

DWG. NO.

SCALE:	CIVIL ENGINEERING DIVISION
DR:	
CH:	
ARCH:	
ENGR:	
DATE:	

APPROVED BY

AEP AMERICAN ELECTRIC POWER
AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

SCALE: AS SHOWN
DR: CW
CH: EMK
ENGR: ON
DATE: JUNE, 2010

Stantec

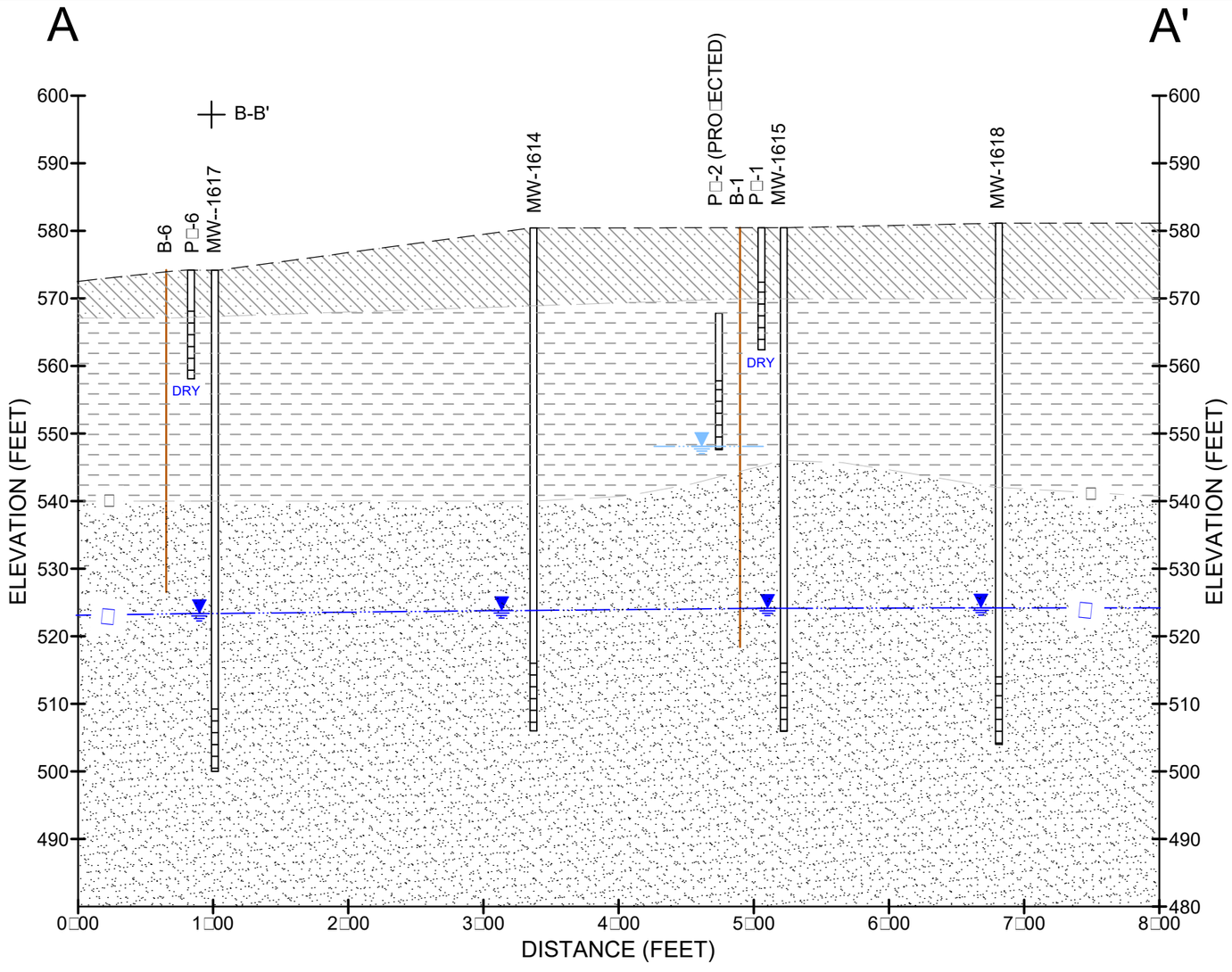
Stantec Consulting Services Inc.
11687 Lebanon Rd.
Cincinnati, Ohio
45241
513-842-8200
www.stantec.com

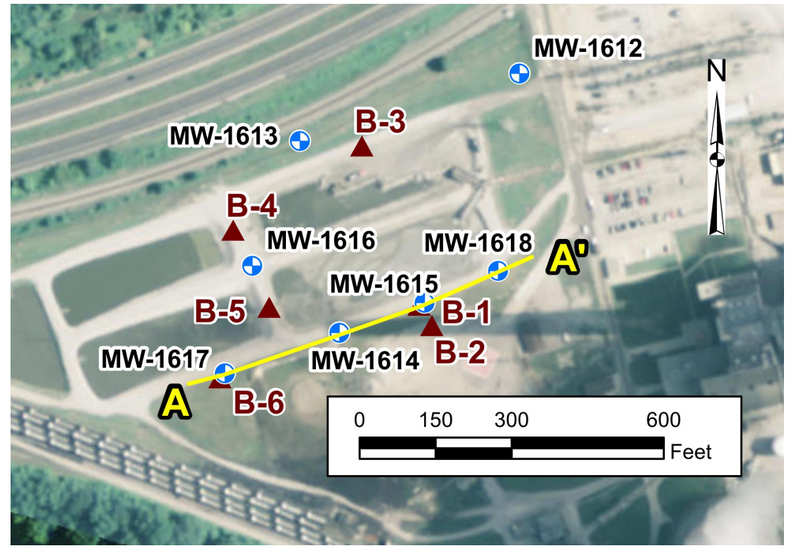
PLOT DATE: 06/17/2010 - USER: WITHERS, CATHERINE
M:\1785\ACTIVE\178539501\GEOTECHNICAL\DRAWING\539018-205-C-ASX.DWG

1050694

APPENDIX C

GEOLOGIC CROSS SECTIONS





KEY MAP

LEGEND

- FILL: LEAN CLAY, SANDY LEAN CLAY AND SILT
- ALLUVIUM: LEAN CLAY, SANDY LEAN CLAY AND SILT
- ALLUVIUM: SAND AND GRAVEL
- EXISTING GROUND SURFACE
- WATER TABLE SURFACE
- PERCHED WATER TABLE
- LITHOLOGIC CONTACT (APPROXIMATE)
- SOIL BORING
- PIE□OMETER

NOTES:
1. GROUNDWATER ELEVATION IS BASED ON THE □ULY 14, 2016 MEASUREMENT.
2. SOIL BORINGS, B-1 AND B-6, AND PIE□OMETERS P□-1, P□-2, AND P□-6 DATA WERE OBTAINED FROM REPORT OF GEOTECHNICAL EXPLORATION (STANTEC, 2010)

0 100' 200'
SCALE IN FEET (HORI□ONTAL)

0 20' 40'
SCALE IN FEET (VERTICAL)
VERTICAL EXAGGERATION □ 5X

GEOLOGIC CROSS SECTION A-A'

BIG SANDY BOTTOM ASH PONDS
LOUISA, KENTUCKY

Geosyntec consultants

PRO□ECT NO: TX0510

OCTOBER 2016

FIGURE 1

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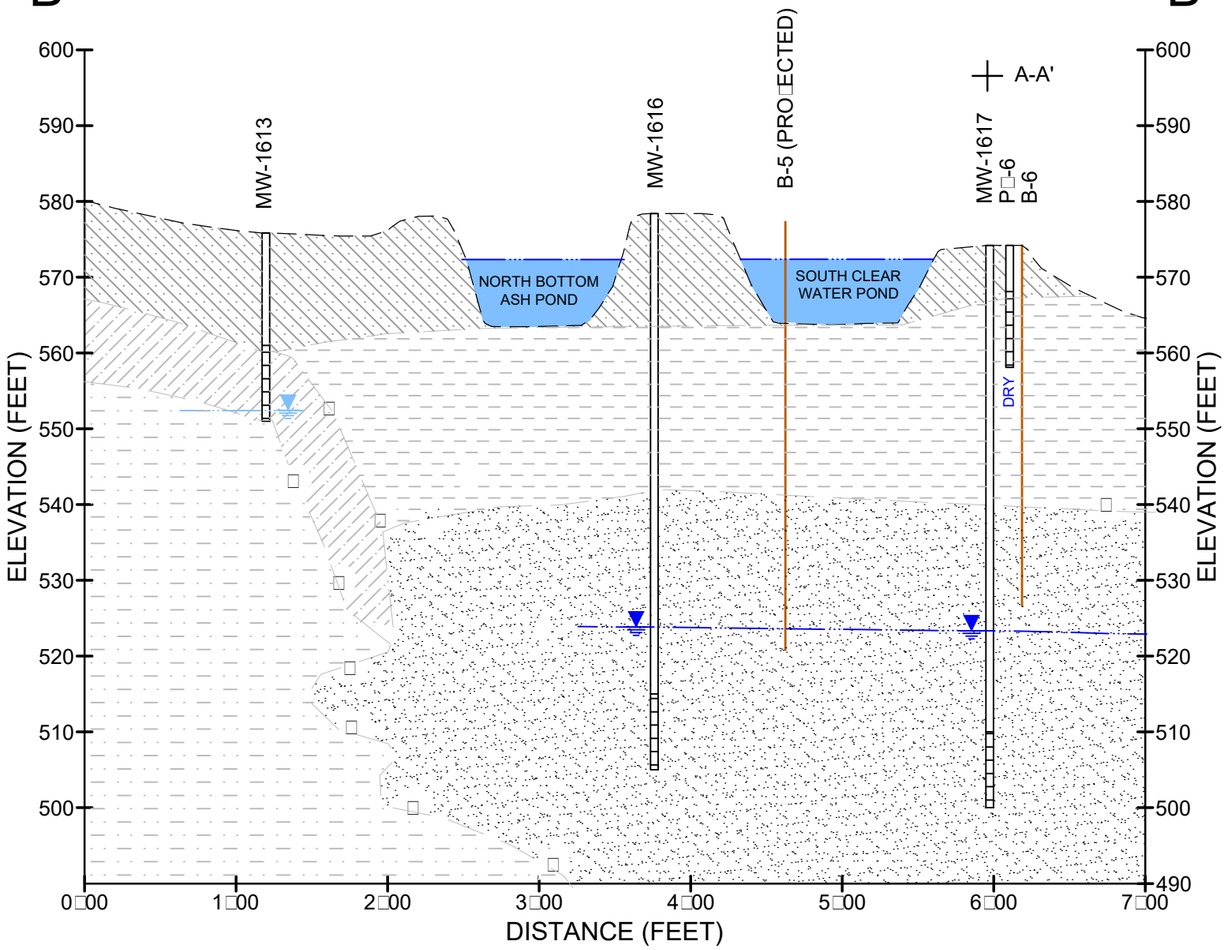

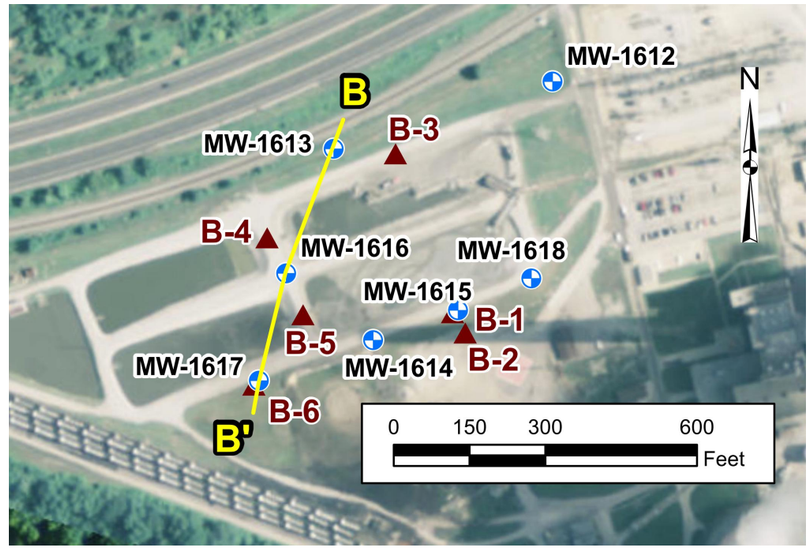

KEY MAP

LEGEND

- FILL: LEAN CLAY, SANDY LEAN CLAY AND SILT
- ALLUVIUM: LEAN CLAY, SANDY LEAN CLAY AND SILT
- ALLUVIUM: SAND AND GRAVEL
- RESIDUAL SOIL: SILT AND SAND
- WEATHERED SHALE AND COMPETENT ROCK
- EXISTING GROUND SURFACE
- WATER TABLE SURFACE
- PERCHED WATER TABLE
- LITHOLOGIC CONTACT (APPROXIMATE)
- SOIL BORING
- PIEZOMETER

NOTES:
1. GROUNDWATER ELEVATION IS BASED ON THE JULY 14, 2016 MEASUREMENT.
2. SOIL BORING, B-5 AND B-6, AND PIEZOMETER P-6 DATA WERE OBTAINED FROM REPORT OF GEOTECHNICAL EXPLORATION (STANTEC, 2010)

0 100' 200'
SCALE IN FEET (HORIZONTAL)

0 20' 40'
SCALE IN FEET (VERTICAL)
VERTICAL EXAGGERATION = 5X

GEOLOGIC CROSS SECTION B-B'

BIG SANDY BOTTOM ASH PONDS
LOUISA, KENTUCKY

Geosyntec consultants

FIGURE 2

PROJECT NO: TX0510 | OCTOBER 2016

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APPENDIX D

BORING LOGS AND MONITORING WELL CONSTRUCTION DIAGRAMS

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BORING AND WELL LOG LEGEND

LITHOLOGY	WATER LEVEL	WELL/BORING COMPLETION	SAMPLE TYPE	DESCRIPTION
				ASPHALT
				CONCRETE
				FILL
				TOPSOIL
				COBBLES
				IGNEOUS Rock
				METAMORPHIC Rock
				SEDIMENTARY Rock
				Well-graded GRAVEL (GW)
				Poorly graded GRAVEL (GP)
				Silty GRAVEL (GM)
				Clayey GRAVEL (GC)
				Well-graded GRAVEL with silt (GW-GM)
				Poorly graded GRAVEL with silt (GP-GM)
				Well-graded GRAVEL with clay (GW-GC)
				Poorly graded GRAVEL with clay (GP-GC)
				Well-graded SAND (SW)
				Poorly graded SAND (SP)
				Silty SAND (SM)
				Clayey SAND (SC)
				Well-graded SAND with silt (SW-SM)
				Poorly graded SAND with silt (SP-SM)
				Well-graded SAND with clay (SW-SC)
				Poorly graded SAND with clay (SP-SC)
				SILT (ML)
				Lean CLAY (CL)
				Organic SOIL (OL)
				Elastic SILT (MH)
				Fat CLAY (CH)
				Organic SOIL (OH)
				PEAT (PT)
				Volume Descriptors: Trace = <5% Few = 5-10% Little = 15-25% Some = 30-45% Mostly = >=50%
				Water Level During Drilling Water Level at End of Drilling/in Completed Well
				Cap Riser Screen Cement Bentonite Grout Bentonite Seal Filter Pack Backfill
			GR	Grab
			EN	Encore
			SS	Split Spoon
			SH	Shelby Tube
			CO	Core Barrel
			DP	Direct Push
			ID	Lab Sample and ID

NOTES:

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG

Well No. **MW-1612**
Page: **1 of 2**

Drilling Start Date:	**04/18/2016**	Boring Depth (ft):	**36**	Well Depth (ft):	**35**
Drilling End Date:	**04/19/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**Split Spoon**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):	**18.0**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME95**	DTW After Drilling (ft):	**13.3**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**576.06**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Dawit Yifru**	Location (X,Y):	**2108825.54, 249047.75***	Filter Pack:	**Global Filter Pack #5**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (ft)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: PID (ppm)	MEASURE: Lab Sample	ELEV. (ft msl)
0						4		(0') Grass.			
						8					
						10		(0.5') SILT (ML); mostly silt, few clay, nonplastic, medium stiff, moist, light brown, 7.5YR5/6.			
						10					
				SS	04/18 13:46	8		(2') SILT (ML); trace fine gravel, trace fine sand, mostly silt, trace clay, nonplastic, medium stiff, moist, light brown, 7.5YR5/6.			570
						8					
						10					
						12					
				SS	04/18 13:56	5		(4') SILT (ML); trace fine sand, mostly silt, little clay, low plasticity, stiff, moist, light brown, 7.5YR6/6.			
5						6					
						6					
						6					
				SS	04/18 14:14	2					
						3					
						5					
						6					
				SS	04/18 14:05	4		(8') SILT (ML); mostly silt, some clay, low plasticity, medium stiff, moist, dark brown, 7.5YR/4/4.			565
						8					
						8					
						9					
10				SS	04/18 14:22	4					
						4					
						8					
						12		(11') SILT with sand (ML); trace fine gravel, few fine-medium sand, mostly silt, few clay, low plasticity, stiff, moist, light brown, 7.5YR4/4.			
				SS	04/18 14:32	2					
						4		(12.5') Lean CLAY (CL); some silt, mostly clay, medium plasticity, stiff, moist, light brown, 7.5YR4/4.			560
						6					
						6					
				SS	04/18 14:41	3					
						4					
15						7		(15') SILT (ML); trace fine sand, mostly silt, some clay, low plasticity, medium stiff, moist, light brown, 7.5YR6/3.			
						7					
				SS	04/18 14:55	3					
						3					
						10		(17') Well-graded GRAVEL with sand (GW); little fine grained gravel, some fine-medium sand, trace silt, loose, moist, light reddish-brown, 10YR6/6.			
						12					555
				SS	04/18 15:02	10					
						10					
						12					
20						8					

NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.85 ft above ground surface. Ground surface elevation is 573.21 ft MSL.

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Client: American Electric Power
Project: Big Sandy Plant
Address: 23000 US-23, Louisa, KY

WELL LOG
Well No. MW-1612
Page: 2 of 2

Drilling Start Date:	04/18/2016	Boring Depth (ft):	36	Well Depth (ft):	35
Drilling End Date:	04/19/2016	Boring Diameter (in):	8	Well Diameter (in):	4
Drilling Company:	Layne	Sampling Method(s):	Split Spoon	Screen Slot (in):	0.010
Drilling Method:	Hollow Stem Auger	DTW During Drilling (ft):	18.0	Riser Material:	Sch 40 PVC
Drilling Equipment:	CME95	DTW After Drilling (ft):	13.3	Screen Material:	Sch 40 PVC Slotted
Driller:	Tim Woods	Top of Casing Elev. (ft msl):	576.06	Seal Material(s):	Bentonite Chips
Logged By:	Dawit Yifru	Location (X,Y):	2108825.54, 249047.75*	Filter Pack:	Global Filter Pack #5

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (ft)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: PID (ppm)	MEASURE: Lab Sample	ELEV. (ft msl)
20				SS	04/18 15:15	4 5 5 6					
				SS	04/18 15:45	3 3 3 3		(22') SILT with sand (ML); few fine sand, mostly silt, few clay, low plasticity, soft, wet, light yellowish-brown, 7.5YR5/1.			550
25				SS	04/18 15:48	2 2 3 3					
				SS	04/18 15:54	2 2 3 2		(26') Lean CLAY with sand (CL); little fine-medium sand, little silt, mostly clay, medium plasticity, soft, wet, dark gray, 10YR4/1.			545
				SS	04/18 16:06	2 2 4 4					
30				SS	04/18 16:14	3 4 3 3		(30') Lean CLAY (CL); some silt, mostly clay, medium plasticity, medium stiff, wet, dark gray, 10YR4/1.			
				SS	04/18 16:20	2 3 3 3		(32') Fat CLAY (CH); few silt, mostly clay, high plasticity, stiff, wet, dark gray, 10YR4/1.			540
35				SS	04/18 16:34	10 10 12 26					
				SS	04/18 16:51	70		(36') WEATHERED SHALE; laminated, moderately weathered, hard, light gray, moist.			535
40											

NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.85 ft above ground surface. Ground surface elevation is 573.21 ft MSL.

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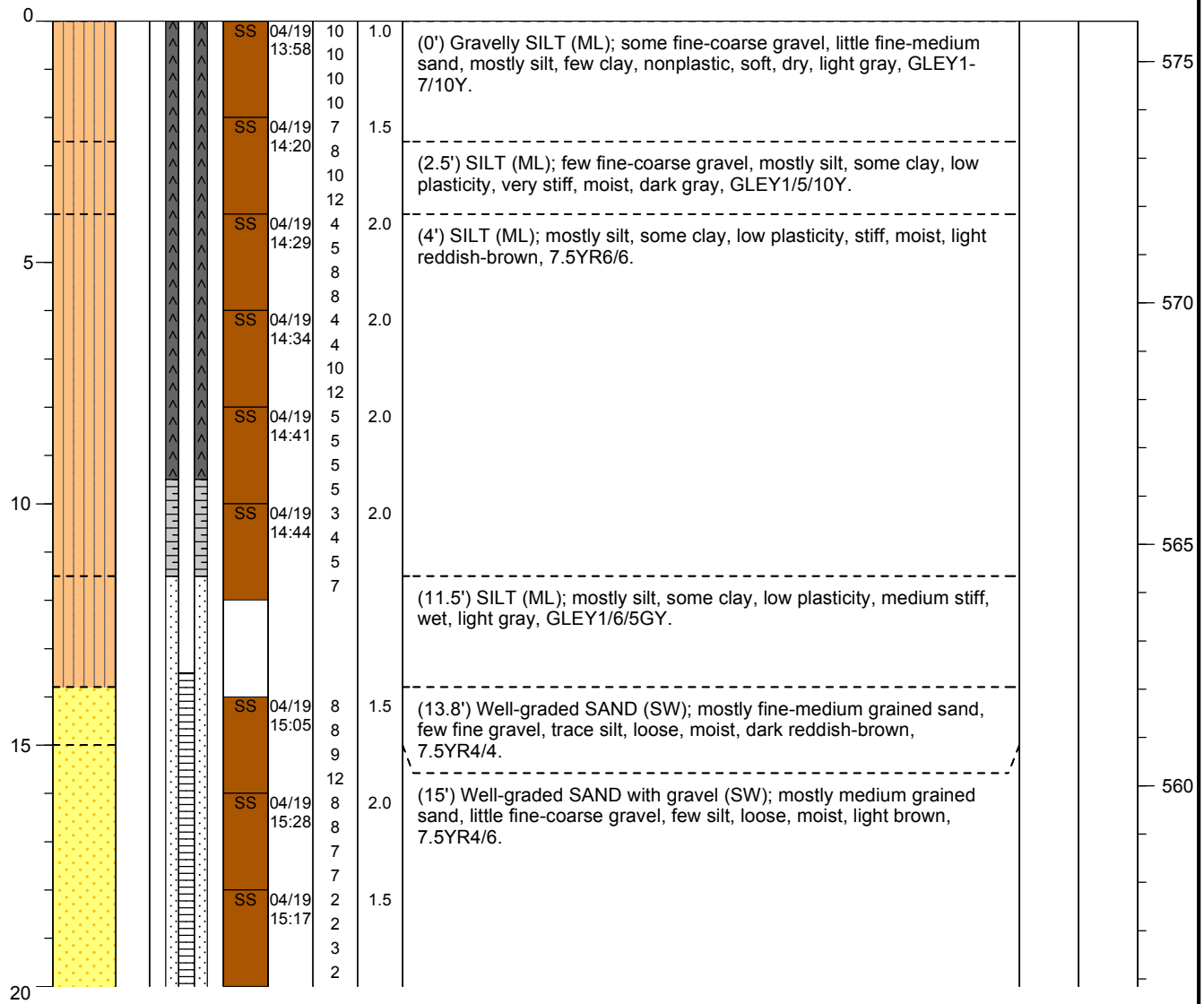
Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG

Well No. MW-1613

Page: 1 of 2

Drilling Start Date:	**04/19/2016**	Boring Depth (ft):	**24.3**	Well Depth (ft):	**24**
Drilling End Date:	**04/19/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**Split Spoon**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):	**DRY**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME95**	DTW After Drilling (ft):	**21.6**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**578.79**	Seal Material(s):	**Bentonite Pellets**
Logged By:	**Dawit Yifru**	Location (X,Y):	**2108392.50, 248915.51***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 3.01 ft above ground surface. Ground surface elevation is 578.79 ft MSL.

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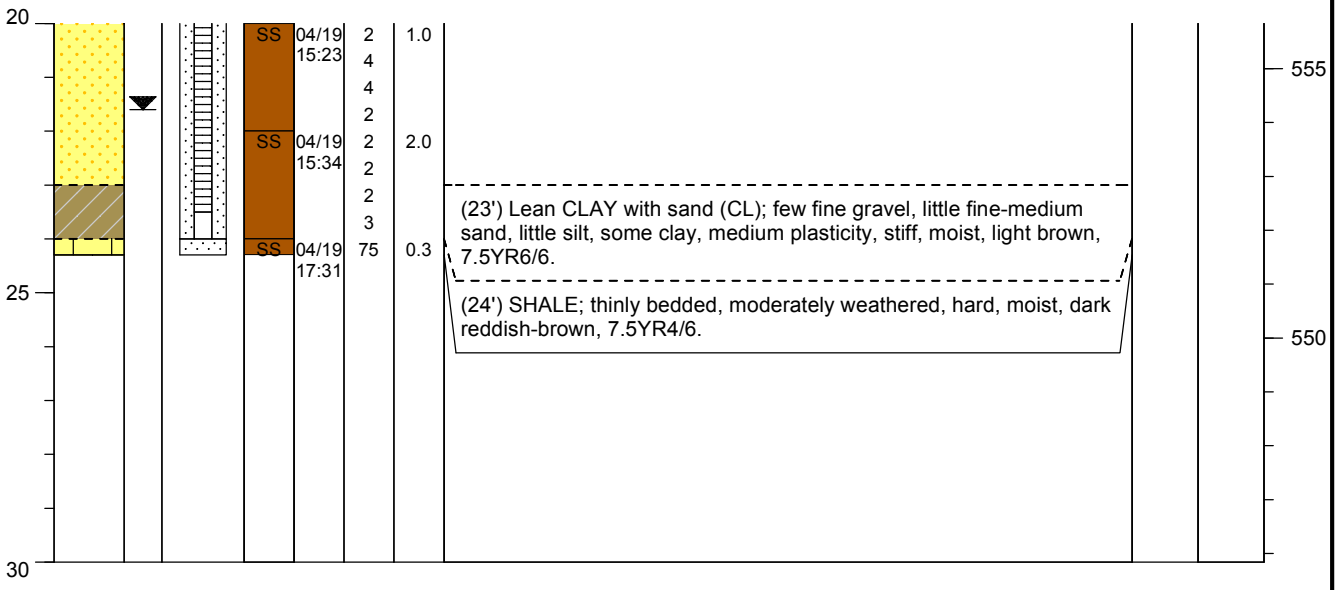
Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1613
Page: 2 of 2

Drilling Start Date:	**04/19/2016**	Boring Depth (ft):	**24.3**	Well Depth (ft):	**24**
Drilling End Date:	**04/19/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**Split Spoon**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):	**DRY**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME95**	DTW After Drilling (ft):	**21.6**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**578.79**	Seal Material(s):	**Bentonite Pellets**
Logged By:	**Dawit Yifru**	Location (X,Y):	**2108392.50, 248915.51***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 3.01 ft above ground surface. Ground surface elevation is 578.79 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1614
Page: 1 of 4

Drilling Start Date:	**04/21/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**74**
Drilling End Date:	**04/21/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**59.32**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**582.95**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108469.48, 248536.83***	Filter Pack:	**Global Filter Pack #5**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (ft)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: PID (ppm)	MEASURE: Lab Sample	ELEV. (ft msl)
0				SS		8 10	2.0	(0') SILT (ML); mostly silt, some clay, nonplastic, soft, dry, light gray, GLEY2/7/5PB, Crushed Lime For Road Gravel.			580
				SS		15 18		(2') Lean CLAY (CL); mostly silt, little clay, medium plasticity, stiff, dry, gray (7.5YR 6/1), Light Gray - Light Brown, Road Crush Heave Top of Spoon.			
				SS		12 10					
5				SS		11 12		(4') SILT (ML); little fine gravel, little fine sand, mostly silt, stiff, dry, light brown, 7.5YR/5/2.			575
				SS		20 13					
				SS		12 13					
				SS		4 11					
10				SS		10 16					570
				SS		5 5					
				SS		5 5					
				SS		5 4					
15				SS		4 5		(14') SILT (ML); little fine gravel, little fine sand, mostly silt, nonplastic, stiff, wet, brown.			565
				SS		5 5					
				SS		8 8					
				SS		10 12					
20				SS		5 6					
				SS		6 8					
				SS		5 5					
				SS		6 6					
				SS		5 5					
				SS		4 5					

NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.56 ft above ground surface. Ground surface elevation is 582.95 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1614
Page: 2 of 4

Drilling Start Date:	**04/21/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**74**
Drilling End Date:	**04/21/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**59.32**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**582.95**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108469.48, 248536.83***	Filter Pack:	**Global Filter Pack #5**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (ft)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: PID (ppm)	MEASURE: Lab Sample	ELEV. (ft msl)
20				SH		2		(20') SILT (ML); little fine gravel, little fine sand, mostly silt, nonplastic, stiff, wet, brown.			560
				SS		4 4					
				SS		5 4					
25				SH		6 7 9					555
				SS		1 1					
				SS		4 2					
30				SS		1 2					550
				SS		2 2					
						2 1					
35				SS		2 2		(36') Lean CLAY with sand (CL); little fine-medium sand, little silt, some clay, medium plasticity, stiff, wet, light brown, 7.5YR/4/6.		PZ-1603 (36-38)	545
				SS		3 2					
						2 3					
40						3 2					

NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.56 ft above ground surface. Ground surface elevation is 582.95 ft MSL.

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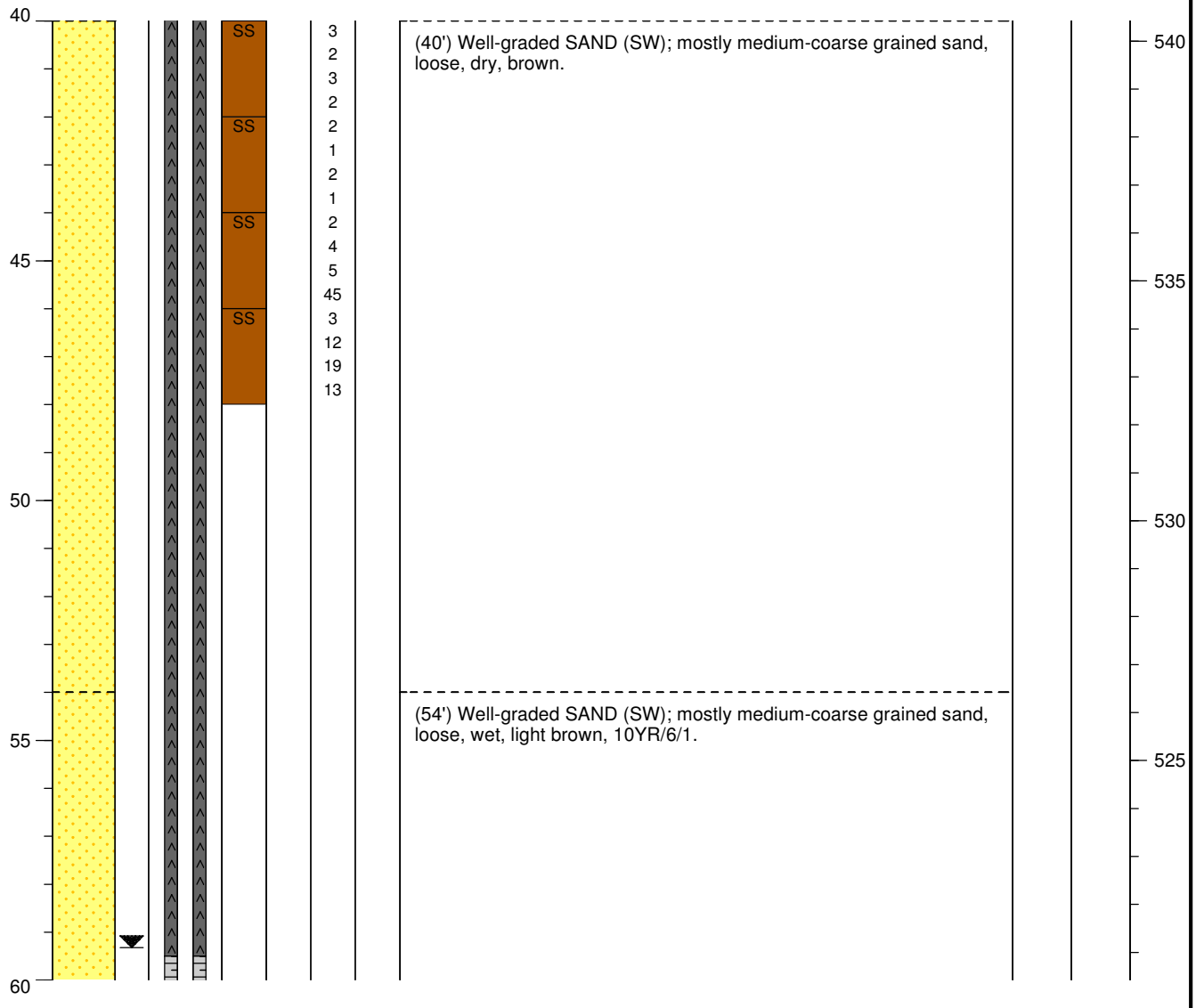
Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1614
Page: 3 of 4

Drilling Start Date:	**04/21/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**74**
Drilling End Date:	**04/21/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**59.32**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**582.95**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108469.48, 248536.83***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.56 ft above ground surface. Ground surface elevation is 582.95 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1614
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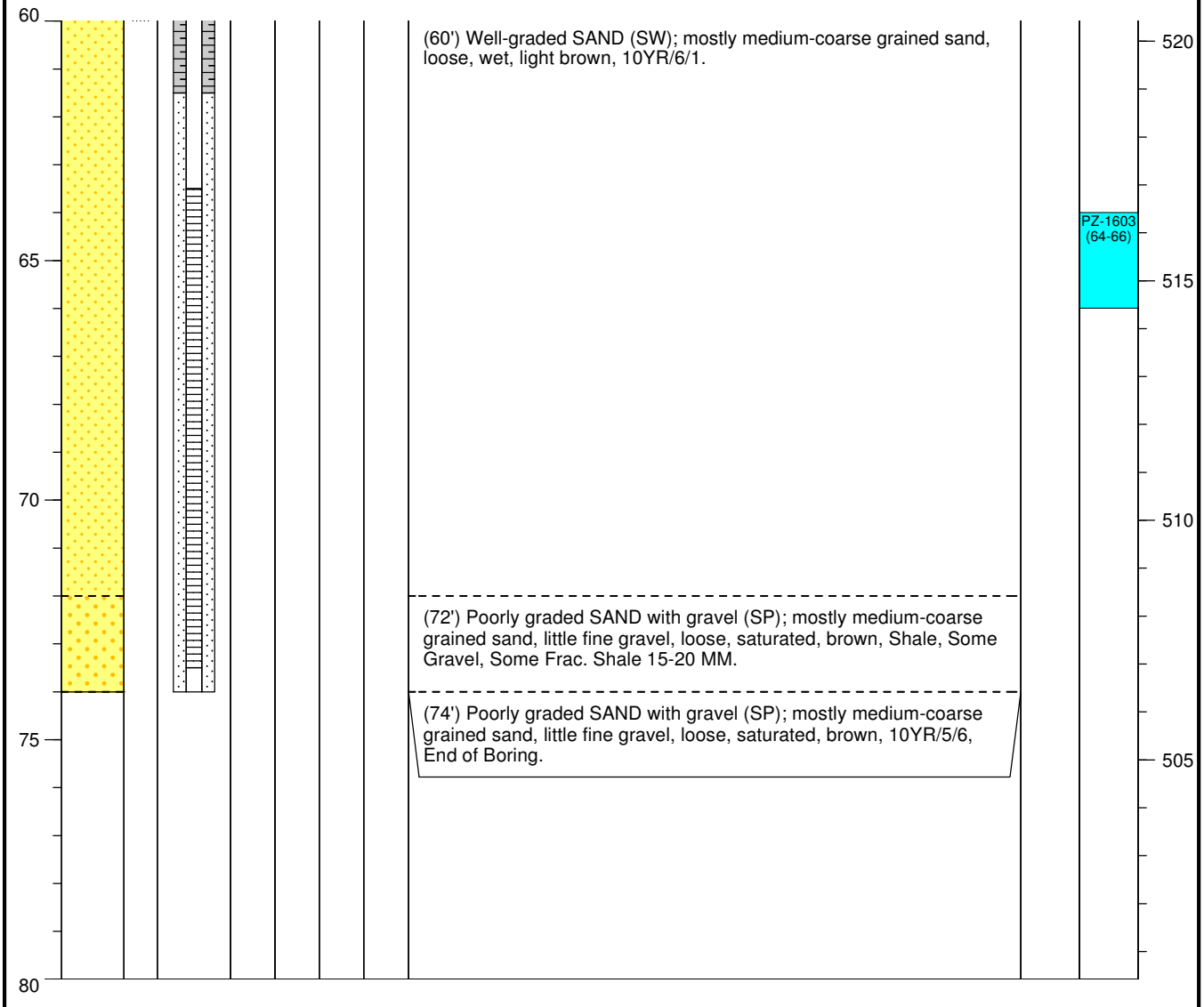
Drilling Start Date:	**04/21/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**74**
Drilling End Date:	**04/21/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**59.32**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**582.95**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108469.48, 248536.83***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.56 ft above ground surface. Ground surface elevation is 582.95 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1615
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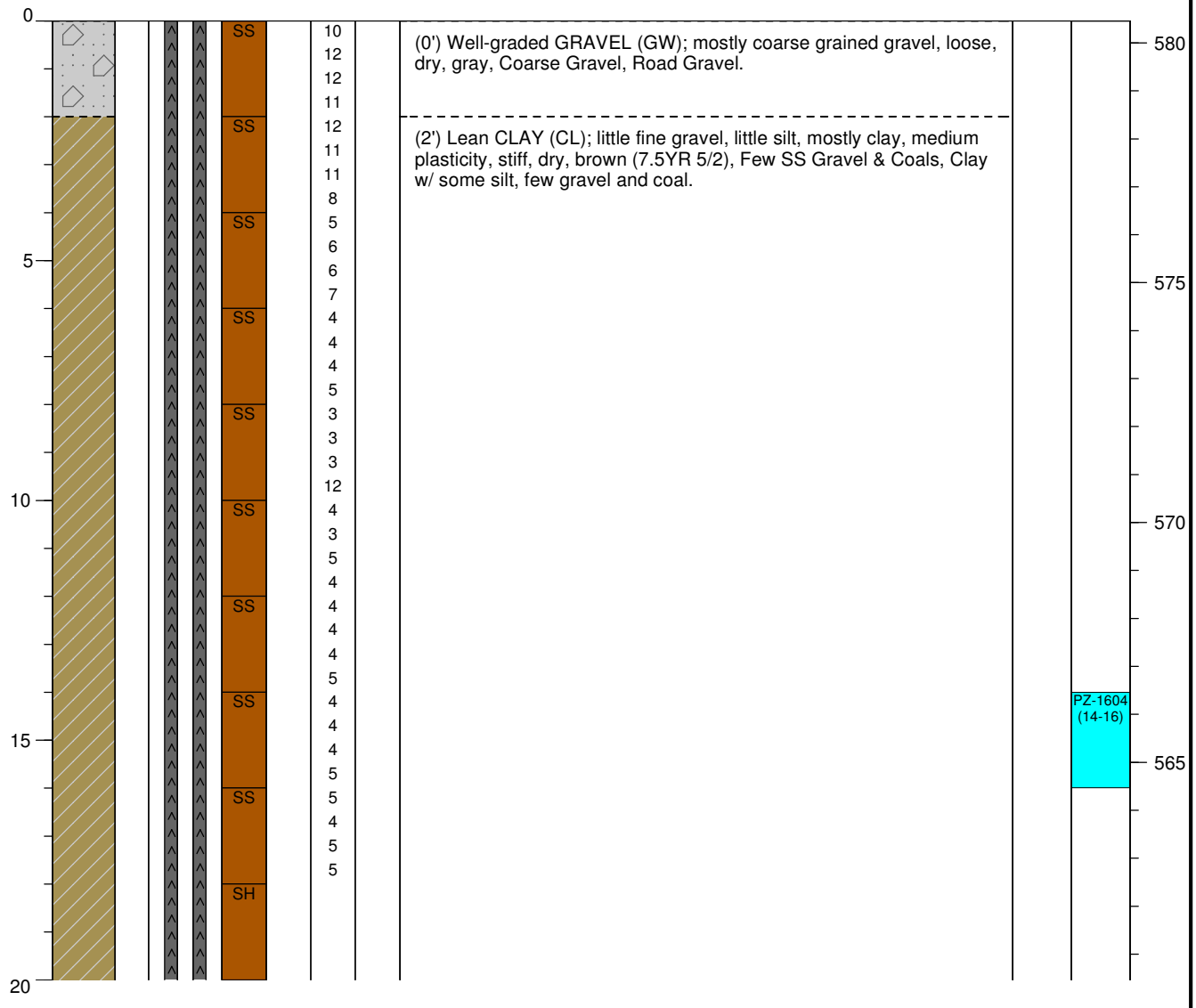
Drilling Start Date:	**05/04/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**74**
Drilling End Date:	**05/04/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**56.33**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**583.22**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108637.78, 248596.46***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.80 ft above ground surface. Ground surface elevation is 583.22 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1615
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Drilling Start Date:	**05/04/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**74**
Drilling End Date:	**05/04/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**56.33**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**583.22**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108637.78, 248596.46***	Filter Pack:	**Global Filter Pack #5**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (ft)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: PID (ppm)	MEASURE: Lab Sample	ELEV. (ft msl)
20				SS		5					560
						5					
						5					
						5					
				SH							
				SS		2		(24') SILT (ML); mostly silt, little clay, stiff, wet, light red (2.5YR 6/6), Light Brown silt w/ some clay.			
25						3					555
						3					
				SS		3					
						4					
						2					
				SS		3					
						3					
						3					
						4					
30				SS		3					550
						3					
						2					
						3					
				SS		3					
						2					
						3					
						2					
						3					
				SS		3		(34') Poorly graded SAND (SP); mostly medium-coarse grained sand, loose, wet, light red (2.5YR 6/8), Light Brown Medium-Coarse Sand, Poorly Graded.			
35						3					545
						4					
				SS		3					
						3					
						4					
						4					
				SS		3					
						4					
						5					
						5					
40						4					

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Top of casing (TOC) is 2.80 ft above ground surface. Ground surface elevation is 583.22 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1615
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Drilling Start Date:	**05/04/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**74**
Drilling End Date:	**05/04/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**56.33**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**583.22**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108637.78, 248596.46***	Filter Pack:	**Global Filter Pack #5**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (ft)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: PID (ppm)	MEASURE: Lab Sample	ELEV. (ft msl)
40											540
45				SS		5 4 4 5 5		(40') Poorly graded SAND (SP); mostly medium-coarse grained sand, loose, wet, light red (2.5YR 6/8), Light Brown Medium-Coarse Sand, Poorly Graded.			535
				SS		3 4 4 4 5					
				SS		5 4 5 5 5					
50				SS		5 4 5 6 6					530
				SS		5 5 6 5 5					
55				SS		6 6 5 5 7					525
				SS		5 6 5 7 7					
60						5 6					

NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1615
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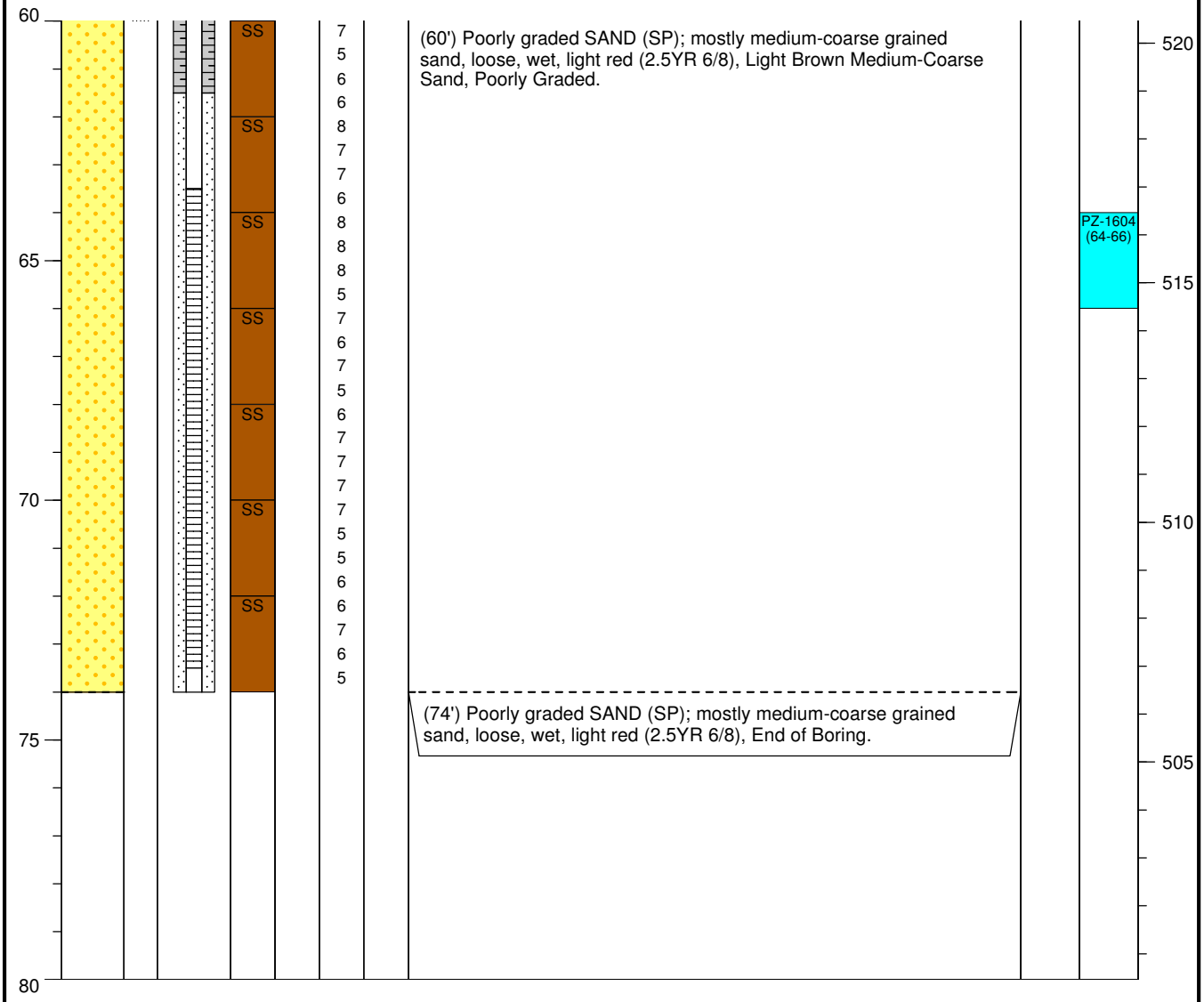
Drilling Start Date:	**05/04/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**74**
Drilling End Date:	**05/04/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**56.33**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**583.22**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108637.78, 248596.46***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
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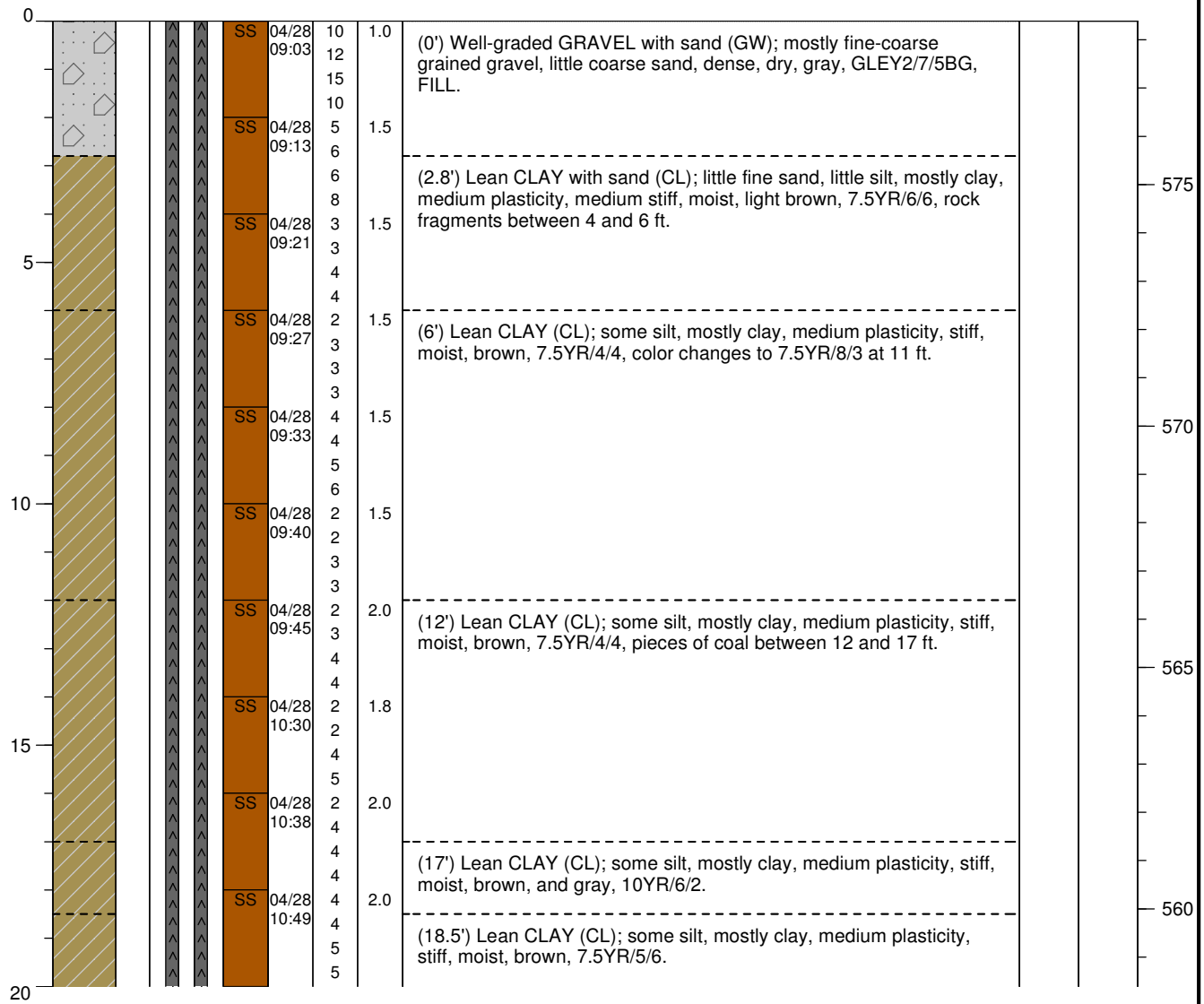
Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1616
Page: 1 of 4

Drilling Start Date:	**04/28/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**73**
Drilling End Date:	**04/28/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**2**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):	**56.0**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME95**	DTW After Drilling (ft):	**54.7**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**578.19**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Dawit Yifru**	Location (X,Y):	**2108298.34, 248668.57***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 0.23 ft below ground surface. Ground surface elevation is 578.19 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1616
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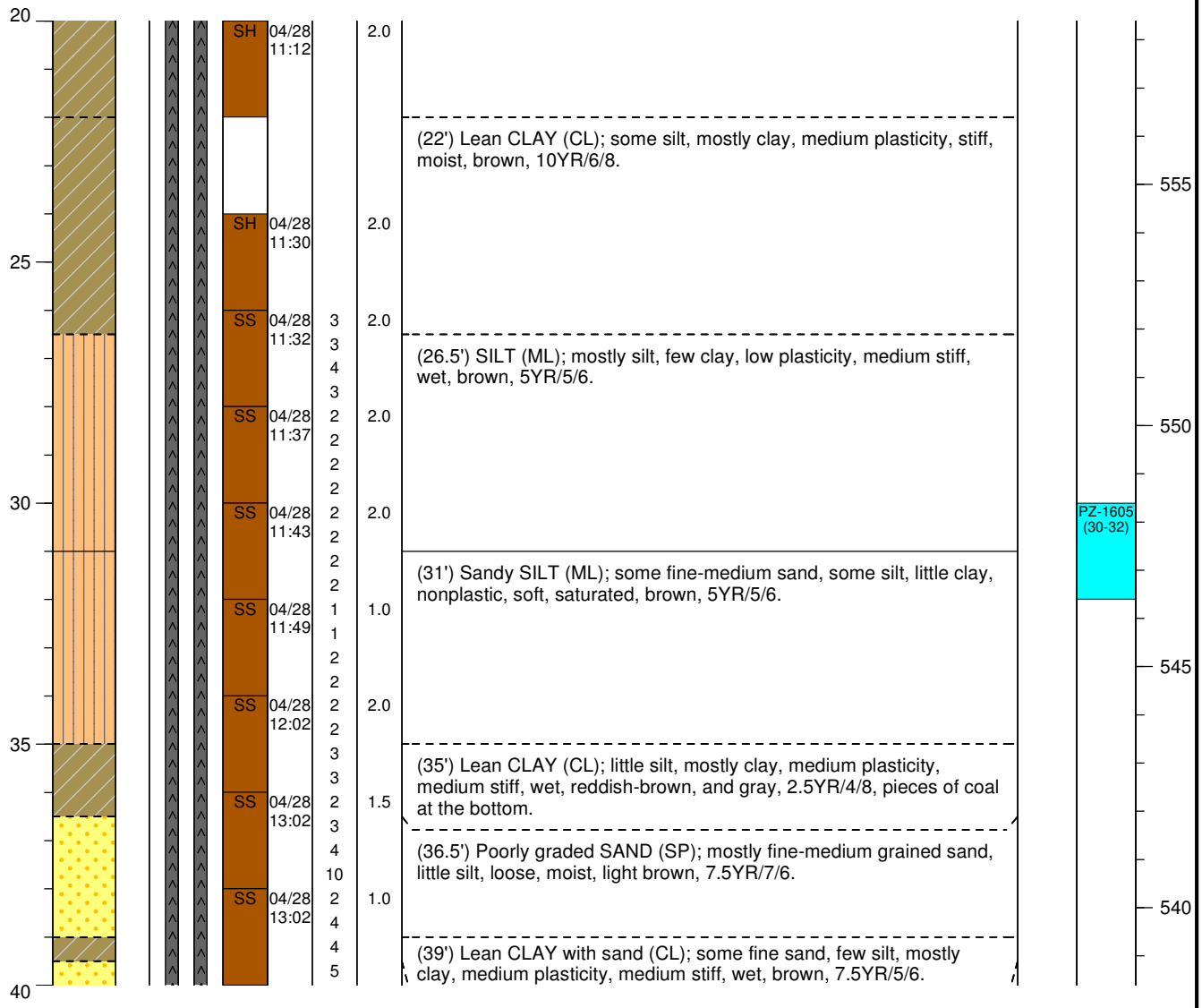
Drilling Start Date:	**04/28/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**73**
Drilling End Date:	**04/28/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**2**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):	**56.0**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME95**	DTW After Drilling (ft):	**54.7**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**578.19**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Dawit Yifru**	Location (X,Y):	**2108298.34, 248668.57***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1616
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Drilling Start Date:	**04/28/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**73**
Drilling End Date:	**04/28/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**2**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):	**56.0**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME95**	DTW After Drilling (ft):	**54.7**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**578.19**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Dawit Yifru**	Location (X,Y):	**2108298.34, 248668.57***	Filter Pack:	**Global Filter Pack #5**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (ft)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: PID (ppm)	MEASURE: Lab Sample	ELEV. (ft msl)
40				SS	04/28 13:13	2 5 5	1.5	(39.5') Poorly graded SAND (SP); mostly fine grained sand, some silt, medium dense, wet, brown, 7.5YR/6/6, 1-inch rock pieces at 45 ft, 2-inches of clay sens at 45.5.			
				SS	04/28 13:24	5 5 6	1.5				535
				SS	04/28 13:29	5 5 6	1.0				
45				SS	04/28 13:35	4 4 5 5 5	1.5	(46') Poorly graded SAND (SP); mostly fine grained sand, some silt, loose, wet, white, GLEY1/8/5GY.			
				SS	04/28 13:43	5 6 6 7 7	1.5				530
				SS	04/28 13:50	7 8 9 5 6	1.5	(49') Poorly graded SAND (SP); mostly fine grained sand, some silt, loose, wet, light brown, 7.5YR/7/6, pieces of coal at 49 ft.			
50						6 8		(50') Lean CLAY (CL); few silt, mostly clay, medium plasticity, stiff, wet, dark gray, GLEY2/5/5PB.			
				SS	04/28 13:59	5 5 5 6	1.5	(51') Poorly graded SAND (SP); mostly fine grained sand, little silt, loose, wet, reddish-brown, 7.5YR/5/8, saturated at 53.5 ft.			525
				SS	04/28 14:06	3 3 4 5	2.0	(54.5') Lean CLAY with sand (CL); few fine sand, little silt, mostly clay, medium plasticity, stiff, wet, dark gray, GLEY2/8/5PB.			
55				SS	04/28 14:15	4 5 5 6	1.8	(55') Poorly graded SAND (SP); mostly fine-medium grained sand, little silt, loose, wet, light brown, 7.5YR/7/4.			
				SS	04/28 14:23	4 4 4 5	2.0	(56') Poorly graded SAND (SP); mostly fine-medium grained sand, little silt, loose, saturated, brown, 7.5YR/6/6, 2-inches of clay at 57.5 ft, pieces of coal at 58 through 66 ft, rounded gravel at 65 through 66 ft.			520
60											

NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 0.23 ft below ground surface. Ground surface elevation is 578.19 ft MSL.

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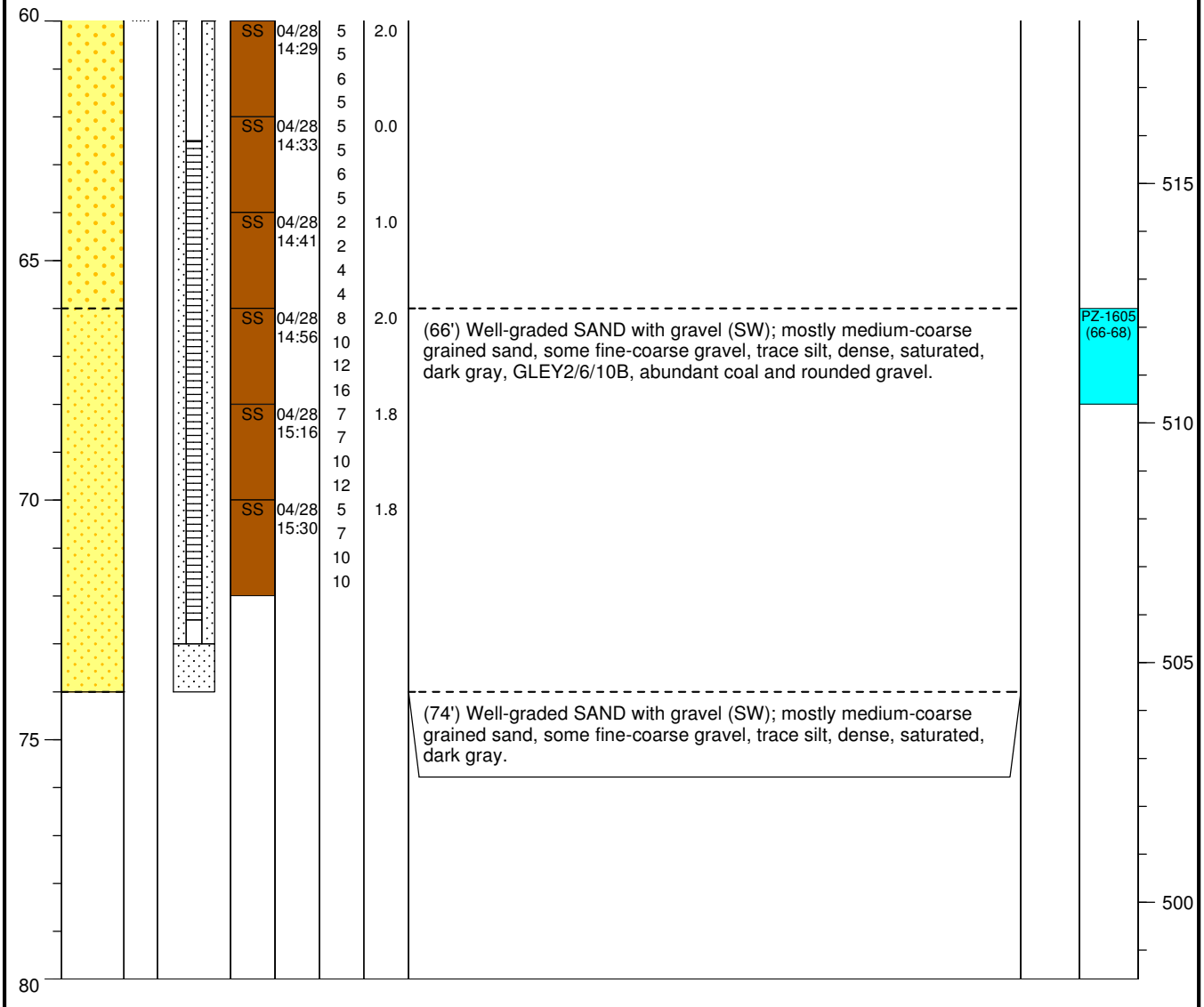
Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1616
Page: 4 of 4

Drilling Start Date:	**04/28/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**73**
Drilling End Date:	**04/28/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**2**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):	**56.0**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME95**	DTW After Drilling (ft):	**54.7**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**578.19**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Dawit Yifru**	Location (X,Y):	**2108298.34, 248668.57***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 0.23 ft below ground surface. Ground surface elevation is 578.19 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG

Well No. **MW-1617**

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Drilling Start Date:	**05/06/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**60**
Drilling End Date:	**05/06/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**Split Spoon**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**53.73**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**577.14**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108244.28, 248457.12***	Filter Pack:	**Global Filter Pack #5**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (ft)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: PID (ppm)	MEASURE: Lab Sample	ELEV. (ft msl)
0				SS		8		(0') SILT (ML); mostly silt, little clay, stiff, dry, reddish yellow (7.5YR 6/6), Silt with Some Clay.			
						10					
						10					
						8					
				SS		11					
						13					
						12					
						11					
				SS		8					570
						10					
5						7					
						6					
				SS		7					
						7					
						6					
						5					
				SS		6					
						7					
						6					
						5					
10				SS		8		(10') Lean CLAY (CL); little fine-medium sand, some silt, some clay, medium plasticity, stiff, dry, light reddish-brown, 5YR/6/5.			565
						6					
						6					
						5					
				SS		6					
						6					
						5					
						8					
				SS		6					560
						5					
15						5					
						5					
				SS		4				PZ-1606 (16-18)	
						5					
						4					
						3					
				SS		4					
						5					
						4					555
						3					
20											

NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.96 ft above ground surface. Ground surface elevation is 577.14 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1617
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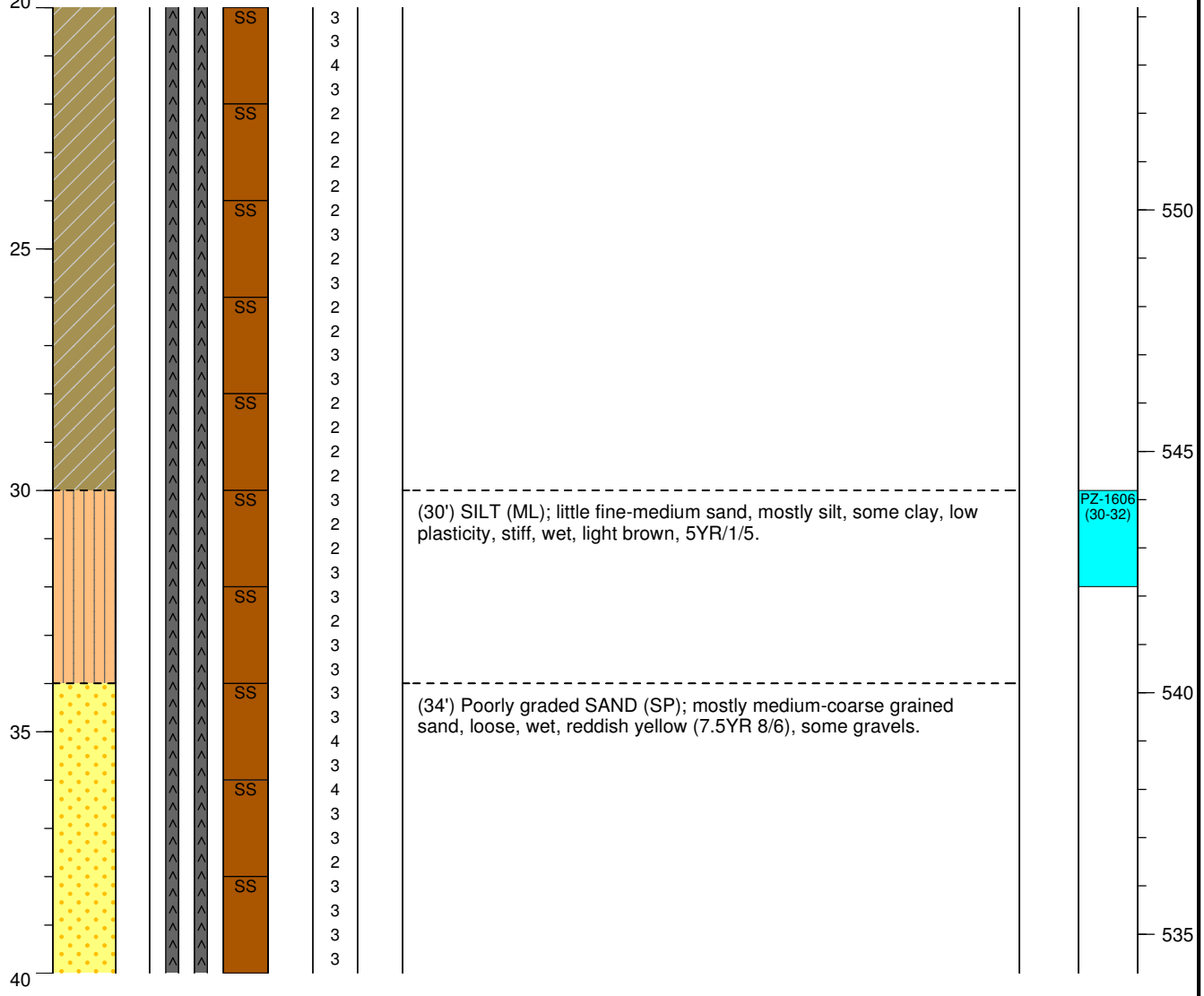
Drilling Start Date:	**05/06/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**60**
Drilling End Date:	**05/06/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**Split Spoon**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**53.73**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**577.14**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108244.28, 248457.12***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.96 ft above ground surface. Ground surface elevation is 577.14 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1617
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Drilling Start Date:	**05/06/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**60**
Drilling End Date:	**05/06/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**Split Spoon**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**53.73**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**577.14**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108244.28, 248457.12***	Filter Pack:	**Global Filter Pack #5**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (ft)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: PID (ppm)	MEASURE: Lab Sample	ELEV. (ft msl)
40				SS		4		(40') Poorly graded SAND (SP); mostly medium-coarse grained sand, loose, wet, reddish yellow (7.5YR 8/6), some gravels.			
						3					
						3					
						2					
				SS		4					
						5					
						4					
						4					
				SS		5					
						4					
45						5					530
						5					
				SS		4					
						5					
						5					
						4					
				SS		3					
						4					
						5					
				SS		3					
						4					
50						4					525
						3					
				SS		4					
						4					
						4					
				SS		4					
						4					
						4					
						4					
				SS		4					
						4					
55						5					520
						5					
				SS		5					
						4					
						4					
						4					
				SS		3					
						4					
						3					
60						3					515

NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.96 ft above ground surface. Ground surface elevation is 577.14 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG

Well No. **MW-1617**
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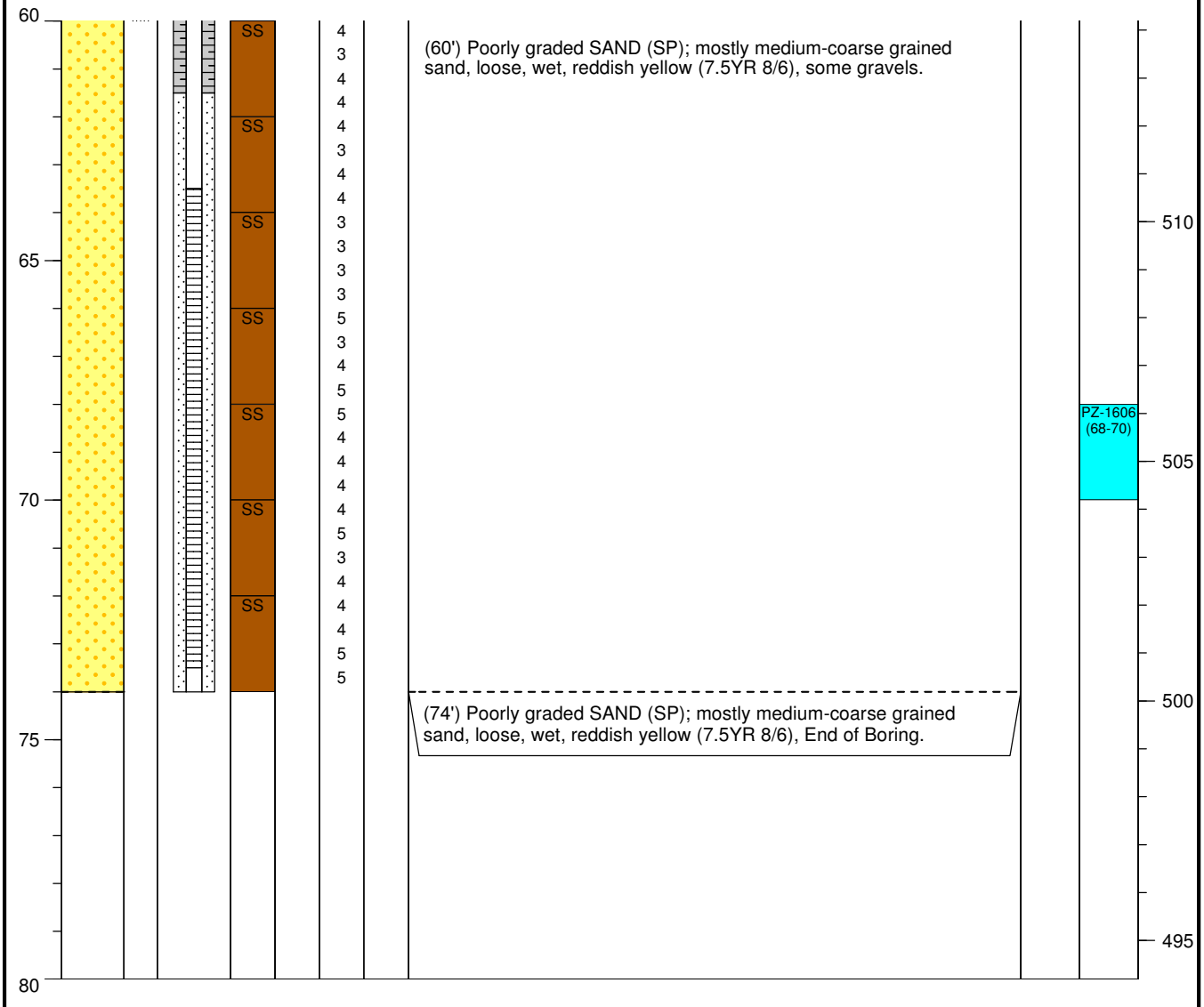
Drilling Start Date:	**05/06/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**60**
Drilling End Date:	**05/06/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**Split Spoon**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**53.73**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**577.14**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108244.28, 248457.12***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.96 ft above ground surface. Ground surface elevation is 577.14 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG

Well No. **MW-1618**

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Drilling Start Date:	**04/22/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**73**
Drilling End Date:	**04/22/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**56.90**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**584.19**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108783.48, 248659.65***	Filter Pack:	**Global Filter Pack #5**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (ft)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: PID (ppm)	MEASURE: Lab Sample	ELEV. (ft msl)
0				SS		8		(0') Clayey GRAVEL with sand (GC); mostly fine-coarse grained gravel, little fine sand, little silt, loose, moist, dark gray, Road Crush.			580
						12					
						12					
						42					
				SS		13		(2') SILT (ML); little fine sand, little silt, mostly clay, stiff, moist, dark gray, Road Crush Heave.			
						16					
						10					
						7					
				SS		2		(4') SILT (ML); little fine sand, little silt, mostly clay, stiff, moist, light brown, 10YR/5/6.			
5						2					
						3					
						4					
				SS		3					575
						4					
						7					
						5					
				SS		2					
						2					
						3					
						4					
10				SS		1					
						2					
						2					
						3					570
				SS		2					
						2					
						2					
						2					
				SS		2		(14') ORGANIC SOIL (OL); little fine sand, little silt, mostly clay, stiff, moist, dark gray (10YR 4/1), Gray, Black Organic Matter.			
						2					
15						4					
						4					
				SS		5		(16') SILT (ML); little fine sand, little silt, mostly clay, stiff, moist, light brown, 10YR/5/6.			565
						8					
						10					
						12					
				SH							
20											

NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 3.02 ft above ground surface. Ground surface elevation is 584.19 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1618
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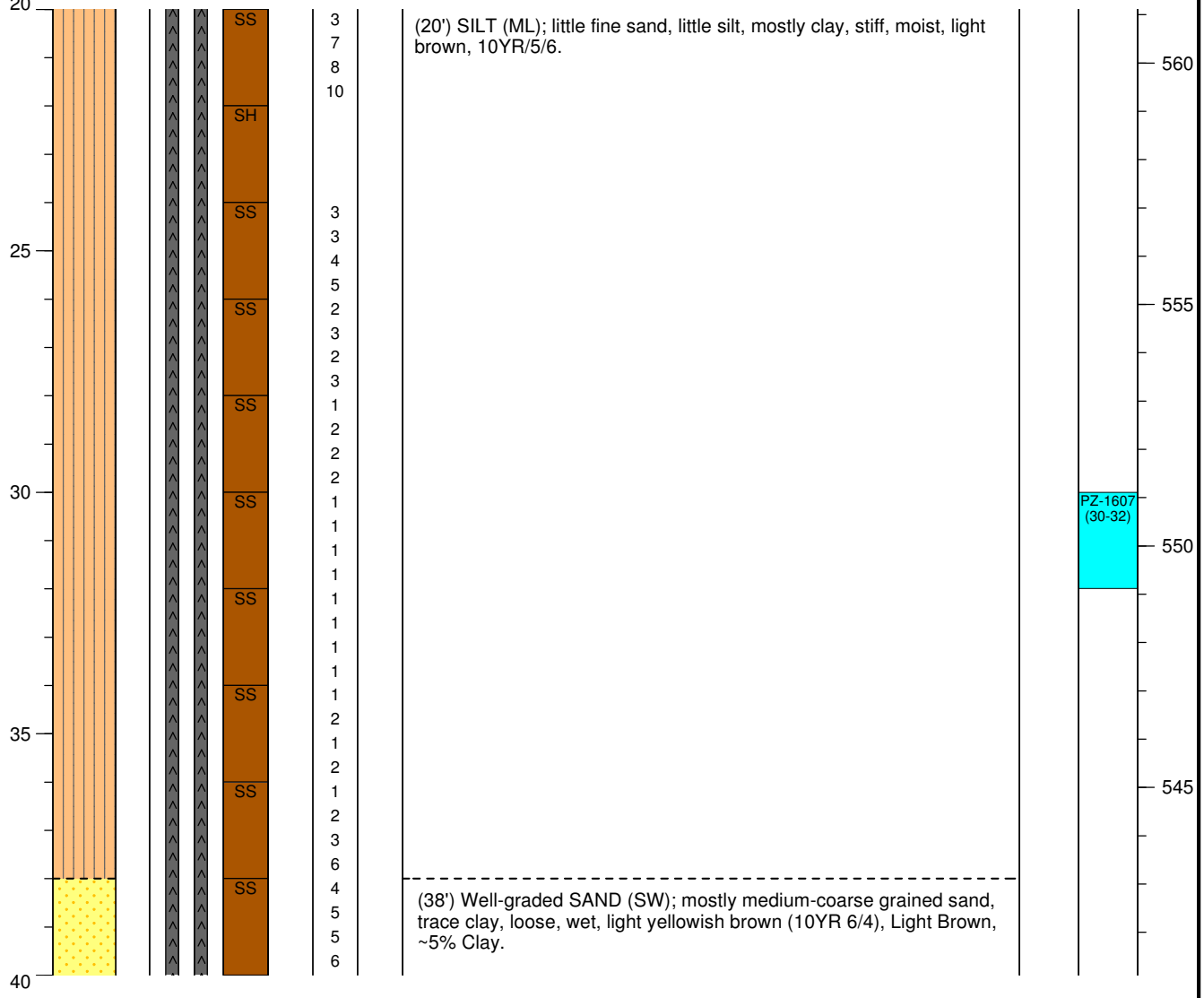
Drilling Start Date:	**04/22/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**73**
Drilling End Date:	**04/22/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**56.90**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**584.19**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108783.48, 248659.65***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 3.02 ft above ground surface. Ground surface elevation is 584.19 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1618
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Drilling Start Date:	**04/22/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**73**
Drilling End Date:	**04/22/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**56.90**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**584.19**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108783.48, 248659.65***	Filter Pack:	**Global Filter Pack #5**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (ft)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: PID (ppm)	MEASURE: Lab Sample	ELEV. (ft msl)
40				SS		3 4 4 4		(40') Well-graded SAND (SW); mostly medium-coarse grained sand, trace clay, loose, wet, light yellowish brown (10YR 6/4), Light Brown, ~5% Clay.			540
				SS		1 14 13 11					
45				SS		1 5 5 6					535
				SS		3 5 10 12					
				SS		3 5 5 5					
50				SS		4 5 5 6					530
				SS		4 4 5 4					
				SS		4 5 5 6					
55				SS		10 13 13 15					525
				SS		10 12 13 15					
60											

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Top of casing (TOC) is 3.02 ft above ground surface. Ground surface elevation is 584.19 ft MSL.

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Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG

Well No. **MW-1618**

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Drilling Start Date:	**04/22/2016**	Boring Depth (ft):	**74**	Well Depth (ft):	**73**
Drilling End Date:	**04/22/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & SH**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME 95**	DTW After Drilling (ft):	**56.90**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**584.19**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2108783.48, 248659.65***	Filter Pack:	**Global Filter Pack #5**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (ft)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: PID (ppm)	MEASURE: Lab Sample	ELEV. (ft msl)
60				SS		8		(60') Well-graded SAND (SW); mostly medium-coarse grained sand, trace clay, loose, wet, light yellowish brown (10YR 6/4), Light Brown, ~5% Clay.			520
						9					
						10					
						11					
65				SS		7				PZ-1607 (66-68)	515
						9					
						8					
						10					
70											510
75								End of Boring.			505
80											

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1619
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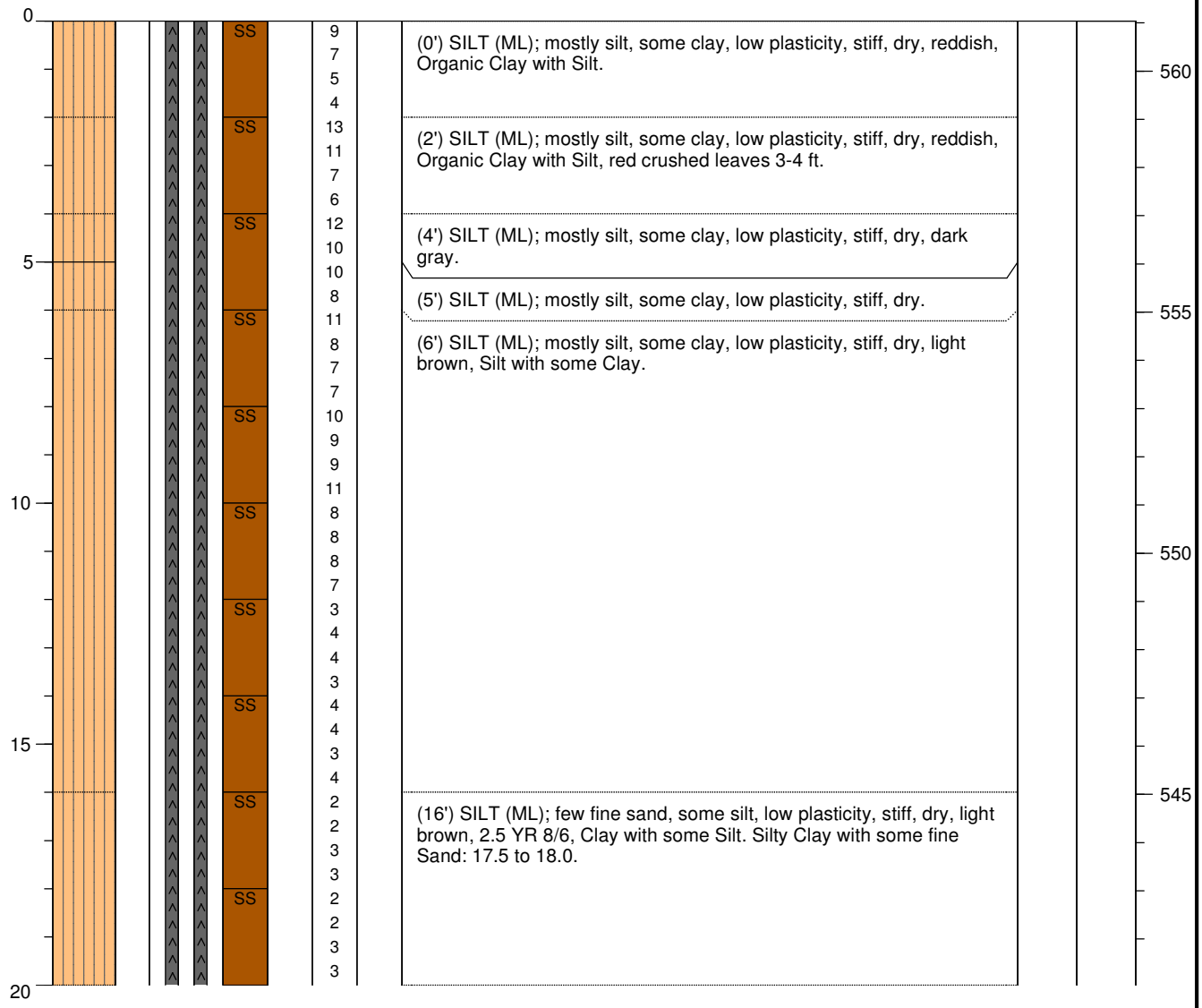
Drilling Start Date:	**05/06/2016**	Boring Depth (ft):	**54**	Well Depth (ft):	**50**
Drilling End Date:	**05/06/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**Split Spoon**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME95**	DTW After Drilling (ft):	**35.17**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**562.95**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2111325.37, 250527.53***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 1.85 ft above ground surface. Ground surface elevation is 562.95 ft MSL.

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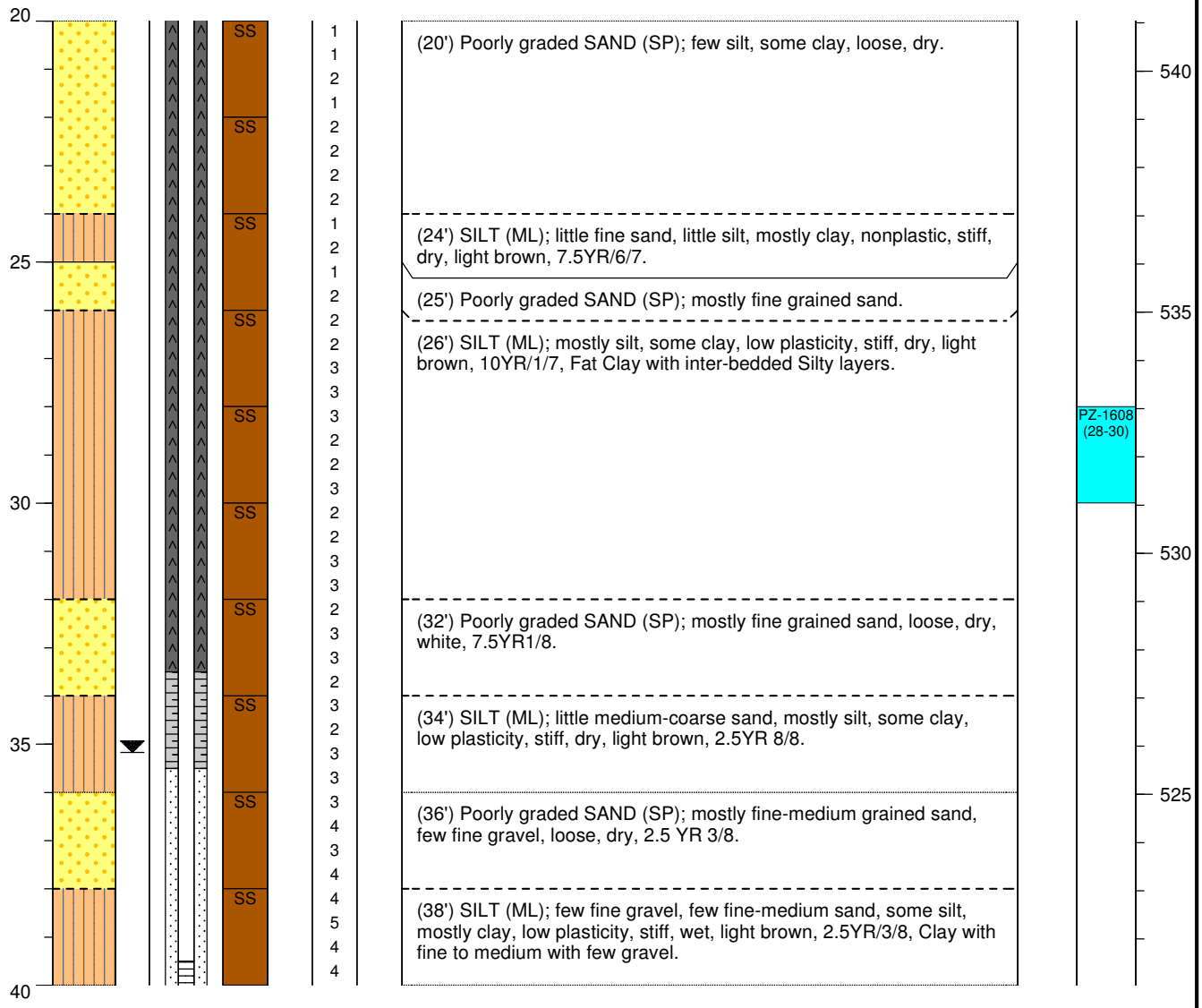
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1619
Page: 2 of 3

Drilling Start Date:	**05/06/2016**	Boring Depth (ft):	**54**	Well Depth (ft):	**50**
Drilling End Date:	**05/06/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**Split Spoon**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME95**	DTW After Drilling (ft):	**35.17**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**562.95**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2111325.37, 250527.53***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 1.85 ft above ground surface. Ground surface elevation is 562.95 ft MSL.

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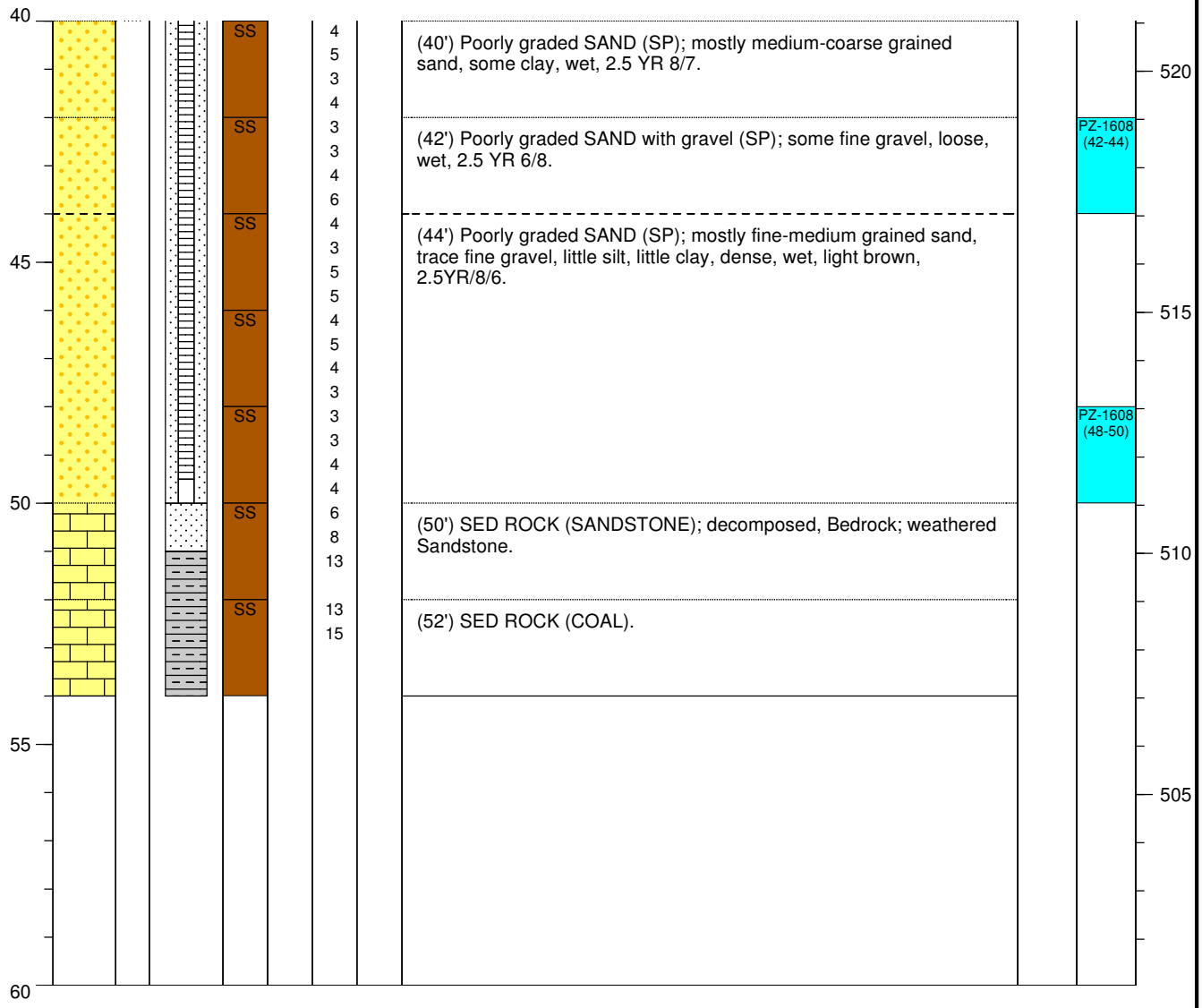
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1619
Page: 3 of 3

Drilling Start Date:	**05/06/2016**	Boring Depth (ft):	**54**	Well Depth (ft):	**50**
Drilling End Date:	**05/06/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**Split Spoon**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME95**	DTW After Drilling (ft):	**35.17**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**562.95**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2111325.37, 250527.53***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 1.85 ft above ground surface. Ground surface elevation is 562.95 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1620
Page: 1 of 3

Drilling Start Date:	**05/04/2016**	Boring Depth (ft):	**53.5**	Well Depth (ft):	**53.5**
Drilling End Date:	**05/05/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**Split Spoon**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME95**	DTW After Drilling (ft):	**34.07**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**571.95**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2107233.10, 248456.53***	Filter Pack:	**Global Filter Pack #5**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (ft)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: PID (ppm)	MEASURE: Lab Sample	ELEV. (ft msl)
0				SS		6 7 6 5		(0') ORGANIC SOIL (OL); little fine-coarse gravel, some silt, mostly clay, low plasticity, stiff, wet, light brown, 2.5YR/1/3, Silty Clay with some gravel and coals.			
				SS		5 7 7 6					
				SS		4 5 5 4		(4') SILT (ML); some clay, stiff, wet, light brown, 10 YR 8/6, Silt with some Clay.			565
5				SS		8 10 11 13		(6') No Recovery.			
				SS		4 4 5 6		(8') SILT (ML); some clay, stiff, wet, light brown, 10YR/5/8.			
				SS		5 6 6 5					560
10				SS		6 6 5 3		(12') Lean CLAY (CL); some silt, medium plasticity, dry, light brown, 10 YR 5/9, clayey silt.			
				SS		3 4 6 4	2.0				555
15				SS		3 3 3 5		(16') Lean CLAY with sand (CL); little medium sand, little silt, some clay, medium plasticity, stiff, dry, light brown, 10YR 5/8.			
				SS		4 4 5 5					550
20						5 4 4 4					

NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.75 ft above ground surface. Ground surface elevation is 571.95 ft MSL.

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Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1620
Page: 2 of 3

Drilling Start Date:	**05/04/2016**	Boring Depth (ft):	**53.5**	Well Depth (ft):	**53.5**
Drilling End Date:	**05/05/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**Split Spoon**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME95**	DTW After Drilling (ft):	**34.07**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**571.95**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2107233.10, 248456.53***	Filter Pack:	**Global Filter Pack #5**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (ft)	SOIL/ROCK VISUAL DESCRIPTION	MEASURE: PID (ppm)	MEASURE: Lab Sample	ELEV. (ft msl)
20				SS		7		(20') Lean CLAY with sand (CL); little medium sand, little silt, some clay, medium plasticity, stiff, dry, light brown, 10YR 5/8.			
				SS		3 3 4					
				SS		1 2 1					
25				SS		1 1 1					545
				SS		1 1 1					
				SS		1 2 3					
				SS		3 2 3					
				SS		2 2 2					540
30				SS		2 2 2				PZ-1609 (30-32)	
				SS		2 1 3					
				SS		3 5 6		(33') Poorly graded SAND (SP); little medium-coarse grained sand, 2.5 YR 8/6.			
				SS		6 4 5		(34') Poorly graded SAND (SP); loose, wet, 2.5 YR 8/6. Sand with Shale.			535
35				SS		4 6 5		(36') Poorly graded SAND (SP); loose, wet, white, White Sand.			
				SS		5 6 5		(38') Poorly graded SAND (SP); very dense, wet, Sand with Shale.			
				SS		5 5 8					530
40											

NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.75 ft above ground surface. Ground surface elevation is 571.95 ft MSL.

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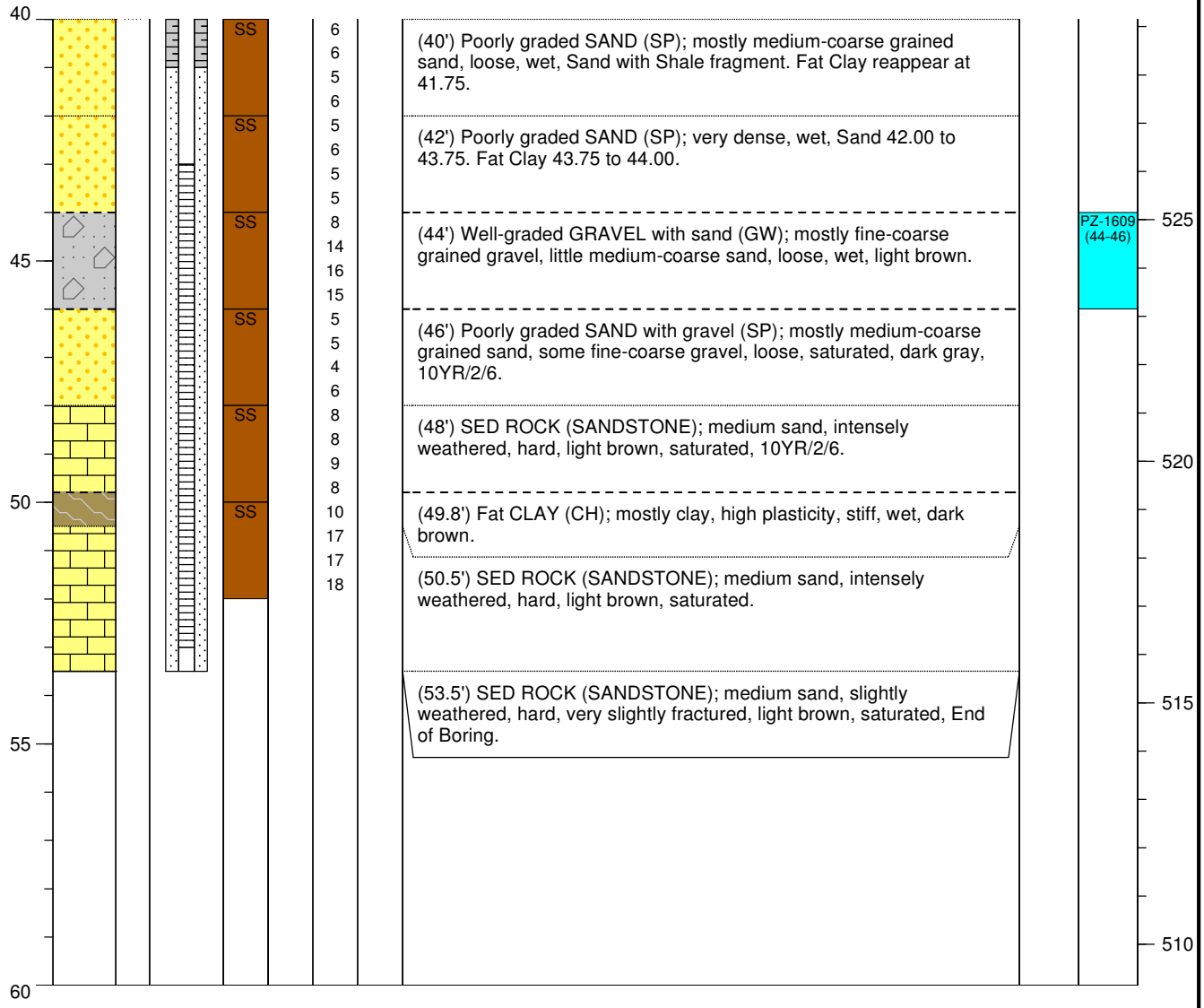
Client:	**American Electric Power**
Project:	**Big Sandy Plant**
Address:	**23000 US-23, Louisa, KY**

WELL LOG
Well No. MW-1620
Page: 3 of 3

Drilling Start Date:	**05/04/2016**	Boring Depth (ft):	**53.5**	Well Depth (ft):	**53.5**
Drilling End Date:	**05/05/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**Split Spoon**	Screen Slot (in):	**0.010**
Drilling Method:	**Hollow Stem Auger**	DTW During Drilling (ft):		Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**CME95**	DTW After Drilling (ft):	**34.07**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Tim Woods**	Top of Casing Elev. (ft msl):	**571.95**	Seal Material(s):	**Bentonite Chips**
Logged By:	**Matt Barnes (Layne)**	Location (X,Y):	**2107233.10, 248456.53***	Filter Pack:	**Global Filter Pack #5**



NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.75 ft above ground surface. Ground surface elevation is 571.95 ft MSL.