US EPA Coal Combustion Residual Rule

Groundwater Monitoring Network Evaluation Addendum for Fly Ash Reservoir (FAR) II

Cardinal Operating Company – Cardinal Power Plant 306 County Road 7E Brilliant, Ohio

September 26, 2022

Submitted to:

Cardinal Operating Company
306 County Road 7E
Brilliant, Ohio 43913

Submitted by:

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Cox-Colvin & ASSOCIATES, INC. ENVIRONMENTAL SERVICES

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1.0 Introduction

Cox-Colvin & Associates, Inc. (Cox-Colvin) is pleased to provide Cardinal Operating Company (Cardinal) with this Groundwater Monitoring Network Addendum for the Fly Ash Reservoir (FAR) II located at the Cardinal Power Plant, 306 County Road 7E, Brilliant, Ohio.

This report was prepared in accordance with the Federal Coal Combustion Residual (CCR) rules in 40 Code of Federal Regulations (CFR) 257 Subpart D. It is intended as an addendum to the initial Groundwater Monitoring Network Evaluation [1] in order to document the replacement of monitoring well M-GS-3 with M-GS-3R.

2.0 Background / Purpose of Addendum

The initial Groundwater Monitoring Network Evaluation was prepared in 2016, and subsequently revised in 2017. A copy is included as Appendix A.

During semi-annual groundwater monitoring of the FAR II monitoring network, it was observed that concentrations at monitoring well M-GS-3 showed greater variability over time than was observed in other wells. Furthermore, the ratios of constituents at M-GS-3 appeared similar to conditions related to acid mine drainage and coal mining operations. Review of the well construction log for M-GS-3, and comparison to the corresponding boring log, showed that a coal seam, along with coal bearing shale, was present in the upper portion of the screened interval of the well.

To better represent groundwater quality in the Morgantown Sandstone, a replacement monitoring well (M-GS-3R) was drilled in the proximity of M-GS-3, but fully screened within the upper portion of the Morgantown Sandstone (i.e., below the coal seam and coal bearing shale). Well construction and boring logs are provided in Appendix B.

The purpose of this addendum is to modify the FAR II groundwater monitoring network so that M-GS-3 will no longer be monitored; M-GS-3R will be monitored in its place.

There has been no exceedance of groundwater protection standards (GWPS) at M-GS-3

[1] *Groundwater Monitoring Network Evaluation; Cardinal Site – Former Fly Ash Reservoir II; Brilliant, Ohio.* Geosyntec Consultants Project No. CHE8126L, September 2016, Revised February 2017.

3.0 Representativeness of M-GS-3R

M-GS-3R was installed in close proximity to M-GS-3, in a location that ensured sufficient and safe access for a sonic drilling rig and support vehicles while not impeding traffic flow in the adjacent roadway (Figure 1). As shown on Figure 2, M-GS-3R is located downgradient of the FAR II reservoir and, therefore, can provide an indication as to whether a release related to FAR II has occurred in the same manner as M-GS-3.

The newly installed M-GS-3R monitoring well provides a better representation of conditions within the Morgantown Sandstone aquifer than M-GS-3.

4.0 Monitoring Network

With this addendum, the groundwater monitoring network consists of five wells located upgradient (CA-0622, M-6, M-12, M-1302, and M-GS-5) and 18 wells located downgradient (FA-8, M-8, M-10, M-11, M-13, M-14, M-15, M-16, M-21, M-22, M-23, M-1003, M-1004, M-1309, M-GS-1, M-GS-2, M-GS-3R and M-GS-4), along with Seep-1, also referred to as the Jules Verne Seep, located downgradient of FAR II (Figure 1).

This network provides detection monitoring for the Morgantown Aquifer. The change outlined in this addendum (replacing downgradient well M-GS-3 with M-GS-3R) does not reduce the effectiveness of the groundwater monitoring network. There is no change to the number of wells in the program, and M-GS-3R is more representative of groundwater conditions in the Morgantown Aquifer than M-GS-3. Consistent with CCR Rules §257.91(c), the groundwater monitoring network has a minimum of one upgradient and three downgradient wells that accurately represent the quality of both background groundwater and groundwater passing the waste boundary of the FAR II.

Future statistical evaluation for potential statistically significant increases (SSIs) at M-GS-3R will be performed using interwell, as opposed to intrawell, methodologies. As such, testing for SSIs and comparison to GWPSs can be performed following the next semi-annual groundwater sampling event without need to establish a background data set specific to M-GS-3R.

5.0 Professional Engineer Certification

The undersigned P.E. registered in the State of Ohio is familiar with the requirements of 40 CFR part 257, subpart D and has (or his designee has) visited and examined the facility. The undersigned P.E. attests that this Groundwater Monitoring Network Addendum for the Cardinal FAR II CCR Unit has been prepared in accordance with good engineering practice, including the design and construction to meet the requirements of §257.91, for the facility to the best of his knowledge. The minimum number of wells specified in §257.91(c)(1) has been met, as documented in Section 4.0 of this report.

This certification in no way relives the owner or operator of the facility of the duty to fully implement this Groundwater Monitoring System in accordance with the requirements of 40 CFR 257 subpart D.

Nick M. Petruzzi, PE, CPG
Principal Engineer
Registration No. E-73052 (Ohio)
Cox-Colvin & Associates, Inc.

9/26/22
Date

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Figures

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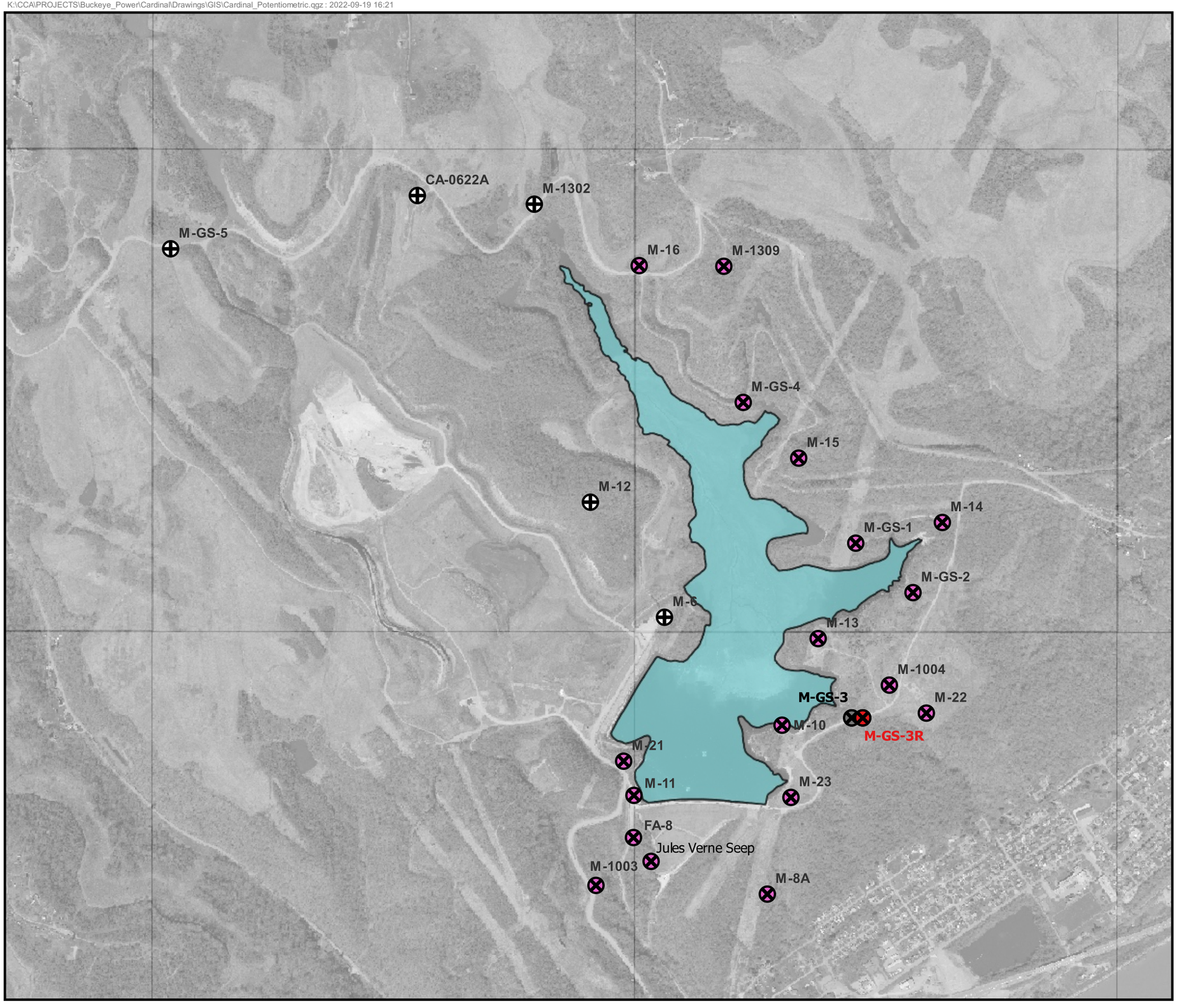

Legend

Fly Ash Reservoir (FAR) II

FAR II Monitor Wells

- Upgradient
- Downgradient
- M-GS-3R (Added to Network)
- M-GS-3 (Removed from Network)

N

0 1,000 2,000 3,000 ft

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Figure

1

Groundwater Monitoring Network
Fly Ash Reservoir II
Cardinal Plant
Brilliant, Ohio

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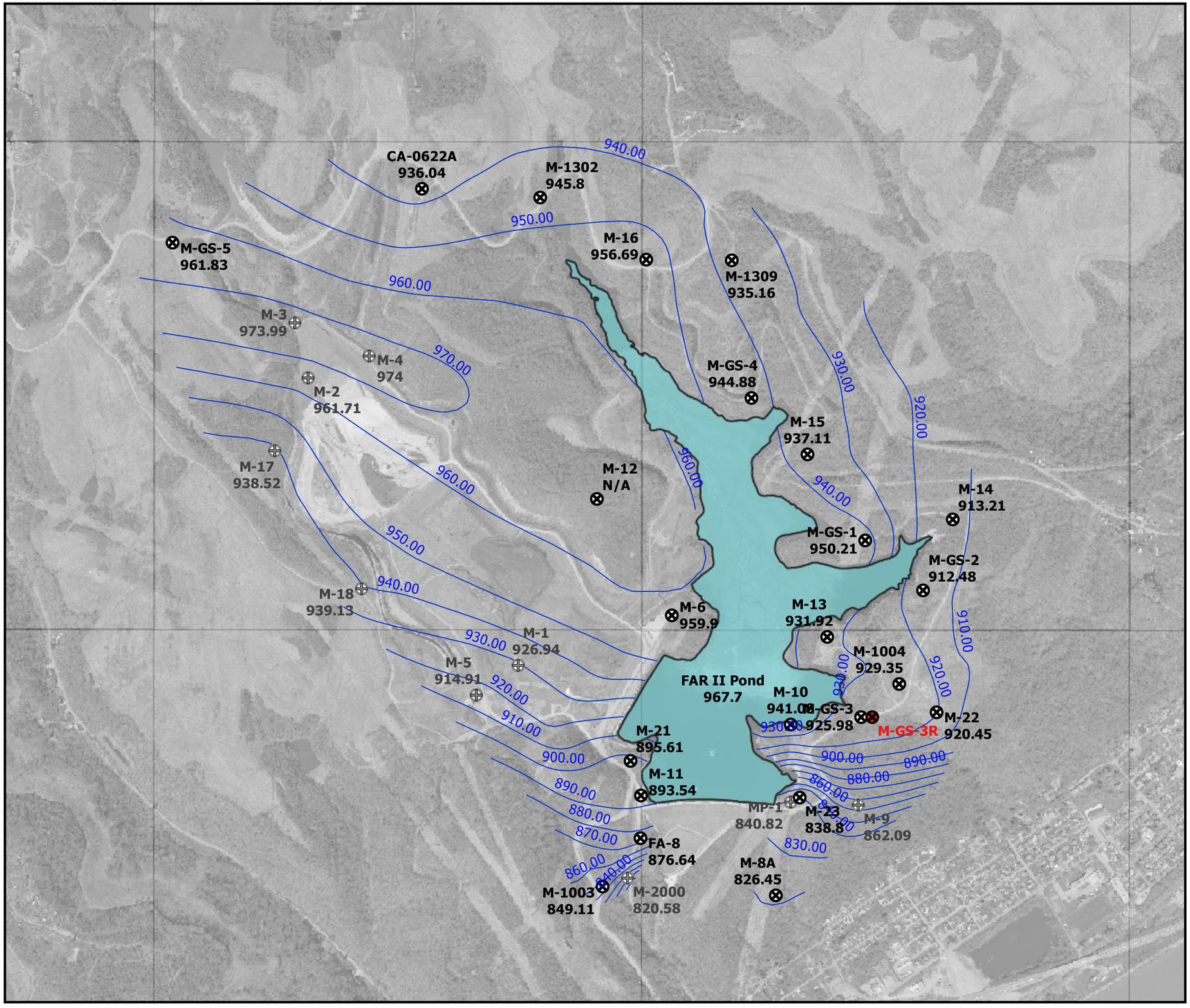

Legend

- FAR II Monitoring Well and Groundwater Elevation
- State/Other Program Monitoring Well
- M-GS-3R (Added to Network in September 2022)
- Groundwater Elevation Contour
- Fly Ash Reservoir (FAR) II

N

0 1,000 2,000 3,000 ft

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Figure

2

Potentiometric Surface Map - Morgantown Sandstone
Fly Ash Reservoir II - April 13, 2022
Cardinal Plant
Brilliant, Ohio

Appendix A

2016/2017 Groundwater Monitoring Network Evaluation

Prepared for

American Electric Power

1 Riverside Plaza
Columbus, Ohio 43215

GROUNDWATER MONITORING NETWORK EVALUATION

CARDINAL SITE – FLY ASH RESERVOIR II

BRILLIANT, OHIO

Prepared by

1420 Kensington Road, Suite 103
Oak Brook, Illinois 60523

Geosyntec Project No.: CHE8126L

September 2016
Revision: February 2017

GROUNDWATER MONITORING NETWORK EVALUATION
CARDINAL FLY ASH RESERVOIR II
BRILLIANT, OHIO

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LIST OF ACRONYMS

AEP	American Electric Power
BAC	Bottom Ash Complex
BAP	Bottom Ash Pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
ESP	Electrostatic Precipitator
FAD	Fly Ash Dam
FAR	Fly Ash Reservoir
FGD	Flue Gas Desulfurization
MCL	Maximum Contaminant Level
MSE	Mechanically Stabilized Earth
MW	Megawatts
MW	Monitoring Well
NAD	North American Datum
NGVD	National Geodetic Vertical Datum
NPDES	National Pollutant Discharge Elimination System
OAC	Ohio Administrative Code
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
PE	Professional Engineer
PMF	Probable Maximum Flood
RCC	Roller Compressed Concrete
RCP	Recirculation Pond
RSW Landfill	Residual Solid Waste Landfill
SCR	Selective Catalytic Reduction
TDS	Total Dissolved Solids
USEPA	United States Environmental Protection Agency

1. OBJECTIVE

1.1 Purpose

The purpose of this report is to provide an assessment of the groundwater monitoring network associated with the Fly Ash Reservoir (FAR) II at the Cardinal Operating Company Cardinal Plant relative to its compliance with the United States Environmental Protection Agency (USEPA) Coal Combustion Residual (CCR) Rule section 40 CFR 257.91.

1.2 Organization of Report

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

1.3 Coordinate System and Datum

The horizontal coordinate values provided in this report are based upon the North American Datum of 1927 (NAD27). The vertical datum utilized for reporting the elevations within this report is National Geodetic Vertical Datum of 1929 (NGVD).

2. BACKGROUND INFORMATION

2.1 Facility Location Description

The Cardinal Plant is located approximately one-mile south of Brilliant, Ohio in Jefferson County along the Ohio River (Figure 2-1). The generating station consists of three units with a nominal capacity of 1,830 megawatts (MW). Units 1 and 2 began operation in 1967 and Unit 3 began operation in 1977. All three units are coal-powered, with an average annual coal use of 5.2 million tons for the entire plant. As of 2012, all three units were equipped with an electrostatic precipitator (ESP), a selective catalytic reduction (SCR) system, and a flue gas desulfurization (FGD) system.

Fly ash was formerly sluiced to the Fly Ash Reservoir 1 (FAR 1), which was filled to capacity in 1988 and began the closure process in 1990. Fly ash is currently sluiced to Fly Ash Reservoir 2 (FAR II), which is impounded by Fly Ash Dam 1 (FAD 1) and Fly Ash Dam 2 (FAD 2). The FAR 1 Residual Solid Waste Landfill (FAR 1 RSW Landfill) Facility began construction in 2006 on top of the former FAR 1 as a permitted landfill for the disposal of solid wastes. Bottom ash and stormwater from the coal processing facility are impounded at the Bottom Ash Complex (BAC), which consists of the Bottom Ash Pond (BAP) and Recirculation Pond (RCP) and is located approximately one-mile south of the FAR and RSW Landfill facilities. The Cardinal Plant currently utilizes three coal combustion residuals (CCR) storage units: the BAC, the FAR 1 RSW Landfill, and the FAR II reservoir. These units are shown in Figure 2-2.

2.2 Description of CCR Unit

FAR II is an existing wet fly ash disposal reservoir that is located approximately one-mile north of the plant site and east of FAR 1 RSW Landfill. The reservoir is contained within Blockhouse Hollow (also referred to as Blockhouse Run in references and drawings) by FAD 2 and the decommissioned FAD 1. FAR II receives stormwater and leachate (treated for neutralization) from the FAR 1 RSW Landfill. FAR II/FAD 2 has a permitted discharge through NPDES Outfall 019 (AEP, 2005a).

2.2.1 Embankment Configuration

FAR II is contained within the north (main) branch of Blockhouse Hollow, by FAD 1 and FAD 2. FAR 1 has been filled with ash and holds no surface water on the upstream side of FAD 1. FAD 1, on the southeast (downstream) side, contains FAR II water and ash along the downstream slope which is 2.5H:1V. FAD 1 has a top-of-dam elevation of 1001.5 ft.

The FAR II maximum design operating pool elevation is 974.0 ft and the PMF elevation is 981.9 ft (AEP, 2012). FAD 2 is approximately 1,400-ft long and 230-ft high and was raised in 2013 from a dam crest elevation of 970.0 ft to a crest elevation of 983.0 ft (AEP, 2012). The previous dam crest width was approximately 30 ft with the top fill consisting of 9 ft of roller compacted concrete

(consisting of cement and bottom ash mixture) placed and compacted in lifts. The slopes of the previous dam were unchanged as the dam raising consisted of constructing back-to-back mechanically stabilized earth (MSE) walls, filling in the old spillway, constructing a new emergency spillway, and raising the existing principal (service) spillway structure. The MSE structure is approximately 21.3-ft wide and contains a 36-ft long vinyl sheet pile vertical cutoff installed within a cement-bentonite slurry trench. The sheet pile toe and trench bottom extend to a minimum of three feet into the clay core of the existing earth dam. (AEP, 2012).

2.2.2 Area and Volume of CCR Units

FAR II has a maximum surface area to the top of dam of approximately 184 acres and receives sluiced fly ash from the generating unit's ESPs. A total of 161 acres at maximum pool will be used for ash waste placement (AEP, 2012). The remaining area is occupied by associated facilities, including leachate treatment facilities, monitoring wells and stormwater conveyances. The Cardinal generating units produce 560,000 cubic yards of fly ash per year. The raising of FAD 2 increased the storage capacity by 2,068 acre-feet (AEP, 2012).

2.2.3 Construction and Operational History

FAR II began receiving ash after FAD 2 construction was completed and approved. FAR 1 received ash only until 1988, although AEP was authorized to place the Tidd Plant PFBC ash until 1995 as part of a clean coal demonstration project (AEP, 2005a). FAR 1 has been undergoing closure capping and all sluiced or trucked ash from the plants goes too FAR II.

2.2.4 Surface Water Control

Surface water draining into FAR II is collected within the main (north) branch of Blockhouse Hollow and contained by FAD 2 and discharged as part of the ash reservoir water through the FAD 2 principal or service spillway. The spillway is a concrete lined spillway located on the upstream face of the dam. The dam raising changed the top portion of the spillway to a vertical stop log structure. The maximum operating water level elevation is 974.0 ft. The discharge is through a 54-inch diameter pre-stressed concrete pipe which exits through the bottom of the dam into a concrete portal flowing to an energy dissipater and a weir for monitoring (AEP, 2012).

2.3 Previous Investigations

The most recent modifications to the FAR II dam, including the raising of the dam crest and modifications to the spillways, are outlined in the following reports:

- Assessment of Dam Safety – Coal Combustion Surface Impoundments (Task 3) (Final Report). December, 2009. CHA Companies.

- Dam Raising Design Summary – Cardinal Fly Ash Retention Pond II – Waste Water PTI Application, April 2012, Submitted to OEPA Division of Water Surface, AEP Service Corp.
- Dam Raising Design Report – Cardinal Fly Ash Reservoir No. 2, January 2013, Submitted to ODNR Division of Soil and Water Resources, AEP Service Corp. and S&ME, Inc., and Revised Permit Application Comment Response, January 16, 2013.

2.4 Hydrogeologic Setting

2.4.1 Climate and Water Budget

The major drainage feature of FAR II is Blockhouse Run, which drains into the Ohio River. Approximately one mile upstream, Blockhouse Run splits into the East Branch and West Branch. The West Branch drains the western watershed and was dammed to form the former FAR 1, while the East Branch drains the eastern watershed. The FAR II inundates the East Branch, and runoff from the western watershed drains into the FAR II. The total area of the western watershed is 677 acres, while the eastern watershed is 675 acres.

The 2015 average monthly temperature and precipitation values for the Brilliant, Ohio area are presented in the table below (NOAA, 2016). The climatological data was collected from the nearest weather station (USC00338025) located in Steubenville, OH.

NOAA Climatological Summary (2015)		
Month	**Average Temperature (°F)**	**Average Precipitation (inches)**
January	23.0	2.16
February	16.0	1.34
March	30.9	4.02
April	51.1	3.60
May	64.6	2.95
June	70.0	10.69
July	71.4	4.66
August	70.5	2.81
September	69.3	6.70
October	53.2	2.56
November	47.8	1.17
December	46.6	3.24

2.4.2 Regional and Local Geologic Setting

The geology at FAR II and the vicinity consists of nearly horizontal sequences of lower Permian and upper Pennsylvanian sedimentary rock. The Permian-age Dunkard Group occurs only on the tops of some ridges above an elevation of approximately 1250 feet (ft), northwest and west of the FAR 1 RSW Landfill and FAR II sites.

The Monongahela Group is up to 230 feet thick in Jefferson County, consisting of shale, sandstone, limestone, coal, claystone and siltstone. These rocks form much of the slopes above the current levels of the FAR II and FAR 1 RSW Landfill sites. Below the Monongahela Group is the Conemaugh Group, which is generally over 500 feet thick in Jefferson County. The Conemaugh Group consists of shale, sandstone, limestone, coal, claystone and siltstone, including the Morgantown Sandstone, which is a developed aquifer in the area. Beneath the Morgantown Sandstone is a sequence of the Conemaugh Group including the Elk Lick Limestone, the Skelly Limestone and shale, the Ames Limestone, several thick shale sequences, the Cow Run Sandstone and the Buffalo Sandstone.

2.4.3 Surface Water and Surface Water-Groundwater Interactions

Both surface stormwater and leachate from the FAR 1 RSW Landfill is transferred to FAR II as FAR II serves as the facilities sedimentation pond and leachate collection pond. The intermittent stream of the western branch of Blockhouse Hollow at the northwest end of the FAR 1 RSW Landfill was historically re-routed during surface mining operations and flows into FAR II. Streams within the watersheds of the western and eastern branches of Blockhouse Run are recharged by precipitation. The entirety of the western and eastern watersheds, including approximately 1,033 acres of woodland, drains into the FAR II Reservoir. Blockhouse run discharges to the Ohio River approximately 1.0 mile further downstream to the east. According to USACE maps, the next nearest tributary which discharges to the Ohio River is Riddles Run, which is located approximately 0.75 miles to the southwest (USACE, 2003).

Recharge of the Morgantown Sandstone aquifer occurs through vertical infiltration of precipitation at upgradient outcrops. The Morgantown Sandstone is also directly recharged by the FAR II Reservoir as it is incised through the Morgantown Sandstone unit.

2.4.4 Water Users

According to water well records obtained from the Ohio Department of Natural Resources (ODNR), the nearest water supply well is located approximately 2,000 feet east of FAR II. Additionally, ODNR records indicate a series of water supply wells in the Tidd-Dale Subdivision of Brilliant, Ohio, approximately 3,000 to 4,000 feet southeast of FAR II. These water supply wells are developed in the deeper Buffalo Sandstone, which underlies the uppermost aquifer. The ground surface elevation for these wells, generally around 750 feet, is lower than the elevation of the bottom

of the Morgantown Sandstone, generally ranging from approximately 780 feet to 800 feet in the vicinity of FAR II. One of these water supply wells has a reported pumping rate of 3.0 gallons per minute (gpm).

Approximately one mile west of FAR II, a series of water supply wells develop several limestone horizons, the Arnoldsburg and Benwood Limestone units. These well logs report pumping rates ranging from approximately 1.0 gpm to 8.0 gpm with significant drawdown (Geosyntec, 2006).

According to the 2014 Drinking Water Consumer Confidence Report prepared by the Jefferson County Water and Sewer District, there are no surface water intakes supplying water to the town of Brilliant, Ohio. Brilliant's water source comes from two groundwater wells located at a water treatment plant approximately one mile east of FAR II. ODNR records indicate these wells are screened within the alluvial deposits of the Ohio River and exhibit pumping rates of up to 700 gpm.

3. MONITORING NETWORK EVALUATION

3.1 Hydrostratigraphic Units

3.1.1 Horizontal and Vertical Position relative to CCR Unit

The principal regional aquifer is comprised of the alluvial sediments along the Ohio River, located east of FAR II. The hydrogeology around FAR II is characterized by an uppermost aquifer comprised of sandstone, shale and limestone units, specifically the Morgantown Sandstone, which lies below a shale aquitard that caps the Morgantown Sandstone. FAR II is positioned within a former river valley and is incised into the Morgantown Sandstone. Geologic cross-sections illustrating the horizontal and vertical position of FAR II relative to the uppermost aquifer are provided in Appendix B.

3.1.2 Overall Flow Conditions

Based on monitoring well data in the vicinity of the FAR II, the uppermost aquifer is the Morgantown Sandstone unit. A shale aquitard above the Morgantown Sandstone has very low hydraulic conductivity values, in the range of 1 x 10-7 to 1 x 10-9 cm/sec. Hydraulic conductivity values of the Morgantown Sandstone are in the range of 1 x 10-1 to 1 x 10-6 cm/sec and tends to be driven by interconnected fracture flow. The Morgantown Sandstone has a gradient to the east, southeast, and southwest, generally flowing away from FAR II (AEP, 2014). Contours depicting the groundwater elevations in the Morgantown Sandstone are shown in Figure 3-1.

3.2 Uppermost Aquifer

3.2.1 CCR Rule Definition

According to the 2015 CCR rule, the term “uppermost aquifer” has the same provisions as in §257.40: “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. This definition includes a shallow, deep, perched, confined, or unconfined aquifer, provided that it yields usable water” (40 CFR 257.60).

For the purposes of this report, it is assumed that the uppermost useable aquifer has the following characteristics: (1) groundwater production rate over a 24-hour period of at least 0.1 gallons per minute (gpm); and (2) groundwater quality with total dissolved solids (TDS) less than 10,000 milligrams per liter (mg/L).

3.2.2 Identified Onsite Hydrostratigraphic Unit

The hydrostratigraphy in the vicinity of FAR II is characterized by an uppermost aquifer system comprised of Morgantown Sandstone unit, which lies below the shale aquitard that caps the Morgantown Sandstone. FAR II is partially incised through the Morgantown Sandstone.

Based on ODNR water well logs, the nearest wells with a recorded pumping rate (not including wells screened in the alluvial sediments near the Ohio River) occur approximately one mile west of FAR II. These wells are screened within limestone and shale units, and at a similar elevation to the upper aquifer system at FAR II. These wells have recorded pumping rates ranging from 1.0 to 8.0 gpm. Another series of wells occurs approximately 3 miles southwest of FAR II, and are screened within sandstone and siltstone units at a similar elevation to the Morgantown Sandstone near FAR II.

Based on the information gathered from ODNR, previous analytical data, and geological conditions at FAR II, the uppermost continuous and usable aquifer is considered to be the Morgantown Sandstone.

3.3 Review of Existing Monitoring Network

3.3.1 Overview

The groundwater monitoring network is shown on Figure 3-2 and consists of five (5) monitoring wells (CA-0622, M-6, M-12, M-1302 and M-GS-5) located upgradient and 18 monitoring wells (FA-8, M-8, M-10, M-11, M-13, M-14, M-15, M-16, M-21, M-22, M-23, M-1003, M-1004, M-1309, M-GS-1, M-GS-2, M-GS-3 and M-GS-4) and Seep-1, also referred to as the Jules Verne Seep, located downgradient of FAR II. The groundwater monitoring wells and Seep-1 provide detection monitoring for the uppermost aquifer (Morgantown Sandstone). The number, spacing, and depth of groundwater monitoring wells included in the groundwater monitoring network are based on site-specific geochemical, geologic and hydrogeologic information and span the full thickness of the uppermost aquifer system. Well construction details are summarized in Table 3-1. Boring and well construction logs for the groundwater monitoring well network wells are provided in Appendix C and Appendix D, respectively.

3.3.2 Compliance Assessment

Review of the existing groundwater monitoring well network in relation to the geologic and hydrogeologic conditions in the area of FAR II indicates that the monitoring well network consists of a sufficient number of wells installed at the appropriate depths to collect groundwater samples from the uppermost aquifer that accurately represent the groundwater quality upgradient and downgradient of FAR II. The groundwater monitoring well network is also capable of providing upgradient background groundwater quality and downgradient detection monitoring for a potential contaminant release to the uppermost aquifer (Morgantown Sandstone) nearest the waste boundary.

Based on the above review, the groundwater monitoring network around the Cardinal FAR II meets the requirements of 40 CFR 257.91.

4. CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

By means of this certification, I certify that I have reviewed the groundwater monitoring network and well construction details in the vicinity of the Fly Ash Reservoir II at the AEP Cardinal Plant and it meets the requirements of section 40 CFR 257.91.

Daniel G. Bodine

Printed Name of Registered Professional Engineer

Daniel G. Bodine

Signature

E-61363	Ohio	Feb. 23, 2017
Registration No.	Registration State	Date

TABLES

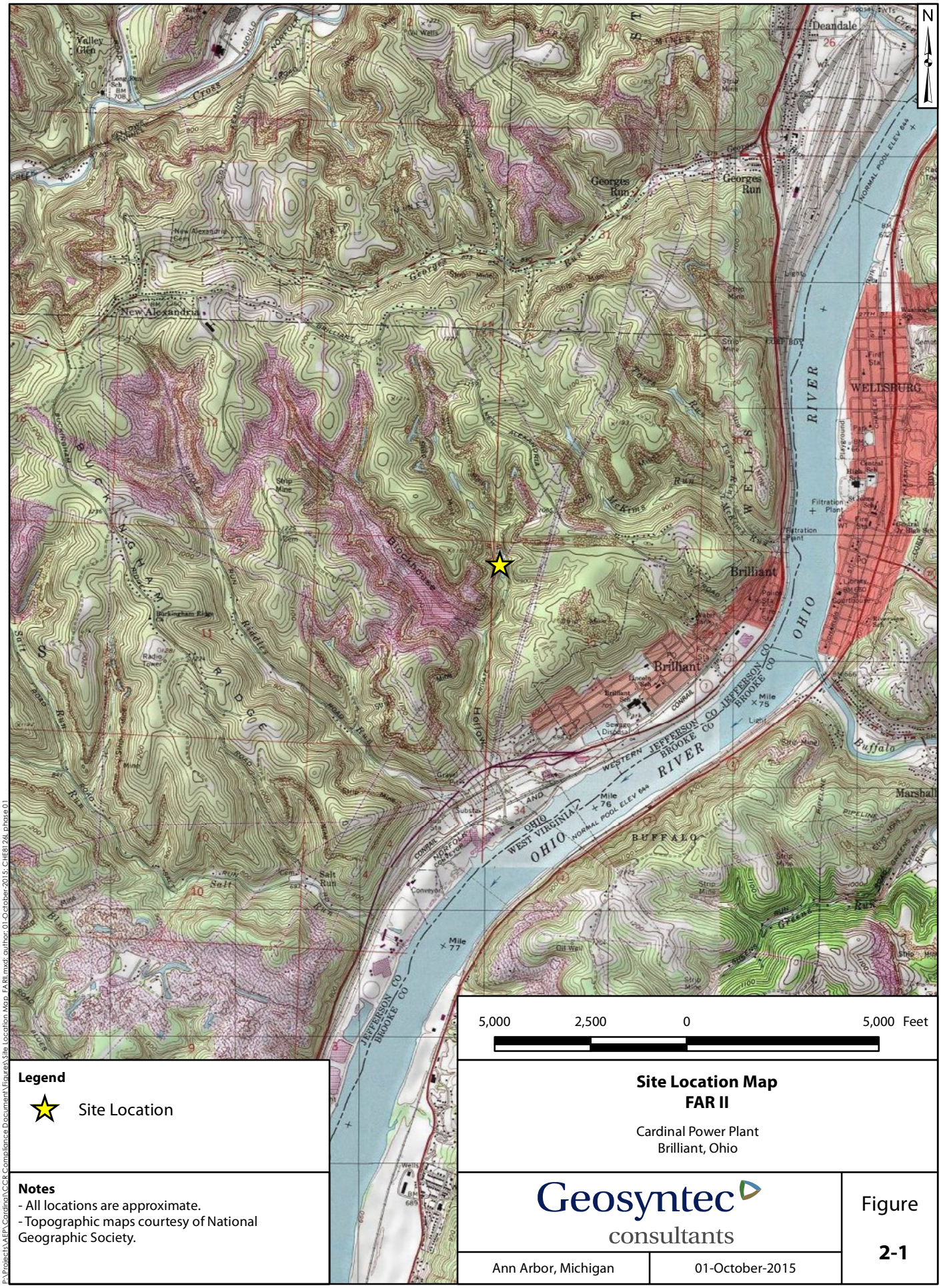
Table 3-1. Groundwater Monitoring Well Network Construction Details

Fly Ash Reservoir II
Cardinal Power Plant
Brilliant, Ohio

Monitoring Well Number	Boring Number	Date Installed	Northing (OH State Plane South (ft.) NAD 27/NGVD 29)	Easting (OH State Plane South (ft.) NAD 27/NGVD 29)	Top of Casing (ft.)	Ground Elevation (ft.)	Top of Bentonite Seal (ft.)	Top of Gravel Pack (ft.)	Top of Screen (ft.)	Bottom of Screen (ft.)	Bottom of Gravel Pack (ft.)	Bottom of Bore Hole (ft.)	Total Well Depth From TOC (ft.)	Casing Type (PVC)	Casing Diameter (In.)	Borehole Diameter (In.)	Hydrologic Unit
CA-0622A	CA-0622	16/8/2016	N 836,291.4	E 2,514,219.5	1162.28	1159.38	821.38	816.38	813.38	803.38	803.38	803.38	356.00	SCH. 40	2.00	6.00	Morgantown
FA-8	FA-8	3/23/2004	N 829,635.1	E 2,516,460.0	921.03	918.23	883.03	880.43	878.23	868.23	866.23	763.23	52.80	SCH. 40	2.00	6.00	Morgantown
M-10	MW-4/ 85W-3	8/7/1985	N 830,800.0	E 2,518,000.0	1033.42	1031.00	859.50	853.00	801.50	800.50	794.00	766.00	267.42	SCH. 80	0.75	4.87	Morgantown
M-1003	M-1003	4/7/2010	N 829,139.10	E 2,516,070.90	935.88	933.55	883.55	876.55	874.25	794.25	792.45	792.45	141.63	SCH. 40	2.00	6.00	Morgantown
M-1004	M-1004D	3/31/2010	N 831,215.40	E 2,519,112.4	1008.29	1005.64	866.24	859.44	857.24	807.24	805.44	791.24	201.05	SCH. 40	2.00	6.00	Morgantown
M-11	MW-5	5/4/1999	N 830,072.4	E 2,516,465.1	980.21	977.82	878.02	870.82	779.82	777.82	776.82	693.82	202.39	SCH. 80	1.00	3.00	Morgantown
M-12	CA-0608	12/13/2006	N 833,112.2	E 2,516,013.2	1190.66	1187.65	861.25	855.55	794.65	789.65	782.85	782.85	401.01	SCH. 40	2.00	6.00	Morgantown
M-13	CA-0610	6/21/2006	N 831,697.9	E 2,518,374.3	991.14	988.42	871.52	864.12	858.12	801.12	798.22	794.02	190.02	SCH. 40	2.00	6.00	Morgantown
M-1302	B-1302M	5/30/2013	N 836,201.9	E 2,515,432.0	1030.72	1028.92	885.92	871.22	860.52	820.92	819.92	819.92	210.80	SCH. 40	2.00	6.00	Morgantown
M-1309	B-1309D	5/30/2013	N 835,558.0	E 2,517,396.3	1172.09	1170.24	880.04	867.74	862.34	822.74	821.24	821.24	350.85	SCH. 40	2.00	6.00	Morgantown
M-14	CA-0612	3/21/2007	N 832,901.9	E 2,519,661.8	988.21	984.91	866.01	859.11	857.61	800.61	797.71	790.21	187.60	SCH. 40	2.00	6.00	Morgantown
M-15	CA-0614	7/25/2007	N 833,569.0	E 2,518,172.3	1074.28	1071.83	868.13	860.83	857.83	797.53	794.43	794.43	1074.28	SCH. 40	2.00	6.00	Morgantown
M-16	CA-0616	1/24/2007	N 835,565.0	E 2,516,519.0	1068.55	1065.75	878.25	871.85	864.45	815.45	813.65	811.15	253.10	SCH. 40	2.00	6.00	Morgantown
M-21	CA-0620	6/1/2006	N 830,426.7	E 2,516,358.1	1018.61	1016.16	861.66	856.66	846.16	756.16	753.06	753.06	172.00	SCH. 40	2.00	6.00	Morgantown
M-22	CA-0702	5/21/2007	N 830,925.1	E 2,519,495.8	1008.04	1005.68	865.28	859.18	852.78	791.28	788.18	786.48	216.76	SCH. 40	2.00	6.00	Morgantown
M-23	CA-0703	4/23/2007	N 830,051.2	E 2,518,092.0	985.90	983.44	858.54	850.74	847.14	806.14	83.14	803.14	252.70	SCH. 40	2.00	6.00	Morgantown
M-6	90CA-22	8/9/1990	N 831,918.94	E 2,516,781.18	1010.57	1008.56	873.06	864.35	788.06	785.56	784.56	788.36	222.40	SCH. 80	1.00	3.00	Morgantown
M-8	2Sa / 85W-1D1	10/15/2003	N 829,048.7	E 2,517,847.4	893.20	890.53	828.73	821.23	808.23	769.23	767.13	767.13	123.97	SCH. 40	2.00	6.00	Morgantown
M-GS-1	M-GS-1	04/13/2016	N 832687.21	E 2518763.64	991.87	988.68	873.68	868.68	866.68	856.68	854.64	779.68	137.56	SCH. 40	2.00	6.00	Morgantown
M-GS-2	M-GS-2	04/13/2016	N 832174.62	E 2519357.61	990.81	987.62	864.62	859.62	857.62	847.62	845.59	774.62	133.54	SCH. 40	2.00	6.00	Morgantown
M-GS-3	M-GS-3	04/12/2016	N 830875.66	E 2518721.99	1000.33	997.42	868.42	863.42	861.42	851.42	849.39	791.42	149.23	SCH. 40	2.00	6.00	Morgantown
M-GS-4	M-GS-4	04/21/2016	N 834146.72	E 2517597.81	1028.73	1025.65	840.65	835.65	833.65	823.65	821.62	793.65	205.41	SCH. 40	2.00	6.00	Morgantown
M-GS-5	M-GS-5	04/05/2016	N 835739.39	E 2511662.31	1039.54	1036.92	829.92	824.92	822.92	812.92	810.89	803.92	226.95	SCH. 40	2.00	6.00	Morgantown

Notes:
Elevation datum is National Geodetic Vertical Datum of 1929 (NGVD29).
Well M-23 is replacement well for 8501/1S (well MP-1) according to well construction log for well M-23 / boring CA-0703.
Well CA-0622 was over-drilled and replaced with CA-0622A on 8/16/2016.

FIGURES



Legend

★ Site Location

Notes
- All locations are approximate.
- Topographic maps courtesy of National Geographic Society.

Site Location Map
FAR II

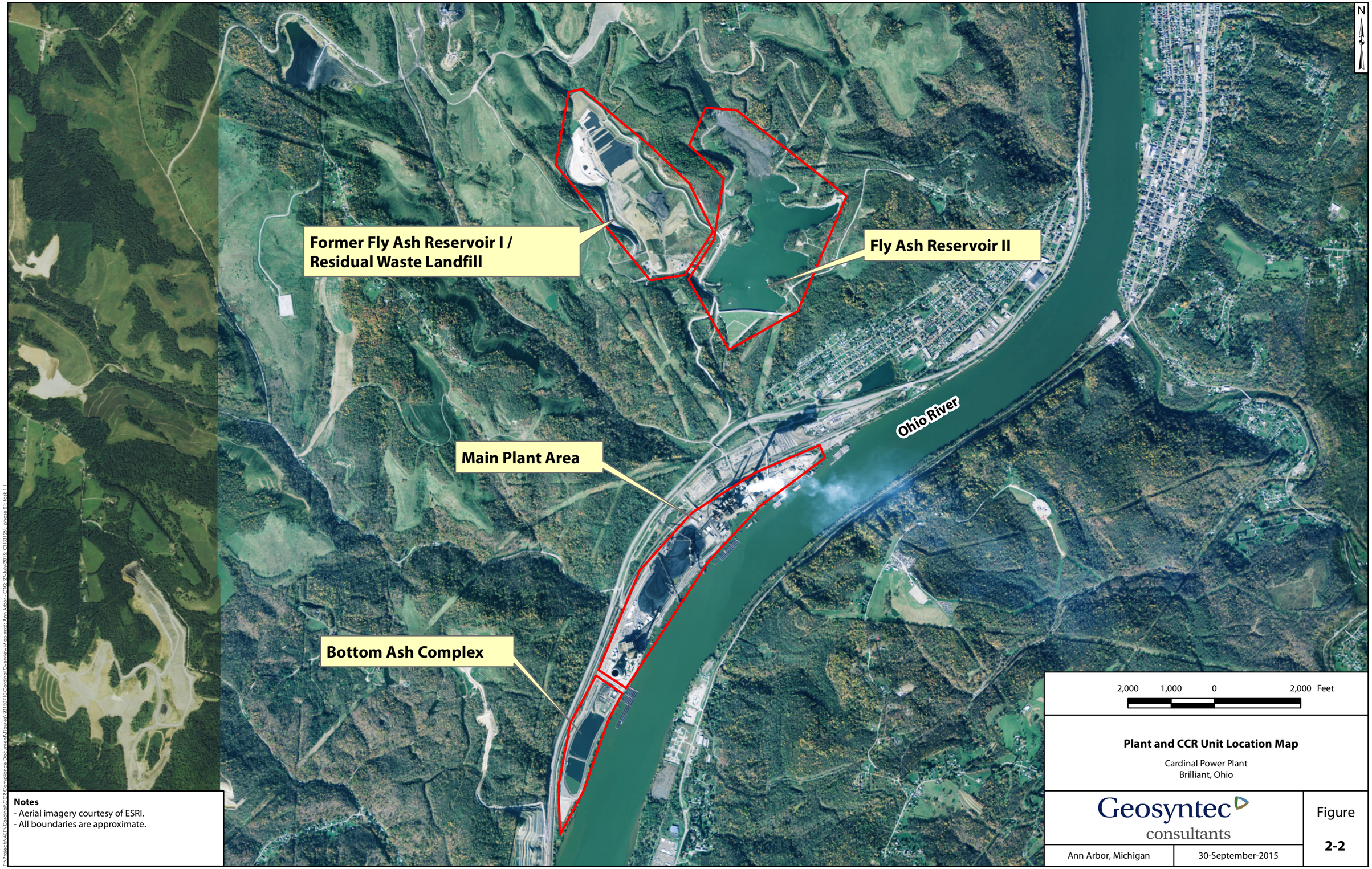
Cardinal Power Plant
Brilliant, Ohio

Geosyntec consultants

Ann Arbor, Michigan | 01-October-2015

Figure **2-1**

P:\Projects\AEP\Cardinal\CCR Compliance Document\Figures\Site Location Map_FAR II.mxd; author: 01-October-2015; CHE8126; phase 01



Notes
- Aerial imagery courtesy of ESRI.
- All boundaries are approximate.

Plant and CCR Unit Location Map

Cardinal Power Plant
Brilliant, Ohio

Geosyntec consultants

Ann Arbor, Michigan | 30-September-2015

Figure **2-2**

P:\Projects\AEP\Cardinal\CCR Compliance Documents\Figures\20150710 Cardinal Overview Map.mxd; Ann Arbor - CTG; 27-July-2015; CH2M2Hill; phase 01; task 1.1

N

CA-0622
1003.73

M-1302
941.39

M-GS-5

M-16
950.35

M-1309
925.25

M-3
971.79

M-4
978.77

M-GS-4

M-17
933.99

0AE 2005 10C
889.88

M-15
930.68

M-12
961.45

Former Fly Ash Reservoir I /
Residual Waste Landfill

960

M-14
910.43

M-GS-1

940

M-18
936.73

M-6
954.52

Fly Ash Reservoir II

M-GS-2

M-13
929.45

940

920

900

M-1
925.06

M-5
912.56

M-1004
927.51

M-19
876.19

M-20
953.52

M-10
891.27

M-GS-3

920

900

M-22
920.48

M-21
897.41

880

M-1001
885.08

FA-7
897.45

M-11
895.63

M-23
838.16

MP-1
839.13

M-9
863.72

880

FA-8
876.03

860

M-1003
850.12

M-1002
844.55

M-8
825.6

Ohio River

Legend

- Monitoring Well Location
- Groundwater Elevation Contour
- Groundwater Flow Direction

Notes

- Aerial imagery courtesy of ESRI.
- All locations are approximate.
- Groundwater levels measured on 15 September 2014.
- Groundwater contours based on Potentiometric Map of the Morgantown Sandstone (AEP, 2014).
- Only wells screened within the Morgantown Sandstone are shown.
- Monitoring network wells and non-monoitoring network wells were used to develop map and groundwater elevation contours.

1,000 500 0 1,000 Feet

Potentiometric Surface Map - Uppermost Aquifer
FAR II

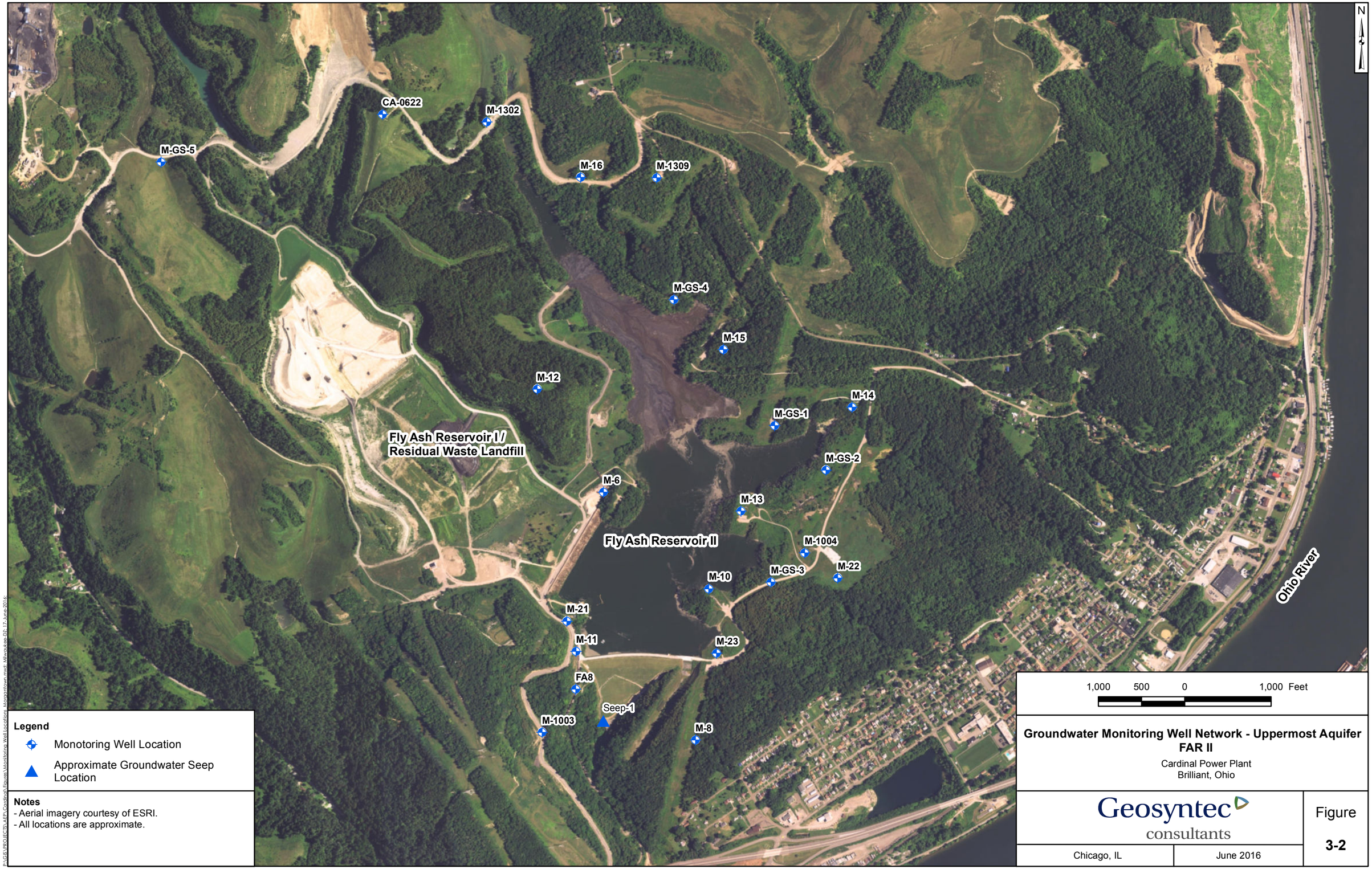
Cardinal Power Plant
Brilliant, Ohio

Geosyntec consultants

Chicago, IL | July 2016

Figure
3-1

P:\GIS\PROJECTS\AEP\Cardinal\Figures\GW Contours Morgantown f2014 Rev7-2014.mxd: Mikwa&kee - D2: 01-August-2016;CHEB1 24/01/1 3/1810



Legend

- Monotoring Well Location
- Approximate Groundwater Seep Location

Notes

- Aerial imagery courtesy of ESRI.
- All locations are approximate.

P:\GIS\PROJECTS\AEP\Cardinal\Figures\Monitoring Well Locations_Morgantown.mxd; Milwaukee-DZ; 17-June-2016;

Groundwater Monitoring Well Network - Uppermost Aquifer
FAR II

Cardinal Power Plant
Brilliant, Ohio

Geosyntec consultants

Chicago, IL | June 2016

Figure **3-2**

APPENDIX A

REFERENCES

American Electric Power and Geosyntec Consultants, Inc. May 2006. Hydrogeological Investigation Report.

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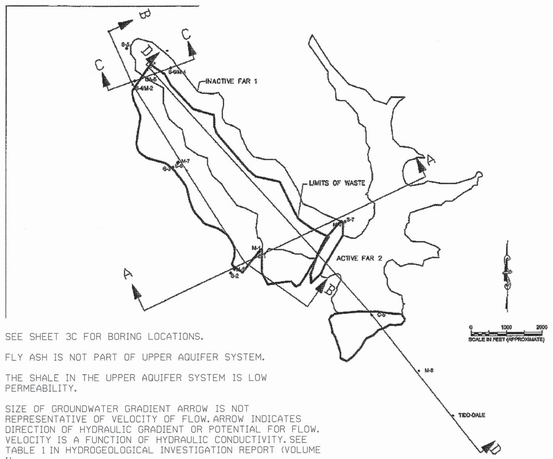
APPENDIX B

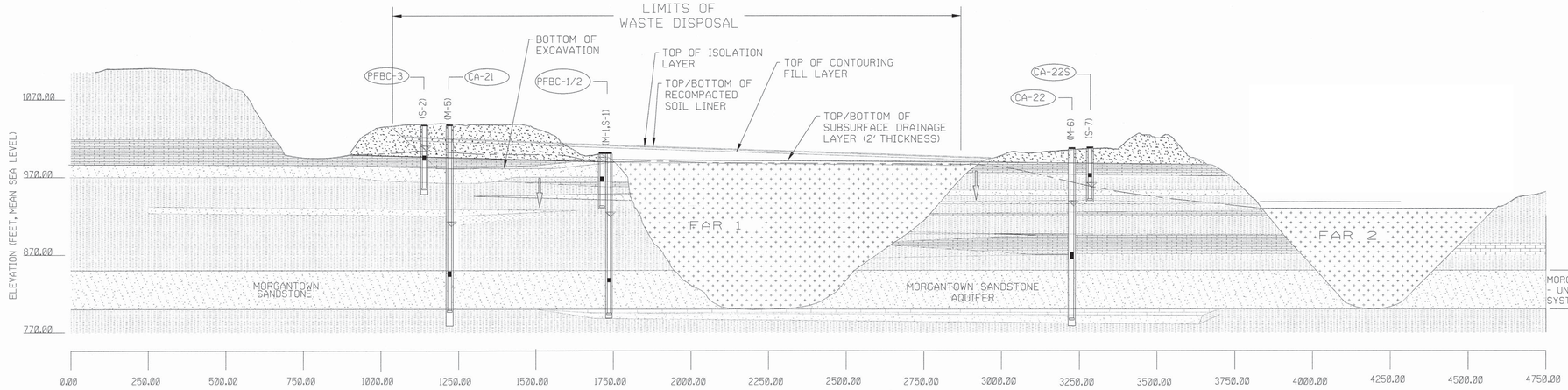
GEOLOGIC CROSS SECTIONS

DWG. NO. - 13-30100-5A

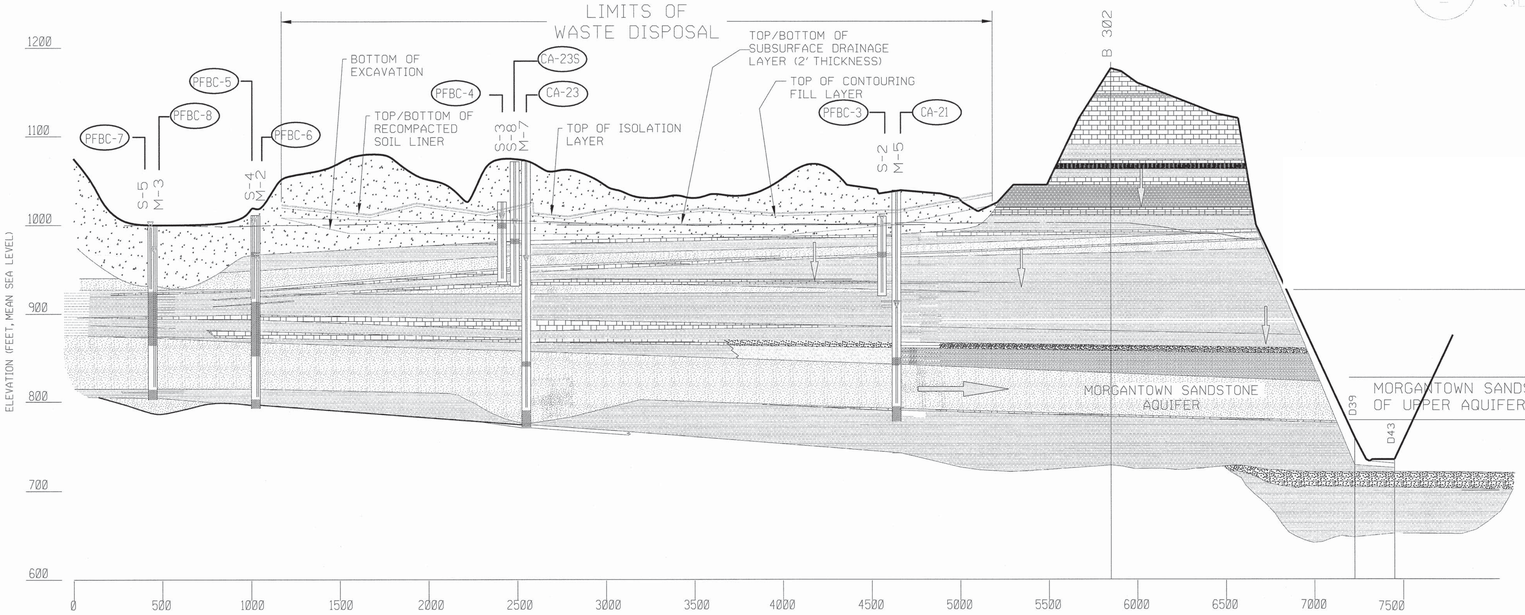
SECTION LOCATION PLAN



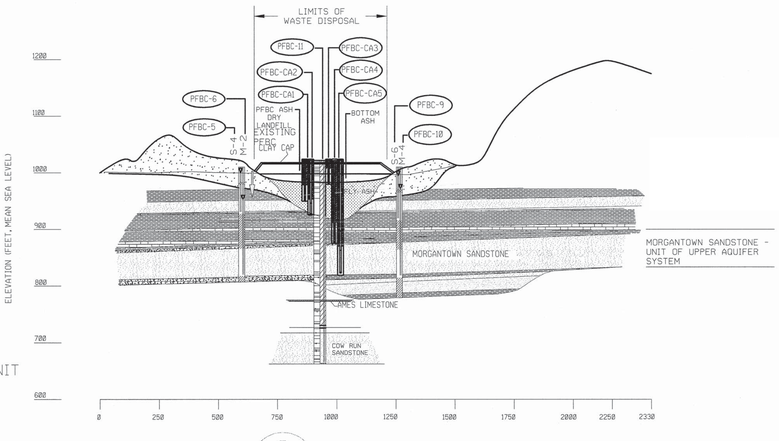
1. SEE SHEET 3C FOR BORING LOCATIONS.
2. FLY ASH IS NOT PART OF UPPER AQUIFER SYSTEM.
3. THE SHALE IN THE UPPER AQUIFER SYSTEM IS LOW PERMEABILITY.
4. SIZE OF GROUNDWATER GRADIENT ARROW IS NOT REPRESENTATIVE OF VELOCITY OF FLOW. ARROW INDICATES DIRECTION OF HYDRAULIC GRADIENT OR POTENTIAL FOR FLOW. VELOCITY IS A FUNCTION OF HYDRAULIC CONDUCTIVITY. SEE TABLE 1 IN HYDROGEOLOGICAL INVESTIGATION REPORT (VOLUME 1).



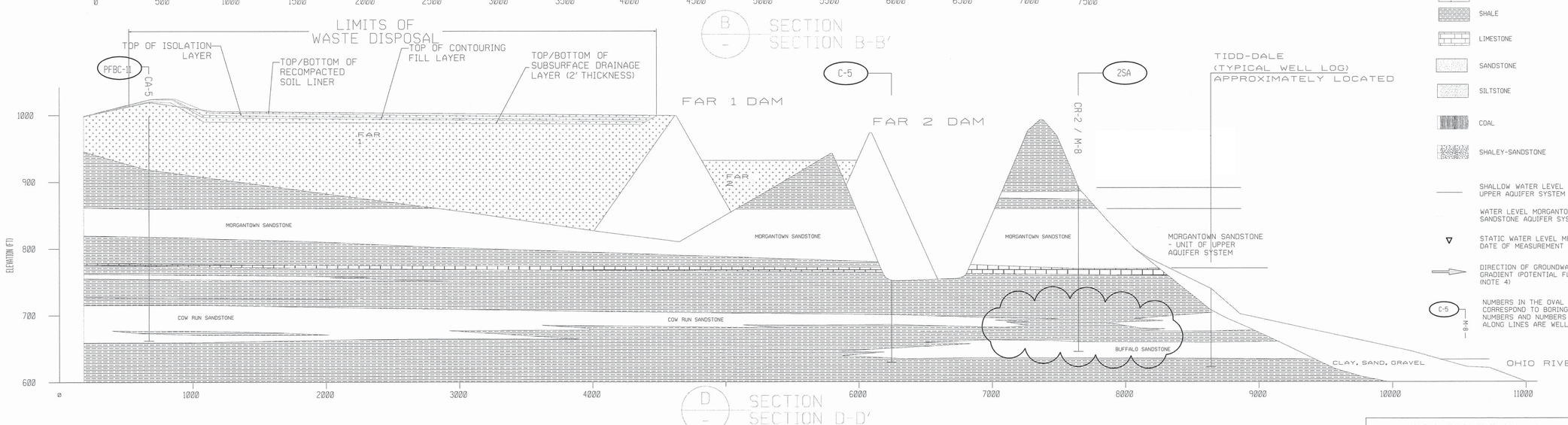
A — SECTION
SECTION A-A'



B — SECTION
SECTION B-B'



C — SECTION
SECTION C-C'



D — SECTION
SECTION D-D'

LEGEND

- FLY ASH
- MINESPOIL
- SHALE
- LIMESTONE
- SANDSTONE
- SILTSTONE
- COAL
- SHALEY-SANDSTONE
- SHALLOW WATER LEVEL UPPER AQUIFER SYSTEM
- WATER LEVEL MORGANTOWN SANDSTONE AQUIFER SYSTEM
- STATIC WATER LEVEL MEASUREMENTS DATE OF MEASUREMENT APR 21, 2004
- DIRECTION OF GROUNDWATER GRADIENT (POTENTIAL FLOW) (NOTE 4)
- C-5 — M-8 — NUMBERS IN THE OVAL CORRESPOND TO BORING NUMBERS AND NUMBERS ALONG LINES ARE WELLS

DATE	NO.	DESCRIPTION	APPD.
5/6/12	D	REVISED BY AEP FOR SECTION D-D TO SHOW SHALE STRATA SEPARATING COW RUN FROM BUFFALO SANDSTONE	HFZ
NOV 17 2010	C	REVISED - NOD 2 RESPONSE	DGB
MAY 25 2006	B	REVISED NOD 1 RESPONSE	DGB
OCT 24 2005	A	ISSUED FOR PERMIT	DGB

REVISIONS

CARDINAL OPERATING COMPANY
CARDINAL PLANT
BRILLIANT OHIO

TITLE: CARDINAL FAR 1 RESIDUAL WASTE LANDFILL GEOLOGIC/HYDROGEOLOGIC CROSS SECTIONS

DWG. NO. 13-30100-5A-D

GeoSyntec CONSULTANTS
55 WEST WACKER DRIVE, SUITE 1100
CHICAGO, IL 60601 USA
(312) 655-0720

SIGNATURE
DATE

PROJECT NO. CHE0126
FILE NO.
DRAWING 5A OF 39

SCALE: CIVIL ENGINEERING DIVISION
DR.
CK.
ENGR.
PROJ. ENGR.
DATE
APPROVED BY: Pedro J. Amaya

AEP AMERICAN ELECTRIC POWER
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

SYSTEM DATE:

APPENDIX C

BORING LOGS

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 830,426.7 E 2,516,358.1**

GROUND ELEVATION **1016.2** SYSTEM

Water Level, ft	▽	▼	▼
TIME			
DATE			

BORING NO. **CA-0620** DATE **7/17/15** SHEET **1** OF **12**

BORING START **8/25/06** BORING FINISH **6/1/06**

PIEZOMETER TYPE WELL TYPE

HGT. RISER ABOVE GROUND **2.45** DIA **6"**

DEPTH TO TOP OF WELL SCREEN **170.0** BOTTOM **260.0**

WELL DEVELOPMENT **YES** BACKFILL **N/A**

FIELD PARTY **GEOSYNTEC CONSULTINGS** LOG

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
1	SS	0.0	2.0							Loose, grayish brown, gravelly **SAND** (SP); dry; non-plastic; coarse to fine sand with approx. 20% fine gravel to cobbles.		
2	SS	2.0										
3	SS	4.0					5					
4	SS	6.0										
5	SS	8.0					10					
6	SS	10.0								Loose, black, **COAL**; dry.		
7	SS	12.0								Loose, orange, silty **SAND** (SM); dry, fine grained; over 6" of grayish brown, clayey silt.		
8	SS	14.0								Loose, grayish brown to orange, silty **SAND** (SM); dry; non-plastic; micaceous.		
9	SS	16.0					15					
10	SS	18.0								Moderately hard, greenish gray, **SANDSTONE**;		

TYPE OF CASING USED

	NQ-2 ROCK CORE	
	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
X	AIR HAMMER	8"

Continued Next Page

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER

AEP_CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0620** DATE **7/17/15** SHEET **2** OF **12**

PROJECT **CARDINAL LANDFILL** BORING START **8/25/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
11	SS	20.0								fine grained; rust color along fractures; massive.		
1	RC	22.0	30.0				25			Hard, light gray, **LIMESTONE**; fine grained; rust color along fractures; vertical fracture at 24.0 ft.; massive.		
										Soft, greenish gray (GLEY1-6/1-5GY), **SANDSTONE**; micaceous; massive.		
2	RC	30.0	40.0				30			Soft, gray, **SAND and SHALE**; micaceous.		
										Soft, gray to greenish gray, **SANDSTONE**; medium grained; slight shale like foliations; 3" sandy shale at 33 ft.; 5 horizontal and vertical fractures.		
							35			Very soft, gray to greenish gray, **CLAYSHALE**; massive.		
										Hard, gray to greenish gray, **SANDSTONE**.		
3	RC	40.0	50.0				40			Very soft, gray to greenish gray, **CLAYSHALE**; high sand content; massive to foliated.		
							45					

Continued Next Page

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0620** DATE **7/17/15** SHEET **3** OF **12**

PROJECT **CARDINAL LANDFILL** BORING START **8/25/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										Moderately hard, greenish gray, **SANDSTONE**; fine grained, rust color along cracks; massive.		
4	RC	50.0	60.0				50					
							55			2 horizontal fractures near 55.0 ft.		
										Soft, gray to black, **CLAYSHALE**; massive to foliated.		
5	RC	60.0	70.0				60			Hard, light gray (GLEY2-7/1-10B), **LIMESTONE**; massive.		
										Soft, gray to black; **CLAYSHALE**; massive.		
							65					
6	RC	70.0	80.0				70					

Continued Next Page

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0620** DATE **7/17/15** SHEET **4** OF **12**

PROJECT **CARDINAL LANDFILL** BORING START **8/25/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										Moderately hard, greenish gray, **SANDSTONE**; fine grained; massive. Vertical fracture at 73.0 ft. Horizontal fracture at 74.5 ft.		
							75			Soft, dark gray, **CLAYSHALE**; massive.		
7	RC	80.0	90.0				80					
										Light gray, **LIMESTONE**; iron staining.		
										Soft, dark gray, **CLAYSHALE**; massive.		
							85					
8	RC	90.0	100.0				90			Light gray, **LIMESTONE**.		
										Soft, dark gray, **CLAYSHALE**; massive.		
							95			Hard, gray (GLEY1-6/2-N), **LIMESTONE**; massive.		
										Soft, dark gray, **CLAYSHALE**; massive.		

Continued Next Page

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0620** DATE **7/17/15** SHEET **5** OF **12**

PROJECT **CARDINAL LANDFILL** BORING START **8/25/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
9	RC	100.0	110.0				100			Hard, gray, **LIMESTONE**; massive.		
										Soft, gray (GLEY1-4/1-N), **CLAYSTONE**; massive.		
							105					
10	RC	110.0	120.0				110					
							115					
11	RC	120.0	130.0				120			Light gray, **LIMESTONE**.		
										Dark gray, **CLAYSHALE**.		

Continued Next Page

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0620** DATE **7/17/15** SHEET **6** OF **12**

PROJECT **CARDINAL LANDFILL** BORING START **8/25/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							125			Light gray, **LIMESTONE**.		
										Dark gray to black to red brown (10R-3/2-/2), **CLAYSHALE**; dry; massive.		
12	RC	130.0	140.0				130					
							135					
13	RC	140.0	150.0				140			Hard, dark gray (GLEY2-3/1-5PB), **CLAYSTONE**; vertical fractures refilled with calcite; massive.		
							145					

Continued Next Page

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0620** DATE **7/17/15** SHEET **7** OF **12**

PROJECT **CARDINAL LANDFILL** BORING START **8/25/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	SAMPLE DEPTH IN FEET TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
14	RC	150.0	160.0							Hard, gray, **SANDSTONE**; medium grained.		
							155			Hard, grayish brown (10YR 5/3), **SANDSTONE**; medium grained.		
15	RC	160.0	170.0				160					
							165			Hard, gray (GLEY2-5/1-10B), **SANDSTONE**; medium grained.		
16	RC	170.0	180.0				170			Vertical fracture at 172.0 ft.		
							175					

Continued Next Page

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0620** DATE **7/17/15** SHEET **8** OF **12**

PROJECT **CARDINAL LANDFILL** BORING START **8/25/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
17	RC	180.0	190.0				180					
							185			Thin (1mm) clay hair line seams between 185.5 and 187.0 ft. and through sandstone to 225.5 ft.		
18	RC	190.0	200.0				190			Pebbly subrounded limestone clasts.		
							195					
19	RC	200.0	210.0				200					

Continued Next Page

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0620** DATE **7/17/15** SHEET **9** OF **12**

PROJECT **CARDINAL LANDFILL** BORING START **8/25/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							205					
20	RC	210.0	220.0				210			Sandstone conglomerate between 210.0 and 211.0 ft.		
										Sandstone conglomerate between 212.0 and 213.5 ft.		
										Sandstone conglomerate between 214.0 and 215.0 ft.		
							215					
21	RC	220.0	230.0				220			Sandstone conglomerae between 221.5 and 221.7 ft.		
							225			Sandstone conglomerate between 225.0 and 225.5 ft.		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0620** DATE **7/17/15** SHEET **10** OF **12**

PROJECT **CARDINAL LANDFILL** BORING START **8/25/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										Hard, dark gray, **SANDSTONE**; fine grained.		
22	RC	230.0	240.0				230			Moderately hard to hard, dark gray to black, **CLAYSHALE**; contains brown, angular, coarse to fine gravel inclusions (>5%); massive.		
										Sandstone conglomerate between 233.0 and 233.3 ft.		
							235					
										Sandstone conglomerate between 237.6 and 238.0 ft.		
23	RC	240.0	250.0				240					
							245					
										Hard, light gray, **SANDSTONE**; medium grained; thin coal streaks (1mm) throughout.		
24	RC	250.0	260.0				250			Dark gray claystone between 250.0 and 250.5 ft.		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0620** DATE **7/17/15** SHEET **11** OF **12**

PROJECT **CARDINAL LANDFILL** BORING START **8/25/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							255					
										Gray, **SANDSTONE**; conglomerate.		
25	RC	260.0	270.0				260			Soft to moderately hard, greenish gray (GLEY2-4/1-5B), **CLAYSHALE**; slightly foliated.		
										Hard, gray (GLEY1-4/1-5B), **LIMESTONE**; contains fossils, fractured and broken glass at 273.0 ft.		
26	RC	270.0	280.0							Dark gray to black, **CLAYSHALE**; slicken slides throughout.		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0620** DATE **7/17/15** SHEET **12** OF **12**

PROJECT **CARDINAL LANDFILL** BORING START **8/25/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
27	RC	280.0	290.0									
28	RC	290.0	300.0									

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 830,925.1 E 2,519,495.8**

GROUND ELEVATION **1005.7** SYSTEM _____

Water Level, ft	▽	▼	▼
TIME			
DATE			

BORING NO. **CA-0702** DATE **7/17/15** SHEET **1** OF **9**

BORING START **5/1/07** BORING FINISH **5/21/07**

PIEZOMETER TYPE **N/A** WELL TYPE **OW**

HGT. RISER ABOVE GROUND **2.359** DIA **2"**

DEPTH TO TOP OF WELL SCREEN **152.9** BOTTOM **214.4**

WELL DEVELOPMENT **YES** BACKFILL **QUICK GROUT**

FIELD PARTY **MCR / ZLR** RIG **D-120**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							5					
							10					
							15					
1	NQ	15.5	17.9		1.2	0				**HARD N4 MEDIUM GRAY LIMESTONE**		
										SOFT N4 MEDIUM GRAY CLAY		
										HARD N4 MEDIUM GRAY LIMESTONE		
2	NQ	17.9	24.2		4.0	55				**HARD N4 MEDIUM GRAY LIMESTONE** all fractured		
										HARD 5B 7/1 MEDIUM LIGHT BLUISH GRAY LIMEY FINE-GRAIN SANDSTONE		

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
X	AIR HAMMER	8"

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PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER _____

AEP_CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0702** DATE **7/17/15** SHEET **2** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **5/1/07** BORING FINISH **5/21/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
3	NQ	24.2	34.2		9.2	54	25			**HARD 5B 7/1 MEDIUM LIGHT BLUISH GRAY LIMEY FINE-GRAIN SANDSTONE**		
										SOFT N5 MEDIUM GRAY CLAY SHALE		
										HARD LIMESTONE		
										SOFT N5 MEDIUM GRAY CLAY SHALE		
							30			**HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE / LIMESTONE NODULE**		
4	NQ	34.2	40.7		6.4	0	35			**SOFT 5YR 4/1 BROWNISH GRAY CLAY SHALE** w/5G 6/1 greenish gray clay shale, w/high angle fracture		
5	NQ	40.7	49.2		8.2	28	40			**HARD TO MEDIUM 5G 6/1 GREENISH GRAY CLAY SHALE**		
							45					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0702** DATE **7/17/15** SHEET **3** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **5/1/07** BORING FINISH **5/21/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
6	NQ	49.2	59.2		10.0	42	50			**HARD 5G 6/1 GREENISH GRAY CLAY SHALE**		
							55			**SOFT 5G 6/1 GEEENISH GRAY CLAY SHALE**		
										HARD 5G 6/1 GREENISH GRAY CLAY SHALE w/traces of limestone		
7	NQ	59.2	69.2		7.7	43	60			**HARD 5G 6/1 GREENISH GRAY LIMESTONE**		
										HARD 5G 6/1 GREENISH GRAY CLAY SHALE w/fracture 64.0' and 65.0 high angles		
8	NQ	69.2	75.2		6.0	33	65			**HARD 5G 6/1 GREENISH GRAY CLAY SHALE**		
							70					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0702** DATE **7/17/15** SHEET **4** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **5/1/07** BORING FINISH **5/21/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							75			**HARD N5 MEDIUM GRAY LIMESTONE** broken up		
9	NQ	75.2	84.2		8.4	49				**HARD N7 LIGHT GRAY LIMESTONE**		
										HARD 5G 6/1 GREENISH GRAY CLAY SHALE		
							80					
10	NQ	84.2	90.7		4.7	0				**HARD 5G 6/1 GREENISH GRAY CLAY SHALE** w/limestone nodules		
							85					
							90					
11	NQ	90.7	97.7		5.4	61				**HARD 5G 6/1 GREENISH GRAY CLAY SHALE** w/limestone nodules		
							95					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0702** DATE **7/17/15** SHEET **5** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **5/1/07** BORING FINISH **5/21/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
12	NQ	97.7	104.2		6.4	44				**HARD 5G 6/1 GREENISH GRAY CLAY SHALE**		
										HARD 5G 6/1 GREENISH GRAY LIMESTONE		
							100			**HARD 5G 6/1 GREENISH GRAY CLAY SHALE** w/limestone nodules		
										HARD 5G 6/1 GREENISH GRAY LIMESTONE		
13	NQ	104.2	114.2		8.8	70				**MEDIUM TO HARD 5G 6/1 GREENISH GRAY CLAY SHALE**		
							105					
							110					
14	NQ	114.2	121.2		6.2	19				**HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		
							115			**HARD 5B 5/1 MEDIUM BLUISH GRAY LIMESTONE** w/fracture throughout		
										HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE		
										HARD 5B 5/1 MEDIUM BLUISH GRAY LIMESTONE w/fracture throughout		
							120			**HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		
15	NQ	121.2	129.2		8.3	51				**HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0702** DATE **7/17/15** SHEET **6** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **5/1/07** BORING FINISH **5/21/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							125					
16	NQ	129.2	139.2		10.0	33	130			**HARD N5 MEDIUM GRAY CLAY SHALE** w/fractures		
17	NQ	139.2	149.2		10.0	41	135					
							140			**HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		
							145			**COAL**		
										HARD N3 DARK GRAY SHALE		
18	NQ	149.2	159.2		10.0	87				**N5 MEDIUM GRAY WELL CEMENTED MEDIUM GRAIN SANDSTONE**		148.0' - 215.0' MORGANTOWN SANDSTONE / SHALLOW WELL?
										N5 MEDIUM GRAY WELL CEMENTED		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0702** DATE **7/17/15** SHEET **7** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **5/1/07** BORING FINISH **5/21/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										MEDIUM GRAIN SANDSTONE		
19	NQ	159.2	169.2		10.0	93	155			**N5 MEDIUM GRAY WELL CEMENTED MEDIUM GRAIN SANDSTONE**		
							160					
							165					
20	NQ	169.2	179.2		10.0	71				**N5 MEDIUM GRAY WELL CEMENTED MEDIUM GRAIN SANDSTONE**		
							170					
							175					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0702** DATE **7/17/15** SHEET **8** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **5/1/07** BORING FINISH **5/21/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
21	NQ	179.2	189.2		10.0	52	180			**N5 MEDIUM GRAY MEDIUM GRAIN SANDSTONE**		SWL 117.8' 05/21/07; NQ HOLE TO 179.2'; THIS IS A 408 HR READING
										N5 MEDIUM GRAY MEDIUM GRAIN SANDSTONE w/coal		
							185			**N5 MEDIUM GRAY MEDIUM GRAIN SANDSTONE**		
										N5 MEDIUM GRAY MEDIUM GRAIN SANDSTONE w/coal		
22	NQ	189.2	199.2		10.0	85	190			**N5 MEDIUM GRAY MEDIUM GRAIN SANDSTONE**		
										w/coal seams		
										N5 MEDIUM GRAY WELL CEMENTED MEDIUM GRAIN SANDSTONE		
							195					
23	NQ	199.2	209.2		9.2	87	200			**N5 MEDIUM GRAY WELL CEMENTED MEDIUM GRAIN SANDSTONE**		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0702** DATE **7/17/15** SHEET **9** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **5/1/07** BORING FINISH **5/21/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										COAL SEAM		
										N5 MEDIUM GRAY SANDY COARSE STONE		
							205					
										N5 MEDIUM GRAY MEDIUM GRAIN WELL CEMENTED SANDSTONE		
24	NQ	209.2	219.2		10.0	95				**N5 MEDIUM GRAY WELL CEMENTED MEDIUM GRAIN SANDSTONE**		
							210					
							215					
										HARD N5 MEDIUM GRAY SILTY SHALE		
												STOPPED BORING @ 219.2' 05/21/07; INSTALLED 2" PVC MONITORING WELL; SWL 90.8' 05/22/07; NQ HOLE TO 219.2' ; 14 HR READING

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 835,565.0 E 2,516,519.0**

GROUND ELEVATION **1065.8** SYSTEM

Water Level, ft	▽	▼	▼
TIME			
DATE			

BORING NO. **CA-0616** DATE **7/17/15** SHEET **1** OF **11**

BORING START **1/18/07** BORING FINISH **1/24/07**

PIEZOMETER TYPE **N/A** WELL TYPE **OW**

HGT. RISER ABOVE GROUND **2.798** DIA **2"**

DEPTH TO TOP OF WELL SCREEN **201.3** BOTTOM **250.3**

WELL DEVELOPMENT **YES** BACKFILL **QUICK GROUT**

FIELD PARTY **MCR / ZLR** RIG **D-120**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							5					GROUNDING PROCEDURES NOT IN USE; DECONNED TOOLS 01/08/07; WATER TO DRILL AND DECON FROM FIRE PROTECTION SYSTEM @ CARDINAL PLANT; BLIND DRILL HW 4" CASING FROM GRADE TO BEDROCK @ 78' THROUGH MINE SPOIL; BLIND DRILLED 4" ROLLER BIT FROM 78' TO 82.8'
							10					
							15					

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
	AIR HAMMER	8"

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PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER

AEP CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0616** DATE **7/17/15** SHEET **2** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **1/18/07** BORING FINISH **1/24/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							25					
							30					
							35					
							40					
							45					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0616** DATE **7/17/15** SHEET **3** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **1/18/07** BORING FINISH **1/24/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							50					
							55					
							60					
							65					
							70					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0616** DATE **7/17/15** SHEET **4** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **1/18/07** BORING FINISH **1/24/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							75					
							80					
1	NQ	82.8	89.6		6.6	12				**MEDIUM HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		STARTED CORING @ 82.8'
							85					
2	NQ	89.6	97.6		7.4	36				**MEDIUM HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		
							90					
							95					
3	NQ	97.6	104.6		6.8	56				**SOFT 5YR 3/4 MODERATE BROWN SHALE**		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0616** DATE **7/17/15** SHEET **5** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **1/18/07** BORING FINISH **1/24/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE		
							100					
4	NQ	104.6	114.6		10.0	67	105			**SOFT 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		
										HARD SILTY FINE 5B 5/1 MEDIUM BLUISH GRAY SANDSTONE w/limestone nodules		
							110					
										HARD 5B 5/1 MEDIUM BLUISH GRAY FINE TO MEDIUM GRAIN SANDSTONE		
5	NQ	114.6	124.6		10.0	82	115			**HARD 5B 5/1 MEDIUM BLUISH GRAY FINE TO MEDIUM GRAIN SANDSTONE**		
												LOST ALL DRILL RETURN WTAER @
							120					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0616** DATE **7/17/15** SHEET **6** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **1/18/07** BORING FINISH **1/24/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
6	NQ	124.6	129.6		4.6	13	125			**SOFT TO HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		123.0'; NO VISABLE SIGNS OF FRACTURES OR IRON STAINING
										HARD N5 MEDIUM GRAY SHALEY LIMESTONE		
7	NQ	129.6	139.6		9.6	39	130			**HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE** w/limestone nodules throughout		SWL 1,122' ON 01/22/07 (80 HR READING) NQ HOLE TO 129.6'
							135			**HARD N5 MEDIUM GRAY LIMESTONE**		
										HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE		
8	NQ	139.6	146.1		5.7	32	140			**SOFT TO HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		
										HARD N5 MEDIUM GRAY LIMEY SHALE		
							145			**HARD N5 MEDIUM GRAY LIMESTONE**		
9	NQ	146.1	154.6		8.4	31				**HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0616** DATE **7/17/15** SHEET **7** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **1/18/07** BORING FINISH **1/24/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										SOFT 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE		
10	NQ	154.6	159.6		5.0	22	155			**SOFT TO HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		SWL 109.4' ON 01/23/07 (~15 HR READING) NQ HOLE TO 159.6'
										HARD N5 MEDIUM GRAY LIMESTONE		
11	NQ	159.6	169.6		5.8	72	160			**HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE** w/limestone nodules throughout		FROM 159.6' - 169.6' INNER TUBE DID NOT LATCH IN CORE BARREL; PULLED TOOLS & RECOVERED 5.8' OF CORE FROM INSIDE CORE BARREL; CURE COULD BE MISPLACED IN BOX; RESET TOOLS & STARTED CORING @ 169.6', CORED 5.0' - 174.6'; PICKED UP 2.1' OF CORE FROM RUN #11
12	NQ	169.6	174.6		7.1	75	165			**HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE** w/limestone nodules		
							170			**HARD 5B 7/1 LIGHT BLUISH GRAY SILTY FINE GRAIN WELL CEMENTED SANDSTONE**		
13	NQ	174.6	184.6		10.0	64	175			**HARD 5B 5/1 MEDIUM BLUISH GRAY SILTY FINE GRAIN WELL CEMENTED SANDSTONE**		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0616** DATE **7/17/15** SHEET **8** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **1/18/07** BORING FINISH **1/24/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							180					
										HARD N4 MEDIUM DARK GRAY SILTY SILTSTONE		
14	NQ	184.6	194.6		10.0	25	185			**HARD 5B 7/1 LIGHT BLUISH GRAY MEDIUM SANDSTONE**		
										HARD 5B 5/1 MEDIUM BLUISH GRAY SILTY FINE SANDSTONE		
							190					
										HARD N7 LIGHT GRAY MEDIUM SANDSTONE		
										HARD 5B 5/1 MEDIUM BLUISH GRAY SILTY FINE SANDSTONE		
										HARD N7 LIGHT GRAY MEDIUM SANDSTONE		
15	NQ	194.6	199.6		5.1	90	195			**HARD N7 LIGHT GRAY MEDIUM TO COARSE SANDSTONE**		SWL 117.6' ON 01/24/07 (18 HR READING) NQ HOLE TO 199.6'
16	NQ	199.6	209.6		10.1	94	200			**HARD N6 MEDIUM LIGHT GRAY WELL CEMENTED MEDIUM TO COARSE SANDSTONE**		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0616** DATE **7/17/15** SHEET **9** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **1/18/07** BORING FINISH **1/24/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							205					
17	NQ	209.6	219.6		9.9	97	210			**HARD N6 MEDIUM LIGHT GRAY WELL CEMENTED MEDIUM TO COARSE SANDSTONE** w/small 1" seams of coal		
							215					
18	NQ	219.6	229.6		10.0	86	220			**HARD N6 MEDIUM LIGHT GRAY WELL CEMENTED MEDIUM TO COARSE SANDSTONE**		
							225			**HARD N4 MEDIUM DARK GREY SILTSTONE**		
										HARD N6 MEDIUM LIGHT GRAY WELL CEMENTED MEDIUM TO COARSE SANDSTONE		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0616** DATE **7/17/15** SHEET **10** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **1/18/07** BORING FINISH **1/24/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
19	NQ	229.6	239.6		10.0	84	230			**HARD N6 MEDIUM LIGHT GRAY WELL CEMENTED MEDIUM TO COARSE SANDSTONE**		
							235			**HARD N4 MEDIUM DARK GRAY SILTSTONE**		
										HARD N6 MEDIUM LIGHT GRAY WELL CEMENTED MEDIATE TO COARSE SANDSTONE		
										HARD N4 MEDIUM DARK GRAY SILTSTONE		
20	NQ	239.6	249.6		9.9	72	240			**HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE** w/limestone nodules		
										HARD N6 MEDIUM LIGHT GRAY WELL CEMENTED MEDIUM TO COARSE SANDSTONE		
										COAL SEAM		
										HARD N6 MEDIUM LIGHT GRAY WELL CEMENTED MEDIUM TO COARSE SANDSTONE		
							245					
										HARD N4 MEDIUM DARK GRAY SILTSTONE		
21	NQ	249.6	254.6		5.1	41	250			**HARD N5 MEDIUM GRAY WELL CEMENTED MEDIUM TO COARSE SANDSTONE** w/siltstone crossbedded throughout		
										HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE w/limestone nodules		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0616** DATE **7/17/15** SHEET **11** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **1/18/07** BORING FINISH **1/24/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	SAMPLE DEPTH IN FEET TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
												STOPPED BORING @ 254.6 ON 01/24/07; BUILD 2" MONITORING WELL; 111.0' - 130.0' IS CONNELLSVILLE; 194.6' - 249.7' IS MORGANTOWN

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 833,569.0 E 2,518,172.3**

GROUND ELEVATION **1071.8** SYSTEM _____

Water Level, ft			
TIME			
DATE			

BORING NO. **CA-0614** DATE **7/17/15** SHEET **1** OF **11**

BORING START **7/18/07** BORING FINISH **7/25/07**

PIEZOMETER TYPE **N/A** WELL TYPE **OW**

HGT. RISER ABOVE GROUND **2.45** DIA **2"**

DEPTH TO TOP OF WELL SCREEN **214.0** BOTTOM **274.3**

WELL DEVELOPMENT **YES** BACKFILL **QUICK GROUT**

FIELD PARTY **MCR/ZLR/RMP** RIG **D-120**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
												GROUNDING PROCEDURES NOT IN USE ON THIS BORING; DRILL AND DECON WATER USED FROM CARDINAL FIRE PROTECTION SYSTEM; DECONNED TOOLS & DRILL 07/18/07; BLIND DRILLED 4" HW CASING TO START CORING @ 8.6'
1	NQ	8.6	14.4		3.7	11	5			**SOFT N6 MEDIUM LIGHT GRAY BROKEN SILTY CLAYSHALE**		
2	NQ	14.4	24.4		6.3	30	10			**N5 MEDIUM GRAY BROKEN SILTSTONE**		
							15			**HARD N8 VERY LIGHT GRAY LIMESTONE** w/heavy iron staining throughout		

TYPE OF CASING USED

	NQ-2 ROCK CORE	
	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
	AIR HAMMER	8"

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PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER _____

AEP CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0614** DATE **7/17/15** SHEET **2** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **7/18/07** BORING FINISH **7/25/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
3	NQ	24.4	29.9		4.3	47	25			**HARD N7 LIGHT GRAY SILTY CLAYSHALE** w/iron staining		
4	NQ	29.9	39.4		9.1	31	30			**HARD N5 MEDIUM GRAY WELL CEMENTED FINE SANDY SILTSTONE** w/iron staining throughout; high angle fracture @ 35.2'		
5	NQ	39.4	49.9		10	22	35					
							40			**HARD N3 DARK GRAY FINE SANDY SILTSTONE** Well Cemented		
							45					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0614** DATE **7/17/15** SHEET **3** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **7/18/07** BORING FINISH **7/25/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										N1 BLACK COAL		
6	NQ	49.9	54.9		3.7	68	50			**N6 MEDIUM LIGHT GRAY LIMESTONE**		
										N5 MEDIUM GRAY LIMEY SILTSTONE		
7	NQ	54.9	59.9		4.6	43	55			**N5 MEDIUM GRAY BROKEN LIMEY SILTSTONE**		
										HARD 5Y 6/4 DUSKY YELLOW FINE GRAIN WELL CEMENTED SANDSTONE w/heavy iron staining; vertical fracture @ 56.5'		
8	NQ	59.9	69.9		7.1	61	60			**HARD N5 MEDIUM GRAY WELL CEMENTED LIMESTONE**		
							65			**N5 MEDIUM GRAY BROKEN CLAYSHALE** w/fractures @ 61' and 64.0'		
9	NQ	69.9	79.9		5.4	43	70			**HARD N5 MEDIUM GRAY LIMESTONE**		
										SOFT N7 LIGHT GRAY CLAYSHALE		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0614** DATE **7/17/15** SHEET **4** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **7/18/07** BORING FINISH **7/25/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							75					
10	NQ	79.9	89.9		6.6	23	80			**N1 BLACK COAL**		
							85			**N5 MEDIUM GRAY SILTSTONE** w/high angle fracture		
11	NQ	89.9	99.9		10	12	90			**N6 MEDIUM LIGHT GRAY FINE GRAIN WELL CEMENTED SANDY CLAYSHALE**		
							95					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0614** DATE **7/17/15** SHEET **5** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **7/18/07** BORING FINISH **7/25/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
12	NQ	99.9	106.9		5.8	53	100			**N6 MEDIUM LIGHT GRAY FINE GRAIN SANDY CLAYSHALE**		
13	NQ	106.9	114.9		5.6	0	105			**N6 MEDIUM LIGHT GRAY WELL CEMENTED FINE GRAIN SANDSTONE** w/high angle fracture throughout whole piece		
										N6 MEDIUM LIGHT GRAY WELL CEMENTED FINE GRAIN SANDSTONE		
										HARD N4 MEDIUM GRAY SHALE w/machine break		
							110			**SOFT N4 MEDIUM GRAY CLAYSHALE**		
14	NQ	114.9	120.9		5.2	8	115			**HARD N5 MEDIUM GRAY CLAYSHALE**		
										N6 MEDIUM LIGHT GRAY LIMESTONE w/ high angle fracture from 117' - 118.4'		
							120			**SOFT N5 MEDIUM GRAY CLAYSHALE**		
15	NQ	120.9	129.9		4.8	38				**HARD N5 MEDIUM GRAY CLAYSHALE**		
										N6 MEDIUM LIGHT GRAY LIMESTONE		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0614** DATE **7/17/15** SHEET **6** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **7/18/07** BORING FINISH **7/25/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							125			**HARD N5 MEDIUM GRAY CLAYSHALE**		
16	NQ	129.9	134.9		3.9	10	130			**HARD N6 MEDIUM LIGHT GRAY SILTSTONE** w/high angle fracture @ 130.9'		SWL 74.4' 07/23/07 - 50 HR READING / NQ HOLE TO 129.9'
										SOFT N6 MEDIUM LIGHT GRAY CLAYSHALE		
17	NQ	134.9	138.4		2.3	17	135			**HARD N5 MEDIUM GRAY LIMESTONE**		
										N5 MEDIUM GRAY SILTSTONE		
18	NQ	138.4	143.9		6.5	0				**HARD N5 MEDIUM GRAY CLAYSHALE**		
							140			**HARD N5 MEDIUM GRAY CLAYSHALE**		
19	NQ	144.4	149.4		4.0	18	145					
										SOFT N4 MEDIUM DARK GRAY CLAYSHALE		
										N5 MEDIUM GRAY LIMEY SILTSTONE		
20	NQ	149.4	154.4		3.9	0				**SOFT N5 MEDIUM GRAY CLAYSHALE**		
										N4 MEDIUM DARK GRAY CLAYSHALE		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0614** DATE **7/17/15** SHEET **7** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **7/18/07** BORING FINISH **7/25/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
21	NQ	154.4	158.4		3.5	11	155			**HARD N6 MEDIUM LIGHT GRAY SILTSTONE**		
22	NQ	158.4	164.9		5.7	16	160			**HARD N5 MEDIUM GRAY CLAYSHALE**		
23	NQ	164.9	168.9		3.4	0	165			**SOFT N6 MEDIUM LIGHT GRAY CLAYSHALE** w/high angle fracture @ 168.7'		
24	NQ	168.9	174.9		5.7	0	170			**HARD N5 MEDIUM GRAY CLAYSHALE**		
25	NQ	174.9	179.9		5	10	175			**HARD N5 MEDIUM GRAY SILTSTONE**		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0614** DATE **7/17/15** SHEET **8** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **7/18/07** BORING FINISH **7/25/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
26	NQ	179.9	182.4		1.9	0	180			**HARD N4 MEDIUM DARK GRAY LIMESTONE**		
										N4 MEDIUM DARK GRAY SILTSTONE		
27	NQ	182.4	183.9		1	0				**N4 MEDIUM DARK GRAY SILTY LIMESTONE**		SWL 67.4' - 14 HR READING / NQ HOLE TO 182.9'
28	NQ	183.9	187.9		3.4	50				**HARD N5 MEDIUM GRAY LIMEY SILTSTONE**		
							185			**SOFT N5 MEDIUM GRAY SILTSTONE** w/high angle fracture @ 186.7'		
										SOFT N5 MEDIUM GRAY LIMEY SILTSTONE		
29	NQ	187.9	189.9		2.4	0				**HARD N5 MEDIUM GRAY LIMEY SILTSTONE**		
30	NQ	189.9	194.9		4.9	0	190			**HARD N6 MEDIUM LIGHT GRAY LIMEY SILTSTONE**		
										SOFT N6 MEDIUM LIGHT GRAY CLAYSHALE		
31	NQ	194.9	199.9		5	32	195			**N5 MEDIUM GRAY CLAYSHALE**		
										N5 MEDIUM GRAY FINE GRAIN WELL CEMENTED SANDSTONE		
										N6 MEDIUM LIGHT GRAY SILTSTONE		
32	NQ	199.9	204.9		5	36	200			**N6 MEDIUM LIGHT GRAY SANDY FINE GRAIN WELL CEMENTED SILTSTONE** w/crossbeddings in sandstone		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0614** DATE **7/17/15** SHEET **9** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **7/18/07** BORING FINISH **7/25/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										N6 MEDIUM LIGHT GRAY FINE GRAIN WELL CEMENTED SANDSTONE badly broken by machine		
33	NQ	204.9	214.9		10.2	28	205			**N6 MEDIUM LIGHT GRAY FINE GRAIN SANDSTONE**		
										N4 MEDIUM DARK SANDY CLAYSHALE		
										N6 MEDIUM LIGHT GRAY SILTY SANDSTONE w/crossbeddings		
							210			**SOFT N4 MEDIUM DARK GRAY SANDY CLAYSHALE**		
										N6 MEDIUM LIGHT GRAY WELL CEMENTED FINE GRAIN SANDSTONE		
										N4 LIGHT GRAY WELL CEMENTED FINE SANDY SILTSTONE w/sandstone lenses		
34	NQ	214.9	224.9		10	76	215			**N5 MEDIUM GRAY FINE GRAIN SILTSTONE** w/sandstone lenses		
										N5 MEDIUM GRAY FINE SANDSTONE w/crossbedding throughout		
										N5 MEDIUM GRAY FINE GRAIN SILTSTONE w/sandstone lenses		
							220			**N5 MEDIUM GRAY COARSE SANDSTONE** well cemented throughout		
35	NQ	224.9	229.9		5	86	225			**N6 MEDIUM LIGHT GRAY COARSE SANDSTONE** crossbedded w/siltstone		
										N5 MEDIUM GRAY SILTSTONE		
										N6 MEDIUM LIGHT GRAY COARSE SANDSTONE		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0614** DATE **7/17/15** SHEET **10** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **7/18/07** BORING FINISH **7/25/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										N5 MEDIUM GRAY SILTSTONE		
36	NQ	229.9	234.9		5	90	230			**N6 MEDIUM LIGHT GRAY COARSE SANDSTONE** w/coal lenses		
										HARD N7 LIGHT GRAY COARSE SANDSTONE		
										COAL PARTINGS		
										HARD WELL CEMENTED COAL LENSES		
37	NQ	234.9	244.9		10	90	235			**N7 LIGHT GRAY MEDIUM GRAIN SANDSTONE** w/1" cross of clayshale		
							240			**HARD WELL CEMENTED CLAYSHALE** crossbedded w/fine grain sandstone		
38	NQ	244.9	254.9		9.2	91	245			**N6 MEDIUM LIGHT GRAY MEDIUM GRAIN SANDSTONE** w/clayshale crossbedding		
										N2 GRAYISH BLACK CLAYSHALE crossbedded w/fine grain sandstone		
							250			**N6 MEDIUM LIGHT GRAY MEDIUM GRAIN SANDSTONE** w/clayshale crossbedding		
										N2 GRAYISH BLACK CLAYSHALE crossbedded w/fine grain sandstone		
										HARD N7 MEDIUM LIGHT GRAY MEDIUM GRAIN WELL CEMENTED SANDSTONE		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0614** DATE **7/17/15** SHEET **11** OF **11**

PROJECT **CARDINAL LANDFILL** BORING START **7/18/07** BORING FINISH **7/25/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										crossbedded w/clayshale		
39	NQ	254.9	264.1		9.2	100	255			**N7 LIGHT GRAY COURSE GRAIN SANDSTONE** w/lenses		
							260					
40	NQ	264.1	269.6		6.2	89	265			**HARD N6 MEDIUM LIGHT GRAY WELL CEMENTED COARSE SANDSTONE** w/coal parting @ 266.0'		
41	NQ	269.9	277.4		7.5	65	270			**HARD N6 MEDIUM LIGHT GRAY WELL CEMENTED COARSE SANDSTONE** w/limestone nodules @ 273.9' - 274.9'		
							275			**HARD N5 MEDIUM GRAY WELL CEMENTED SILTSTONE**		STOPPED BORING @ 277.4' 07/25/07

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 832,901.9 E 2,519,661.8**

GROUND ELEVATION **984.9** SYSTEM _____

Water Level, ft	▽	▼	▼
TIME			
DATE			

BORING NO. **CA-0612** DATE **7/17/15** SHEET **1** OF **8**

BORING START **3/6/07** BORING FINISH **3/21/07**

PIEZOMETER TYPE _____ WELL TYPE **OW**

HGT. RISER ABOVE GROUND **3.301** DIA **2"**

DEPTH TO TOP OF WELL SCREEN **127.3** BOTTOM **184.3**

WELL DEVELOPMENT **YES** BACKFILL **QUICK GROUT**

FIELD PARTY **MCR / ZLR** RIG **D-120**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
												GROUNDING PROCEDURES NOT IN USE; DECONNED TOOLS & DRILL 03/01/07; DRILL WATER USED COMING FROM FIRE PROTECTION SYSTEM @ CARDINAL; BLIND DRILLED 325 HSA'S TO TOP OF BEDROCK @ 14.0'; STARTED CORING AT 14.0'
							5					
							10					
1	NQ	14.0	19.3		2.2	18				**HARD N6 LIGHT GRAY CLAY SHALE**		
							15			**SOFT 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		
2	NQ	19.3	24.7		2.7	30				**SOFT 5B 5/1 MEDIUM BLUISH GRAY CLAY**		

TYPE OF CASING USED

	NQ-2 ROCK CORE	
	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
	AIR HAMMER	8"

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PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER **ZLR**

AEP CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0612** DATE **7/17/15** SHEET **2** OF **8**

PROJECT **CARDINAL LANDFILL** BORING START **3/6/07** BORING FINISH **3/21/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										SHALE		
3	NQ	24.7	34.7		9.9	23	25			**HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE** w/vertical fractures		
4	NQ	34.7	41.7		4.6	0	30			**HARD N5 MEDIUM GRAY CLAY SHALE** w/limestone nodules throughout, w/fractures		
5	NQ	41.7	44.7		1.5	27	35			**HARD N5 MEDIUM GRAY CLAY SHALE** w/limestone nodules throughout		
6	NQ	44.7	54.7		10.0	69	40			**SOFT 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		
							45					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0612** DATE **7/17/15** SHEET **3** OF **8**

PROJECT **CARDINAL LANDFILL** BORING START **3/6/07** BORING FINISH **3/21/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE		
							50			**SOFT 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		
7	NQ	54.7	64.7		9.6	49	55			**SOFT N7 LIGHT GRAY CLAY SHALE**		
										HARD N7 LIGHT GRAY CLAY SHALE		
							60			**SOFT N7 LIGHT GRAY CLAY SHALE**		
8	NQ	64.7	72.7		7.9	28	65			**SOFT 5G 6/1 GREENISH GRAY CLAY SHALE**		
							70			**HARD 5G 6/1 GREENISH GRAY CLAY SHALE** w/limestone nodules		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0612** DATE **7/17/15** SHEET **4** OF **8**

PROJECT **CARDINAL LANDFILL** BORING START **3/6/07** BORING FINISH **3/21/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
9	NQ	72.7	79.7		7.0	27				**HARD 5G 6/1 GREENISH GRAY CLAY SHALE** w/limestone nodules		
							75			**SOFT 5G 6/1 GREENISH GRAY CLAY SHALE**		
10	NQ	79.7	89.7		10.0	67	80			**HARD 5G 6/1 GREENISH GRAY LIMESTONE**		
										HARD WELL CEMENTED SILTSTONE w/limestone nodules		
							85					
11	NQ	89.7	99.7		10.0	40	90			**HARD 5G 6/1 GREENISH GRAY WELL CEMENTED SILTSTONE**		
										SOFT 5G 6/1 GREENISH GRAY SHALE		
							95			**HARD N7 LIGHT GRAY LIMESTONE**		
										SOFT N7 LIGHT GRAY SHALE		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0612** DATE **7/17/15** SHEET **5** OF **8**

PROJECT **CARDINAL LANDFILL** BORING START **3/6/07** BORING FINISH **3/21/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										HARD N7 LIGHT GRAY LIMESTONE		
12	NQ	99.7	109.7		10.0	60	100			**HARD 5G 6/1 GREENISH GRAY CLAY SHALE**		
										HARD 5G 6/1 GREENISH GRAY WELL CEMENTED SILTSTONE		
							105					
										HARD 5G 6/1 GREENISH GRAY CLAY SHALE		
13	NQ	109.7	119.7		9.6	66	110			**HARD 5G 6/1 GREENISH GRAY CLAY SHALE**		
							115					
										HARD 5G 6/1 GREENISH GRAY WELL CEMENTED SILTSTONE		
14	NQ	119.7	129.7		10.0	82	120			**HARD 5G 6/1 GREENISH GRAY CLAY SHALE**		
										N3 DARK GRAY COAL		
										HARD N5 MEDIUM GRAY CLAY SHALE		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0612** DATE **7/17/15** SHEET **6** OF **8**

PROJECT **CARDINAL LANDFILL** BORING START **3/6/07** BORING FINISH **3/21/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										w/traces of sandstone		
							125			**HARD N7 LIGHT GRAY WELL CEMENTED MEDIUM TO COARSE SANDSTONE** w/cross bedding throughout		
15	NQ	129.7	139.7		10.0	96	130			**MEDIUM TO COARSE N6 MEDIUM LIGHT GRAY WELL CEMENTED SANDSTONE**		
							135					
16	NQ	139.7	149.7		10.0	90	140			**MEDIUM TO COARSE N6 MEDIUM LIGHT GRAY WELL CEMENTED SANDSTONE**		
							145					
										HARD 5G 6/1 GREENISH GRAY SILTSTONE		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0612** DATE **7/17/15** SHEET **7** OF **8**

PROJECT **CARDINAL LANDFILL** BORING START **3/6/07** BORING FINISH **3/21/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
17	NQ	149.7	159.7		10.0	56				**MEDIUM TO COARSE N6 MEDIUM LIGHT GRAY WELL CEMENTED SANDSTONE**		
										MEDIUM TO COARSE N6 MEDIUM LIGHT GRAY WELL CEMENTED SILTSTONE		
										FINE TO MEDIUM N6 MEDIUM LIGHT GRAY WELL CEMENTED SANDSTONE w/cross bedding silt stone		
							155					
18	NQ	159.7	169.7		10.0	86	160			**FINE TO MEDIUM N6 MEDIUM LIGHT GRAY WELL CEMENTED SANDSTONE** w/trace siltstone		
							165					
19	NQ	169.7	179.7		9.8	83	170			**FINE TO MEDIUM N7 LIGHT GRAY WELL CEMENTED SANDSTONE**		
							175					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0612** DATE **7/17/15** SHEET **8** OF **8**

PROJECT **CARDINAL LANDFILL** BORING START **3/6/07** BORING FINISH **3/21/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
20	NQ	179.7	189.7		9.8	93	180			**FINE TO MEDIUM N7 LIGHT GRAY WELL CEMENTED SANDSTONE** w/limestone nodules **MEDIUM TO COARSE N7 LIGHT GRAY WELL CEMENTED SANDSTONE** w/limestone nodules		
							185			**5G 6/1 GREENISH GRAY WELL CEMENTED SILSTONE**		
21	NQ	189.7	194.7		4.6	93	190			**5G 6/1 GREENISH GRAY WELL CEMENTED SILTSTONE**		STOPPED BORING @ 194.7'; SWL @ 44.2' 03/23/07; NQ HOLE TO 194.7'

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL FLY ASH DAM**

COORDINATES **N 835,558.0 E 2,517,396.3**

GROUND ELEVATION **1170.2** SYSTEM **State Plane using NAD27/29**

Water Level, ft	▽	▼	▼
TIME			
DATE			

BORING NO. **B-1309D** DATE **7/17/15** SHEET **1** OF **15**

BORING START **5/2/13** BORING FINISH **5/30/13**

PIEZOMETER TYPE WELL TYPE

HGT. RISER ABOVE GROUND **1.85** DIA **2.0**

DEPTH TO TOP OF WELL SCREEN **307.9** BOTTOM **347.5**

WELL DEVELOPMENT **YES** BACKFILL **QUICK GROUT & HC**

FIELD PARTY **ZLR / TAS** RIG **D-120**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
1	SPT	0.0	1.5							STONE PAD		STONE PAD
2	SPT	1.5	3.0	4-7-11	.9					VERY STIFF MODERATE YELLOWISH BROWN 10YR 6/2 CLAY tsf 2.0		
3	SPT	3.0	4.5	8-11-16	1.0					VERY STIFF DARK YELLOWISH BROWN 10YR 4/2 CLAY AND SHALE tsf 2.0		
4	SPT	4.5	4.7	50/.2	.9		5			HARD PALE BROWN 5YR 5/2 SHALEY CLAY tsf 4.5		
5	SPT	6.0	6.4	50/.4	.4					HARD PALE BROWN 5YR 5/2 SHALEY CLAY tsf 0		
1	NQ	8.2	14.1		5.9	22				HARD LIGHT OLIVE GRAY 5Y 5/2 CLAYSHALE		STOPPED SAMPLING / AUGER REFUSAL @ 7.0' / SET 4" CASING
2	NQ	14.1	24.1		10.0	9	10					
							15					

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
X	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
	AIR HAMMER	8"

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PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER **TAS**

AEP_CD_FA_DAM.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1309D** DATE **7/17/15** SHEET **2** OF **15**

PROJECT **CARDINAL FLY ASH DAM** BORING START **5/2/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
3	NQ	24.1	26.6		2.5	0	25					
4	NQ	26.6	34.1		7.5	17	30					
5	NQ	34.1	39.1		5.0	40	35					
6	NQ	39.1	44.1		5	53	40			HARD GREENISH GRAY 5G 6/1 CLAYSHALE		
										HARD DARK GRAY N3 CLAYSHALE		
7	NQ	44.1	54.1		10	36	45			HARD BROWNISH GRAY 5YR 4/1 CLAYSHALE w/high angle fractures @ 1.8', 6.0', & 7.3'		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1309D** DATE **7/17/15** SHEET **3** OF **15**

PROJECT **CARDINAL FLY ASH DAM** BORING START **5/2/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							50					
8	NQ	54.1	64.1		10	46	55			VERY HARD MEDIUM LIGHT GRAY N6 LIMEY SHALE w/limestone nodules @ 4.5'		
							60					
9	NQ	64.1	69.1		5	16	65			VERY HARD MEDIUM LIGHT GRAY N6 LIMEY SHALE		
10	NQ	69.1	74.1		5	20	70			HARD MEDIUM DARK GRAY N4 CLAYSHALE		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1309D** DATE **7/17/15** SHEET **4** OF **15**

PROJECT **CARDINAL FLY ASH DAM** BORING START **5/2/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
11	NQ	74.1	84.1		10	52	75			VERY HARD LIGHT OLIVE GRAY 5Y 5/2 LIMESTONE w/high angle fractures @ .8', 1.3', 3.0', & 4.0'		
12	NQ	84.1	94.1		10	98	80			HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYSHALE		
13	NQ	94.1	104.1		10	72	85			HARD MEDIUM DARK GRAY N4 CLAYSHALE		
							90			HARD LIGHT GRAY N7 CLAYSHALE w/limestone nodules, high angle fractures @ 4.9' & 5.4' of recovery		
							95					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1309D** DATE **7/17/15** SHEET **5** OF **15**

PROJECT **CARDINAL FLY ASH DAM** BORING START **5/2/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							100			HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYSHALE w/limestone nodules throughout		
14	NQ	104.1	114.1		10	79	105					
							110					
15	NQ	114.1	124.1		10	76	115			HARD MEDIUM DARK GRAY N4 SILTSTONE		
							120			HARD BLACK N1 COAL		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1309D** DATE **7/17/15** SHEET **6** OF **15**

PROJECT **CARDINAL FLY ASH DAM** BORING START **5/2/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
16	NQ	124.1	134.1		10	65	125					
										VERY HARD VERY LIGHT GRAY N8 LIMESTONE w/high angle fracture @ 6.8'		
							130					
17	NQ	134.1	144.1		10	67				HARD VERY LIGHT GRAY N8 LIMESTONE w/ high angle fracture @ 1.1'		
							135					
							140					
										HARD GREENISH GRAY 5G 6/1 LIMEY CLAYSHALE		
18	NQ	144.1	154.1		10	26				HARD GREENISH GRAY 5G 6/1 CLAYSHALE		
							145					
										MEDIUM HARD BLACK N1 COAL		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1309D** DATE **7/17/15** SHEET **7** OF **15**

PROJECT **CARDINAL FLY ASH DAM** BORING START **5/2/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
19	NQ	154.1	164.1		10	69	155			HARD MEDIUM LIGHT GRAY N6 CLAYSHALE		
20	NQ	164.1	174.1		10	89	160					
21	NQ	174.1	184.1		10	77	165					
							170					
							175			HARD LIGHT BLUISH GRAY 5B 7/1 CLAYSHALE w/limestone nodules @ 3.1' to 3.5'		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1309D** DATE **7/17/15** SHEET **8** OF **15**

PROJECT **CARDINAL FLY ASH DAM** BORING START **5/2/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
22	NQ	184.1	194.1		10	95	180			HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYSHALE		
23	NQ	194.1	204.1		10	62	185					
							190					
							195					
							200					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1309D** DATE **7/17/15** SHEET **9** OF **15**

PROJECT **CARDINAL FLY ASH DAM** BORING START **5/2/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										HARD DARK REDDISH BROWN 10R 3/4 MULTICOLORED CLAYSHALE		
24	NQ	204.1	214.1		10	75	205			HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYSHALE		
							210					
										HARD DARK REDDISH BROWN 10R 3/4 CLAYSHALE		
25	NQ	214.1	224.1		10	90	215			HARD MEDIUM BLUISH GRAY 5B 5/1 SHALE w/limestone nodules		
							220			HARD MEDIUM BLUISH GRAY 5B 5/1 FINE SANDY SHALE		
26	NQ	224.1	234.1		10	76	225					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1309D** DATE **7/17/15** SHEET **10** OF **15**

PROJECT **CARDINAL FLY ASH DAM** BORING START **5/2/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							230					
										HARD DARK GREENISH GRAY 5G 4/1 CLAYSHALE		
27	NQ	234.1	244.1		10	88	235			HARD LIGHT BLUISH GRAY 5B 7/1 CLAYSHALE w/limestone nodules		
							240					
28	NQ	244.1	254.1		10	54	245					
							250					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1309D** DATE **7/17/15** SHEET **11** OF **15**

PROJECT **CARDINAL FLY ASH DAM** BORING START **5/2/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
29	NQ	254.1	264.1		10	65	255					
30	NQ	264.1	274.1		10	77	260			HARD GREENISH GRAY 5G 6/1 CLAYSHALE		
							265			HARD DARK REDDISH BROWN 10R 3/4 MULTICOLORED CLAYSHALE		
										HARD GREENISH GRAY 5G 6/1 CLAYSHALE w/limestone nodules throughout		
31	NQ	274.1	284.1		10	89	270			HARD GREENISH GRAY 5G 6/1 SHALE		
										HARD DARK REDDISH BROWN 10R 3/4 SHALE		
							275			HARD GREENISH GRAY 5G 6/1 SHALE w/limestone nodules		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1309D** DATE **7/17/15** SHEET **12** OF **15**

PROJECT **CARDINAL FLY ASH DAM** BORING START **5/2/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										HARD GREENISH GRAY 5G 6/1 SANDY SHALE		
32	NQ	284.1	294.1		10	88	285			HARD MEDIUM LIGHT GRAY N6 SANDY SHALE		
33	NQ	294.1	304.1		10	97	290			HARD MEDIUM DARK GRAY N4 WELL CEMENTED FINE SANDSTONE		
34	NQ	304.1	314.1		10	100	295			HARD MEDIUM LIGHT GRAY N6 WELL CEMENTED FINE SANDSTONE		
							300					
							305					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1309D** DATE **7/17/15** SHEET **13** OF **15**

PROJECT **CARDINAL FLY ASH DAM** BORING START **5/2/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							310					
35	NQ	314.1	324.1		10	100	315					
							320			MEDIUM HARD BLACK N1 COAL		
36	NQ	324.1	334.1		10	97	325			HARD MEDIUM LIGHT GRAY N6 WELL CEMENTED FINE SANDSTONE		
							330			HARD MEDIUM LIGHT GRAY N6 WELL CEMENTED FINE SANDSTONE w/limestone fragments		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1309D** DATE **7/17/15** SHEET **14** OF **15**

PROJECT **CARDINAL FLY ASH DAM** BORING START **5/2/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
37	NQ	334.1	344.1		10	93	335			HARD MEDIUM GRAY N5 SHALEY SANDSTONE		
										HARD MEDIUM LIGHT GRAY N6 WELL CEMENTED MEDIUM SANDSTONE		
38	NQ	344.1	354.1		10	95	340					
							345					
							350			HARD LIGHT BLUISH GRAY 5B 7/1 CLAYSHALE w/limestone nodules		
39	NQ	354.1	364.1		10	100	355					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1309D** DATE **7/17/15** SHEET **15** OF **15**

PROJECT **CARDINAL FLY ASH DAM** BORING START **5/2/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							360					

AEP CD_FA_DAM.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL FLY ASH DAM**

COORDINATES **N 836,201.9 E 2,515,432.0**

GROUND ELEVATION **1028.9** SYSTEM **State Plane using NAD27/29**

Water Level, ft	▽	▼	▼
TIME			
DATE			

BORING NO. **B-1302M** DATE **7/17/15** SHEET **1** OF **9**

BORING START **3/7/13** BORING FINISH **5/30/13**

PIEZOMETER TYPE **SS** WELL TYPE **OW**

HGT. RISER ABOVE GROUND **1.8** DIA **2.0**

DEPTH TO TOP OF WELL SCREEN **168.4** BOTTOM **208.0**

WELL DEVELOPMENT **YES** BACKFILL **HOLE PLUG**

FIELD PARTY **ZLR / TAS** RIG **D-120**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
1	SPT	0.0	1.5							STONE PAD #4 LIMESTONE		STONE PAD OFF HAUL ROAD
2	SPT	1.5	3.0	5-13-13	1.3					VERY STIFF DUSKY BROWN 5YR 2/2 MINE SPOIL		
3	SPT	3.0	4.5	22-20-10	1.2					VERY STIFF MEDIUM LIGHT GRAY N6 SHALE		
4	SPT	4.5	6.0	4-5-7	1.2		5			STIFF DUSKY BROWN 5YR 2/2 MINE SPOIL		
5	SPT	6.0	7.5	4-5-7	.7					STIFF GRAYISH BROWN 5YR 3/2 MINE SPOIL		
6	SPT	7.5	9.0	7-4-4	1.1					STIFF DARK YELLOWISH BROWN 10YR 5/4 MINE SPOIL tsf 1.5		
7	SPT	9.0	10.5	9-6-6	.6		10			STIFF DARK YELLOWISH BROWN 10YR 4/2 MINE SPOIL		
8	SPT	10.5	12.0	6-8-8	.1					VERY STIFF LIGHT GRAY N7 MINE SPOIL		
9	SPT	12.0	13.5	7-5-5	.5					STIFF MODERATE YELLOWISH BROWN 10YR 5/4 MINE SPOIL		
10	SPT	13.5	15.0	6-5-4	.7					STIFF MODERATE YELLOWISH BROWN 10YR 5/4 MINE SPOIL tsf 2.0		
11	SPT	15.0	16.5	4-5-7	.8		15			STIFF MODERATE YELLOWISH BROWN 10YR 5/4 MINE SPOIL		
12	SPT	16.5	18.0	5-5-9	1.5							
13	SPT	18.0	19.5	27-7-6	.6					STIFF LIGHT BROWN 5YR 5/6 MINE SPOIL		
14	SPT	19.5	21.0	23-12-15	.2					VERY STIFF LIGHT GRAY N7 MINE SPOIL		

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
X	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
	AIR HAMMER	8"

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PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER _____

AEP_CD_FA_DAM.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1302M** DATE **7/17/15** SHEET **2** OF **9**

PROJECT **CARDINAL FLY ASH DAM** BORING START **3/7/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
15	SPT	21.0	21.1	50/.1	.1					HARD LIGHT GRAY N7 LIMESTONE		
16	SPT	22.5	22.8	50/.3	1.5					HARD LIGHT GRAY N7 LIMEY CLAYSHALE		
17	SPT	24.0	24.3	50/.3	.2					HARD DUSKY BROWN 5YR 2/2 LIMEY CLAYSHALE		
1	NQ	25.5	34.0		8.5	27	25			MEDIUM HARD MEDIUM BLUISH GRAY 5B 5/1 SANDY CLAYSHALE		
2	NQ	34.0	44.0		5.3	28	30			MEDIUM HARD MEDIUM GRAY N5 CLAYSHALE		
							35			HARD MEDIUM GRAY N5 LIMESTONE		
										MEDIUM HARD MEDIUM GRAY N5 CLAYSHALE badly broken w/iron stains throughout		Lost water return @ 36.0'
3	NQ	44.0	54.0		3.9	51	40			MEDIUM HARD LIGHT BLUISH GRAY 5B 7/1 SANDY CLAYSHALE w/iron stains throughout		
							45					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1302M** DATE **7/17/15** SHEET **3** OF **9**

PROJECT **CARDINAL FLY ASH DAM** BORING START **3/7/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
4	NQ	54.0	64.0		6.4	80	50			MEDIUM HARD LIGHT BLUISH GRAY 5B 7/1 TO GRAYISH PURPLE 5P 4/2 CLAYSHALE		
5	NQ	64.0	74.0		7.7	62	55, 60, 65, 70			HARD LIGHT BLUISH 5B 7/1 WELL CEMENTED FINE GRAIN SANDSTONE		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1302M** DATE **7/17/15** SHEET **4** OF **9**

PROJECT **CARDINAL FLY ASH DAM** BORING START **3/7/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
6	NQ	74.0	84.0		9.3	63	75					
7	NQ	84.0	94.0		9.8	68	80					
							85					
							90			MEDIUM HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYSHALE		
8	NQ	94.0	104.0		1.3	0	95					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1302M** DATE **7/17/15** SHEET **5** OF **9**

PROJECT **CARDINAL FLY ASH DAM** BORING START **3/7/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							100					
9	NQ	104.0	114.0		3.5	23	105			MEDIUM HARD LIGHT BLUISH GRAY 5B 7/1 CLAYSHALE		
10	NQ	114.0	124.0		6.5	48	110					
							115			HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYSHALE		
							120			HARD MEDIUM GRAY N5 LIMESTONE		
										HARD MEDIUM GRAY N5 CLAYSHALE		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1302M** DATE **7/17/15** SHEET **6** OF **9**

PROJECT **CARDINAL FLY ASH DAM** BORING START **3/7/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
11	NQ	124.0	134.0		10	73	125			HARD MEDIUM GRAY 5B 5/1 CLAYSHALE w/limestone nodules, high angle fracture @ 2.8' (126.8')		
12	NQ	134.0	144.0		10	46	130			HARD MEDIUM GRAY N5 CLAYSHALE		
13	NQ	144.0	154.0		7.85	38	135			HARD MEDIUM GRAY N5 CLAYSHALE w/limestone nodules		
							140					
							145					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1302M** DATE **7/17/15** SHEET **7** OF **9**

PROJECT **CARDINAL FLY ASH DAM** BORING START **3/7/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
14	NQ	154.0	159.0		5.1	59	155			HARD MEDIUM GRAY N5 CLAYSHALE w/high fractures @ 1.7', 3.6', & 4.1'		
15	NQ	159.0	164.0		2.25	53	160			HARD MEDIUM GRAY N5 CLAYSHALE w/high angle fracture @ .4'		
16	NQ	164.0	174.0		10		165			HARD MEDIUM GRAY N5 SANDY CLAYSHALE		
										HARD MEDIUM GRAY N5 WELL CEMENTED FINE SANDSTONE		
17	NQ	174.0	184.0		10.1	94	170					
							175					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1302M** DATE **7/17/15** SHEET **8** OF **9**

PROJECT **CARDINAL FLY ASH DAM** BORING START **3/7/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							180					
18	NQ	184.0	194.0		9.6	81	185			HARD MEDIUM LIGHT GRAY N6 WELL CEMENTED FINE SANDSTONE w/shale lenses, limestone nodules @ 6.8'		
							190					
19	NQ	194.0	204.0		10	69	195			HARD MEDIUM LIGHT GRAY N6 WELL CEMENTED FINE SANDSTONE w/shale lenses, pyrite and limestone nodules @ 7.8' and 8.3'		
							200					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **B-1302M** DATE **7/17/15** SHEET **9** OF **9**

PROJECT **CARDINAL FLY ASH DAM** BORING START **3/7/13** BORING FINISH **5/30/13**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
20	NQ	204.0	209.0		5.0	66	205			HARD MEDIUM LIGHT GRAY N6 WELL CEMENTED FINE GRAIN STANDSTONE		
21	NQ	209.0	219.0		10	56	210			HARD MEDIUM GRAY N5 CLAYSHALE w/limestone nodules throughout HARD MEDIUM DARK GRAY N4 CLAYSHALE w/limestone nodules throughout		
							215					

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 831,697.9 E 2,518,374.3**

GROUND ELEVATION **988.4** SYSTEM

Water Level, ft	▽	▼	▼
TIME			
DATE			

BORING NO. **CA-0610** DATE **7/17/15** SHEET **1** OF **8**

BORING START **4/3/07** BORING FINISH **4/3/07**

PIEZOMETER TYPE WELL TYPE **OW**

HGT. RISER ABOVE GROUND **2.724** DIA **2"**

DEPTH TO TOP OF WELL SCREEN **130.3** BOTTOM **187.3**

WELL DEVELOPMENT **YES** BACKFILL **QUICK GROUT**

FIELD PARTY **MCR / ZLR** RIG **D-120**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							5					GROUNDING PROCEDURES NOT IN USE ON THIS BORING; DECONNED RIG & TOOL 04/02/07; ALL WATER USED COMING FROM FIRE PROTECTION SYSTEM @ CARDINAL PLANT; BLIND DRILLED 3.25" HSA'S TO 19.0'; STARTED CORING @ 19.0'
							10					
							15					
1	NQ	19.0	24.4		5.4	20				**SOFT N7 LIGHT GRAY SANDY CLAY SHALE**		

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
	AIR HAMMER	8"

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PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER **RACER**

AEP CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0610** DATE **7/17/15** SHEET **2** OF **8**

PROJECT **CARDINAL LANDFILL** BORING START **4/3/07** BORING FINISH **4/3/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
												LOST ALL DRILL RETURN WATER @ +/-22.0'
										HARD FINE SANDY LIMESTONE		
2	NQ	24.4	34.4		7.3	7	25			**HARD N7 LIGHT GRAY FINE SANDY LIMESTONE**		
										HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE w/trace of iron staining throughout		
							30					
3	NQ	34.4	42.4		2.4	0	35			**SOFT 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		
										HARD N7 LIGHT GRAY LIMESTONE		
							40					
4	NQ	42.4	49.4		3.4	0				**HARD N6 MEDIUM LIGHT GRAY CLAY SHALE**		
							45			**SOFT N6 MEDIUM LIGHT GRAY CLAY SHALE**		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0610** DATE **7/17/15** SHEET **3** OF **8**

PROJECT **CARDINAL LANDFILL** BORING START **4/3/07** BORING FINISH **4/3/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
5	NQ	49.4	57.9		6.0	0	50			**MEDIUM HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		
6	NQ	57.9	64.4		6.5	17	55			**SOFT TO MEDIUM 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		SWL @ 13.8' 04/04/07; NQ HOLE TO 64.4' - 14 HOUR READING
7	NQ	64.4	69.4		1.4	0	60			**HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		
8	NQ	69.4	76.4		5.9	0	65			**SOFT N5 MEDIUM GRAY CLAY SHALE**		REASON FOR POOR RECOVERY - HSA'S NOT SEATED @ ROCK & SOIL INTERFACE; PULLED NQ'S RODS
							70					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0610** DATE **7/17/15** SHEET **4** OF **8**

PROJECT **CARDINAL LANDFILL** BORING START **4/3/07** BORING FINISH **4/3/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
												AND HSA'S; DRILLED 4" CASING TO 24.0' FOR GOOD SEAL
9	NQ	76.4	79.4		3.1	39	75			**HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		SWL @ 22.5' 04/09/07; NQ HOLE TO 79.4' - 130 HOUR READING
10	NQ	79.4	89.4		10.0	4	80			**MEDIUM TO HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE** 86.0 to 89.4 has iron staining throughout		
11	NQ	89.4	99.4		10.0	15	85					HIGH ANGLE FRACTURE @ 88.4'
							90			**SOFT 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		
							95			**HARD N5 MEDIUM GRAY LIMESTONE**		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

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COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0610** DATE **7/17/15** SHEET **5** OF **8**

PROJECT **CARDINAL LANDFILL** BORING START **4/3/07** BORING FINISH **4/3/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE		
12	NQ	99.4	106.4		6.7	45	100			**HARD N5 MEDIUM GRAY LIMESTONE**		
										HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE high angle fracture @ 103.9		
13	NQ	106.4	114.4		6.5	74	105			**MEDIUM HARD 5B 5/1 MEDIUM BLUISH GRAY SILTY CLAY SHALE** broken, possibly machine breaks		
										MEDIUM TO HARD N5 MEDIUM GRAY SILTY CLAY SHALE		
14	NQ	114.4	124.4		10.0	68	110			**HARD 5YR 6/1 LIGHT BROWNISH GRAY CLAY SHALE**		
							115			**HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		
										SOFT 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE		
										HARD 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE		
										SOFT 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE		
							120					

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AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0610** DATE **7/17/15** SHEET **6** OF **8**

PROJECT **CARDINAL LANDFILL** BORING START **4/3/07** BORING FINISH **4/3/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
15	NQ	124.4	134.4		10.0	69	125			**SOFT 5B 5/1 MEDIUM BLUISH GRAY CLAY SHALE**		
										HARD N3 DARK GRAY SILTSTONE		
										FINE TO MEDIUM N5 MEDIUM GRAY SANDSTONE well cemented		
							130			**MEDIUM N5 MEDIUM GRAY SANDSTONE** well cemented		
16	NQ	134.4	144.4		10.0	91	135			**N5 MEDIUM GRAY LARGE GRAIN WELL CEMENTED SANDSTONE**		
							140					
17	NQ	144.4	154.4		10.0	62	145			**N5 MEDIUM GRAY LARGE GRAIN WELL CEMENTED SANDSTONE**		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

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COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0610** DATE **7/17/15** SHEET **7** OF **8**

PROJECT **CARDINAL LANDFILL** BORING START **4/3/07** BORING FINISH **4/3/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
18	NQ	154.4	164.4		10.0	75	155			**N5 MEDIUM GRAY LARGE GRAIN WELL CEMENTED SANDSTONE**		
19	NQ	164.4	169.4		5.0	20	160			**HARD 5GY 4/1 DARK GREENISH GRAY SILTSTONE**		
							165			**HARD N5 MEDIUM GRAY SILTSTONE**		
20	NQ	169.4	179.4		10.0	90	170			**N5 MEDIUM GRAY LARGE GRAIN WELL CEMENTED SANDSTONE**		
							175			**N5 MEDIUM GRAY LARGE GRAIN WELL CEMENTED SANDSTONE**		

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COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0610** DATE **7/17/15** SHEET **8** OF **8**

PROJECT **CARDINAL LANDFILL** BORING START **4/3/07** BORING FINISH **4/3/07**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
21	NQ	179.4	189.4		10.0	90	180			**N5 MEDIUM GRAY LARGE GRAIN WELL CEMENTED SANDSTONE**		
							185					
22	NQ	189.4	194.4		5.0	58	190			**HARD N5 MEDIUM GRAY SHALEY LIMESTONE**		
										HARD N5 MEDIUM GRAY SHALEY LIMESTONE		SWL @ 49.8' 04/11/07; NQ HOLE FINISHED @ 194.4'; 18 HR READING; STOPPED BORING @ 194.4 04/10/07; INSTALLED 2" MONITORING WELL

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 833,112.2 E 2,516,013.2**

GROUND ELEVATION **1187.7** SYSTEM

Water Level, ft			
TIME			
DATE			

BORING NO. **CA-0608** DATE **7/17/15** SHEET **1** OF **16**

BORING START **12/13/06** BORING FINISH **12/13/06**

PIEZOMETER TYPE WELL TYPE **GM**

HGT. RISER ABOVE GROUND **3.009** DIA **1.5**

DEPTH TO TOP OF WELL SCREEN **393.0** BOTTOM **398.0**

WELL DEVELOPMENT BACKFILL

FIELD PARTY **MCR / ZLR** RIG **D-120**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
		0.0	10.0							Deconed rig & tools 08/29/06 using fire protection water from Cardinal U3. Grounding procedures not in use on this boring. Drilling water used from cardinal u3 fire protection. Blind drilled 4" roller bit from grade to 10.0'.		
1	NQ	10.0	14.5		3.1	16	10			**HARD 10YR/5/4 MODERATE YELLOWISH BROWN CLAY SHALES** w/fractured and soft areas from 10.0' to 12.0'		Started coring @ 10.0'
2	NQ	14.5	24.5		4.05	69	15			**10YR 5/4 MODERATE YELLOWISH BROWN MEDIUM CLAY SHALE** w/fractures and soft areas **HARD N6 MEDIUM LIGHT GRAY LIMESTONE** **10YR 5/4 MODERATE YELLOWISH BROWN MEDIUM CLAY SHALE** w/fractures		Poor recovery due to sand which locked core in inner tube

TYPE OF CASING USED

	NQ-2 ROCK CORE	
	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
X	AIR HAMMER	8"

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PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER

AEP_CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

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COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0608** DATE **7/17/15** SHEET **2** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **12/13/06** BORING FINISH **12/13/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
3	NQ	24.5	34.5		10.0	100	25			**SOFT 10Y 4/2 GRAYISH OLIVE CLAY SHALE**		
										MEDIUM HARD 10YR 6/6 DARK YELLOWISH ORANGE CLAY SHALE		
										HARD N7 LIGHT GRAY LIMESTONE		
4	NQ	34.5	44.5		10.0	100	30			**5G 6/1 GREENISH GRAY MEDIUM CLAY SHALE**		
										HARD N7 LIGHT GRAY LIMESTONE		
										MEDIUM HARD 5G 6/1 GREENISH GRAY CLAY SHALE		
							35			**MEDIUM HARD 5GY 3/2 GRAYISH OLIVE GREEN and 5GY 6/1 GREENISH GRAY CLAY SHALE** w/fractures and iron staining @ 34.5 - 35.4, 35.7 - 36.5, 36.7 - 40.0, 40.4, & 40.9 - 44.5		
5	NQ	44.5	54.5		9.8	71	40			**HARD 5B 5/1 MEDIUM BLUISH GRAY SHALEY LIMESTONE** w/fractures and iron staining throughout		
							45					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

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COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0608** DATE **7/17/15** SHEET **3** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **12/13/06** BORING FINISH **12/13/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
6	NQ	54.5	59.5		5.0	44	50			**HARD N6 MEDIUM LIGHT GRAY LIMESTONE** w/fractures and iron staining throughout		
7	NQ	59.5	69.5		4.5	100	55			**MEDIUM HARD 5G 6/1 GREENISH GRAY CLAY SHALE** w/fractures and iron staining throughout		
8	NQ	69.5	79.5		9.1	66	60			**HARD N7 LIGHT GRAY LIMESTONE** w/fractures and iron staining throughout		Lost all drill return water @ ~61.5'
							65					
							70			**MEDIUM HARD 5GY 6/1 GREENISH GRAY CLAY SHALE** w/fractures throughout		

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AEP CIVIL ENGINEERING LABORATORY

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COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0608** DATE **7/17/15** SHEET **4** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **12/13/06** BORING FINISH **12/13/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										HARD N5 MEDIUM GRAY LIMESTONE		
							75			**MEDIUM HARD 5GY 6/1 GREENISH GRAY CLAY SHALE**		
										HARD N5 MEDIUM GRAY LIMESTONE		Air hammer to 77.0'
9	NQ	79.5	89.5		9.7	82				**HARD N5 MEDIUM GRAY SHALEY LIMESTONE**		
							80			**HARD N7 LIGHT GRAY LIMESTONE**		
							85			**SOFT N5 MEDIUM GRAY FRACTURED CLAY SHALE**		
										HARD N7 LIGHT GRAY LIMESTONE		
10	NQ	89.5	99.5		9.2	43	90			**HARD N5 MEDIUM GRAY CLAY SHALE** w/fracture		Pumped 70 gals quick grout into bore hole & let set all weekend to try to seal fractures in limestone. SWL DRY 09/05/06; this is 96 hr reading
										SOFT N5 MEDIUM GRAY CLAY SHALE		
							95			**N1 BLACK COAL**		All coal placed in sepatate box.
										SOFT N5 MEDIUM GRAY CLAY SHALE w/fractures & iron staining throughout		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0608** DATE **7/17/15** SHEET **5** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **12/13/06** BORING FINISH **12/13/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
11	NQ	99.5	109.5		10.0	55	100			**HARD N5 MEDIUM GRAY CLAY SHALE** w/fractures and iron staining throughout		
										HARD N5 MEDIUM GRAY CLAY SHALE		
							105					
12	NQ	109.5	119.5		10.0	62				**HARD N7 LIGHT GRAY LIMESTONE** w/fractures		
							110			**HARD N7 LIGHT GRAY LIMESTONE** w/fractures		
										SOFT N5 MEDIUM GRAY CLAY SHALE		
										HARD 5G 6/1 GREENISH GRAY CLAY SHALE w/fractures & fine grain sandstone lenses throughout		
							115					
13	NQ	119.5	122.0		2.5	0	120			**HARD 5G 6/1 GREENISH GRAY CLAY SHALE** w/fractures throughout		
14	NQ	122.0	129.5		6.5	42				**HARD 5G 6/1 GREENISH GRAY CLAY SHALE** w/fractures throughout		9/6/06 - SWL = 123.6' (16 hr reading)

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AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0608** DATE **7/17/15** SHEET **6** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **12/13/06** BORING FINISH **12/13/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							125			**SOFT N5 MEDIUM GRAY CLAY SHALE**		w/ NQ rods @ 149.5'
										HARD N4 MEDIUM DARK GRAY CLAY SHALE w/fractures		
										HARD N7 LIGHT GRAY LIMESTONE w/fractures		
15	NQ	129.5	139.5		10.0	72	130			**HARD N7 LIGHT GRAY LIMESTONE** w/fractures & iron staining throughout		
							135			**HARD 5BG 5/2 GRAYISH BLUE GREEN CLAY SHALE** w/fractures		
										SOFT 5BG 5/2 GRAYISH BLUE GREEN CLAY SHALE		
										HARD 5BG 5/2 GRAYISH BLUE GREEN CLAY SHALE		
16	NQ	139.5	149.5		10.0	74	140			**HARD 5G 6/1 GREENISH GRAY FINE GRAIN SILTY SANDSTONE** w/crossbedding throughout		139.0' - 153.6' Possible Connellsville
							145					
17	NQ	149.5	156.5		5.5	40				**HARD 5G 6/1 GREENISH GRAY FINE GRAIN**		

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COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0608** DATE **7/17/15** SHEET **7** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **12/13/06** BORING FINISH **12/13/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										SILTY SANDSTONE w/crossbedding throughout		
							155					
										COAL		
18	NQ	156.5	159.5		2.45	22				**HARD N5 MEDIUM GRAY SILTY CLAY SHALE** w/limestone modules & fractures		
19	NQ	159.5	169.5		10.0	90	160			**HARD N7 LIGHT GRAY LIMESTONE** w/fractures throughout		
							165					
20	NQ	169.5	179.5		5.4	52	170			**HARD N7 LIGHT GRAY LIMESTONE**		
										SOFT N5 MEDIUM GRAY CLAY SHALE		
										HARD N7 LIGHT GRAY LIMESTONE w/fractures		
							175			**SOFT N5 MEDIUM GRAY CLAY SHALE**		

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JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0608** DATE **7/17/15** SHEET **8** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **12/13/06** BORING FINISH **12/13/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										MINE VOID Lost water pressure @ 176.0'. Stopped rotation @ 176.5'. Using no rotation & water presssure, moved NQ rods from 176.5' to 186.0'. Mine void of abandoned mine from 176.5' to 186.0. SWL at this time - DRY		09/09/06 NQ Rods @ 179.5; SWL Dry @ 32 hr reading; Bottom of mine floor w/ air hammer 186.6' SWL @ 182.7 on 12/11/06; 80 hr reading with NQ hole to 289.8'. HW casing seated on bottom of mine floor
21	NQ	186.6	194.8		7.3	56	180 185			**MEDIUM HARD N5 MEDIUM GRAY SILTY FINE SANDSTONE**		10/6/06 Pulled air hammer & rods. Set HW casing to 186.6'; resumed NQ rock coring SWL @ 187.6 on 12/12/06; 14 hr reading with NQ hole to 312.8'. HW casing seated on bottom of mine floor
22	NQ	194.8	204.8		9.3	73	190 195			**HARD N7 LIGHT GRAY LIMESTONE** **MEDIUM HARD N5 MEDIUM GRAY SILTY CLAY SHALE** **HARD 5G 6/1 GREENISH GRAY SILTY CLAY SHALE** w/limestone nodules throughout		
							200					

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AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0608** DATE **7/17/15** SHEET **9** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **12/13/06** BORING FINISH **12/13/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
23	NQ	204.8	214.8		9.8	61	205			**HARD 5B 5/1 MEDIUM BLUISH GRAY SILTY CLAY SHALE**		
							210			**SOFT 5GY 6/1 GREENISH GRAY CLAY SHALE**		
24	NQ	214.8	224.8		10.0	53	215			**HARD 5GY 6/1 GREENISH GRAY FINE SANDY CLAY SHALE**		
							220					
25	NQ	224.8	234.8		9.9	41	225			**HARD 5GY 6/1 GREENISH GRAY FINE SANDY CLAY SHALE**		

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COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0608** DATE **7/17/15** SHEET **10** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **12/13/06** BORING FINISH **12/13/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							230			**HARD N7 LIGHT GRAY LIMESTONE**		
										HARD 5GY 6/1 GREENISH GRAY CLAY SHALE w/limestone nodules throughout		
26	NQ	234.8	243.8		7.9	20	235			**SOFT 5G 6/1 GREENISH GRAY CLAY SHALE**		
							240			**HARD 5B 5/1 MEDIUM BLUISH GRAY FINE SANDY CLAY SHALE**		
27	NQ	243.8	249.8		6.0	75				**HARD 5B 5/1 MEDIUM BLUISH GRAY FINE SANDY CLAY SHALE** w/limestone nodules throughout		
							245					
28	NQ	249.8	259.8		9.8	79	250			**HARD 5B 5/1 MEDIUM BLUISH GRAY FINE GRAIN SANDY CLAY SHALE**		

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AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0608** DATE **7/17/15** SHEET **11** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **12/13/06** BORING FINISH **12/13/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							255					
29	NQ	259.8	269.8		9.3	42	260			**MEDIUM HARD 5G 6/1 GREENISH GRAY CLAY SHALE**		
										HARD 5B 7/1 LIGHT BLUISH GRAY SHALEY LIMESTONE		
										HARD 5G 6/1 GREENISH GRAY CLAY SHALE w/limestone nodules throughout		
										HARD 5B 7/1 LIGHT BLUISH GRAY SHALEY LIMESTONE		
							265			**HARD 5G 6/1 GREENISH GRAY CLAY SHALE** w/limestone nodules throughout		
30	NQ	269.8	275.8		5.1	55	270			**MEDIUM TO HARD 5G 6/1 GREENISH GRAY CLAY SHALE**		
							275					
31	NQ	275.8	284.8		9.0	60				**HARD 5G 6/1 GREENISH GRAY CLAY SHALE** w/limestone nodules throughout		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0608** DATE **7/17/15** SHEET **12** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **12/13/06** BORING FINISH **12/13/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
32	NQ	284.4	289.4		5.0	28	285			**HARD GRAY SHALE** **N6 MEDIUM LIGHT GRAY HARD GRAY SHALE** w/limestone nodules **HARD N6 MEDIUM LIGHT GRAY SHALE** **HARD N6 MEDIUM LIGHT GRAY SHALE** w/limestone nodules **HARD N6 MEDIUM LIGHT GRAY SHALE**		
33	NQ	289.8	299.8		10.0	63	290			**5YR 4/1 BROWNISH GRAY SHALE** **SOFT GRAY SHALE** wet **HARD 5YR 4/1 BROWNISH GRAY SHALE** **SOFT GRAY SHALE** **5YR 4/1 BROWNISH GRAY SHALE** w/brownish red shale		
							295			**HARD GRAY / RED SHALE**		
34	NQ	299.8	309.8		10.0	62	300			**RED GRAY SHALE**		
							305					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0608** DATE **7/17/15** SHEET **13** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **12/13/06** BORING FINISH **12/13/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										GRAY SILTY SHALE		
										GRAY HARD LIMESTONE		
35	NQ	309.8	312.8		3.0	93	310			**HARD 5B 7/1 LIGHT BLUISH GRAY FINE GRAIN SANDY SILTSTONE** w/limestone lenses throughout		
36	NQ	312.8	319.8		7.0	93				**HARD N4 MEDIUM DARK GRAY FINE GRAIN STILTY SANDSTONE**		
							315					
37	NQ	319.8	329.8		10.0	100	320			**HARD N4 MEDIUM DARK GRAY FINE GRAIN SILTY SANDSTONE**		
							325					
38	NQ	329.8	339.8		10.0	80	330			**HARD N5 MEDIUM DARK GRAY FINE SILTY SANDSTONE**		Start of Morgantown Sandstone @ +/- 331'

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0608** DATE **7/17/15** SHEET **14** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **12/13/06** BORING FINISH **12/13/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										MEDIUM HARD N5 MEDIUM DARK GRAY SANDSTONE		
							335			**HARD N5 MEDIUM DARK GRAY FINE SILTY SANDSTONE**		
										MEDIUM HARD N5 MEDIUM DARK GRAY SANDSTONE		
39	NQ	339.8	349.8		10.0	100	340			**HARD N7 LIGHT GRAY WELL CEMENTED MEDIUM to COARSE GRAIN SANDSTONE** w/some crossbedding		
							345					
40	NQ	349.8	359.8		10.0	100	350			**HARD MEDIUM DARK GRAY WELL CEMENTED MEDIUM to COARSE GRAIN SANDSTONE** w/some crossbedding		
							355					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0608** DATE **7/17/15** SHEET **15** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **12/13/06** BORING FINISH **12/13/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
41	NQ	359.8	369.8		10.0	100	360			**HARD MEDIUM DARK GRAY WELL CEMENTED MEDIUM to COARSE GRAIN SANDSTONE** w/some crossbeddings		
							365					
42	NQ	369.8	379.8		10.0	97	370			**HARD MEDIUM DARK GRAY WELL CEMENTED MEDIUM to COARSE GRAIN SANDSTONE** w/some crossbeddings		
							375					
										HARD N4 MEDIUM DARK GRAY SHALE		
43	NQ	379.8	389.8		10.0	95	380			**HARD N4 MEDIUM DARK GRAY SILTY SHALE**		
										HARD N4 MEDIUM DARK GRAY WELL CEMENTED MEDIUM to COARSE GRAIN SANDSTONE w/some crossbedding		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0608** DATE **7/17/15** SHEET **16** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **12/13/06** BORING FINISH **12/13/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							385					
										COAL PARTING IN SANDSTONE		
										HARD N4 MEDIUM DARK GRAY WELL CEMENTED MEDIUM to COARSE GRAIN SANDSTONE w/some crossbedding		
44	NQ	389.8	399.8		10.0	88	390			**N5 MEDIUM GRAY FINE GRAIN SANDSTONE**		
										COAL LENSE		
										N5 MEDIUM GRAY FINE GRAIN SANDSTONE w/ coal lenses		
							395					
												Bottom of Morgantown Sandstone @ 398.4'
										HARD N4 MEDIUM DARK GRAY FINE GRAIN SANDY CLAY SHALE		
45	NQ	399.8	809.6		5.0	34	400					
										FINE GRAIN SILTY SANDSTONE w/limestone nodules		
										FINE GRAIN CLAY SHALE		
												Stopped boring @ 404.8' on 12/13/06. Flushed w/~700 gals water; installed 1" geomon type well w/ 5' screen.

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL FLY ASH DAM**

COORDINATES **N 830,072.4 E 2,516,465.1**

GROUND ELEVATION **977.8** SYSTEM _____

Water Level, ft	▽	▼	▼
TIME			
DATE			

BORING NO. **MW-5** DATE **7/20/15** SHEET **1** OF **12**

BORING START _____ BORING FINISH **5/4/99**

PIEZOMETER TYPE **GEO-MON** WELL TYPE **GM**

HGT. RISER ABOVE GROUND **2.39** DIA **3**

DEPTH TO TOP OF WELL SCREEN **198** BOTTOM **200**

WELL DEVELOPMENT _____ BACKFILL **100 gallons of Quick**

FIELD PARTY **TJH-REB** RIG **CME-75**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										NO SAMPLE - RUN 3"CASING TO 7.3'		Decon drill with potable water & alconox prior to setup.
1	NQ-2	7.3	9.6		2.3	22	5			**5GY 6/1 GREENISH GRAY SANDSTONE**		Started coring at 7.3' Note: No water return.
2	NQ-2	9.6	13.3		3.0	0	10			**5GY 6/1 GREENISH GRAY SANDY SHALE** Badly broken.		
3	NQ-2	13.3	14.6		1.1	0						
4	NQ-2	14.6	16.5		2.1	0	15					
5	NQ-2	16.5	19.6		2.3	0				**5GY 6/1 GREENISH GRAY CLAY SHALE**		
6	NQ-2	19.6	22.1		2.4	0				**N6 MEDIUM LIGHT GRAY LIMESTONE**		

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
	AIR HAMMER	8"

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PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER **REB**

AEP CD_FA_DAM.GPJ AEP.GDT 7/20/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **MW-5** DATE **7/20/15** SHEET **2** OF **12**

PROJECT **CARDINAL FLY ASH DAM** BORING START BORING FINISH **5/4/99**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										With iron stain		
										N5 MEDIUM GRAY CLAY SHALE		
										N6 MEDIUM LIGHT GRAY LIMESTONE		
										Broken up; iron stain		
7	NQ-2	22.1	24.6			0				**N5 MEDIUM GRAY CLAY SHALE** Broken up		
8	NQ-2	24.6	29.2		4.0	30	25			**N6 MEDIUM LIGHT GRAY CLAY SHALE**		
9	NQ-2	29.2	34.6		5.4	33	30			**5GY 6/1 GREENISH GRAY SANDY SHALE**		
										N6 MEDIUM LIGHT GRAY CLAY SHALE		
10	NQ-2	34.6	34.7		0.1	0	35			**5GY 6/1 GREENISH GRAY SANDSTONE**		
11	NQ-2	34.7	39.6		5.0	32				**N5 MEDIUM GRAY CLAY SHALE**		
12	NQ-2	39.6	43.8		3.0	20	40			**RED,BROWN & GRAY CLAY SHALE**		
										N6 MEDIUM LIGHT GRAY LIMESTONE Oxidized above & below		
										N5 MEDIUM GRAY CLAY SHALE		
13	NQ-2	43.8	49.1		3.8	0				**N5 MEDIUM GRAY CLAY SHALE**		
							45			**RED & GREENISH GRAY CLAY SHALE**		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **MW-5** DATE **7/20/15** SHEET **3** OF **12**

PROJECT **CARDINAL FLY ASH DAM** BORING START BORING FINISH **5/4/99**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
14	NQ-2	49.1	54.6		2.5	0	50			**N6 MEDIUM LIGHT GRAY LIMESTONE**		
										N6 MEDIUM LIGHT GRAY CLAY SHALE		
										N6 MEDIUM LIGHT GRAY LIMESTONE		
										N6 MEDIUM LIGHT GRAY CLAY SHALE Iron stain at 56.8'		
15	NQ-2	54.6	59.6		4.6	30	55					
16	NQ-2	59.6	64.6		3.3	0	60			**N6 MEDIUM LIGHT GRAY LIMESTONE** Iron stain; broken up		
										N5 MEDIUM GRAY CLAY SHALE		
										10R 4/2 GRAYISH RED CLAY SHALE		
17	NQ-2	64.6	69.3		4.7	60	65			**N6 MEDIUM LIGHT GRAY CLAY SHALE** Soft from 64.6'-67.2'		
18	NQ-2	69.3	74.6		4.6	26	70			**N5 MEDIUM GRAY CLAY SHALE**		Note: At approx. 70.0', the rock became more competent.

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **MW-5** DATE **7/20/15** SHEET **4** OF **12**

PROJECT **CARDINAL FLY ASH DAM** BORING START BORING FINISH **5/4/99**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										5GY 6/1 GREENISH GRAY CLAY SHALE Iron stain; fractures		
										N5 MEDIUM GRAY CLAY SHALE		
19	NQ-2	74.6	84.6		10.0	30	75					
										5GY 6/1 GREENISH GRAY CLAY SHALE		
							80			**N5 MEDIUM GRAY CLAY SHALE**		
										N5 MEDIUM GRAY LIMESTONE		
										N5 MEDIUM GRAY CLAY SHALE with LIMESTONE LENSES		
20	NQ-2	84.6	94.6		10.0	53	85					
										5R 4/2 GRAYISH RED CLAY SHALE		
							90			**N5 MEDIUM GRAY CLAY SHALE**		
21	NQ-2	94.6	104.6		9.9	84	95					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **MW-5** DATE **7/20/15** SHEET **5** OF **12**

PROJECT **CARDINAL FLY ASH DAM** BORING START BORING FINISH **5/4/99**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							100					
22	NQ-2	104.6	114.6		9.6	85	105					
										N5 MEDIUM GRAY SANDY CLAY SHALE		
							110			**10YR 5/4 MODERATE YELLOWISH BROWN SANDSTONE**		
23	NQ-2	114.6	124.2		10.0	96	115					
							120					

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AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

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COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **MW-5** DATE **7/20/15** SHEET **6** OF **12**

PROJECT **CARDINAL FLY ASH DAM** BORING START BORING FINISH **5/4/99**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
24	NQ-2	124.2	129.6		5.4	100	125					
										N5 MEDIUM GRAY SANDSTONE		
										10YR 5/4 MODERATE YELLOWISH BROWN SANDSTONE		
25	NQ-2	129.6	134.6		5.0	100	130			**N5 MEDIUM GRAY SANDSTONE**		
26	NQ-2	134.6	144.6		10.0	100	135					
							140					0.1' limestone at 141.0'
27	NQ-2	144.6	154.6		9.6	76	145					
										10YR 5/4 MODERATE YELLOWISH BROWN SANDSTONE		

AEP CD_FA_DAM.GPJ AEP.GDT 7/20/15

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JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **MW-5** DATE **7/20/15** SHEET **7** OF **12**

PROJECT **CARDINAL FLY ASH DAM** BORING START BORING FINISH **5/4/99**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										N5 MEDIUM GRAY SANDSTONE		
										10YR 5/4 MODERATE YELLOWISH BROWN SANDSTONE		
28	NQ-2	154.6	164.6		10.0	80	155					Lost drill water at 155'; geared rig down from 5th to 3rd gear.
										N5 MEDIUM GRAY SANDSTONE		
										10YR 5/4 MODERATE YELLOWISH BROWN SANDSTONE		
										N5 MEDIUM GRAY SANDSTONE		
										10YR 5/4 MODERATE YELLOWISH BROWN SANDSTONE		
29	NQ-2	164.6	174.6		10.0	68	165					
										N5 MEDIUM GRAY SANDSTONE with COAL STREAKS		
										10YR 5/4 MODERATE YELLOWISH BROWN SANDSTONE		
										N5 MEDIUM GRAY SANDSTONE with COAL STREAKS		
							170			**10YR 5/4 MODERATE YELLOWISH BROWN SANDSTONE** Mud seam at 169.8'		Mud seam at 169.8'
										N5 MEDIUM GRAY SANDSTONE with COAL STREAKS		
30	NQ-2	174.6	184.6		10.0	64	175					

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AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **MW-5** DATE **7/20/15** SHEET **8** OF **12**

PROJECT **CARDINAL FLY ASH DAM** BORING START BORING FINISH **5/4/99**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										N5 MEDIUM GRAY SANDSTONE CONGLOMERATE		
							180			**N5 MEDIUM GRAY SANDSTONE with COAL STREAKS** (Morgantown) Vertical crack at 189.3'		
31	NQ-2	184.6	194.6		10.0	90	185					
							190					
32	NQ-2	194.6	204.6		10.0	89	195					
							200			**N5 MEDIUM GRAY CLAY SHALE**		Mud seam at 200.2'

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AEP CIVIL ENGINEERING LABORATORY

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COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **MW-5** DATE **7/20/15** SHEET **9** OF **12**

PROJECT **CARDINAL FLY ASH DAM** BORING START BORING FINISH **5/4/99**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
33	NQ-2	204.6	214.6		10.0	96	205			**N4 MEDIUM DARK GRAY SANDY SHALE**		
34	NQ-2	214.6	224.6		10.0	80	210					Rock fracture at 209.7'
35	NQ-2	224.6	234.6		10.0	83	215			**N6 MEDIUM LIGHT GRAY SHALEY SANDSTONE**		
							220			**N6 MEDIUM LIGHT GRAY LIMESTONE** Vertical crack at 220.1'-220.7' (fossils)		
							225			**N6 MEDIUM LIGHT GRAY SHALEY LIMESTONE** **N5 MEDIUM GRAY CLAY SHALE**		
										N5 MEDIUM GRAY SANDY SHALE		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **MW-5** DATE **7/20/15** SHEET **10** OF **12**

PROJECT **CARDINAL FLY ASH DAM** BORING START BORING FINISH **5/4/99**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							230					Mud seam at 230.0'
										N6 MEDIUM LIGHT GRAY LIMESTONE Shale streaks.		
36	NQ-2	234.6	235.2		.6	100	235			**N5 MEDIUM GRAY SHALEY SANDSTONE** With calcite.		
37	NQ-2	235.2	237.6		2.4	0				**N5 MEDIUM GRAY CLAY SHALE** Broken up		Mud seam at 235.2'
										N3 DARK GRAY CLAY SHALE Broken up.		
38	NQ-2	237.6	244.6		6.3	33						
							240			**N5 MEDIUM GRAY SANDSTONE**		
										N5 MEDIUM GRAY CLAY SHALE Broken up		Mud seam at 239.9'
39	NQ-2	244.6	249.2			0	245					
40	NQ-2	249.2	254.6		2.3	0						Note: Run 3" casing to 83.6'
							250					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

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COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **MW-5** DATE **7/20/15** SHEET **11** OF **12**

PROJECT **CARDINAL FLY ASH DAM** BORING START _____ BORING FINISH **5/4/99**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
41	NQ-2	254.6	264.6		9.8	51	255			**N3 DARK GRAY CLAY SHALE**		
										N1 BLACK COAL		
										N4 MEDIUM DARK GRAY CLAY SHALE Limestone nodules.		
							260					
42	NQ-2	264.6	264.8		0.2	0						
43	NQ-2	264.8	274.6		9.8	70	265					
							270			**10Y 6/2 PALE OLIVE LIMESTONE**		
										N5 MEDIUM GRAY SHALEY LIMESTONE		
										N5 MEDIUM GRAY CLAY SHALE Limestone nodules		
44	NQ-2	274.6	284.6		10.0	38	275					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **MW-5** DATE **7/20/15** SHEET **12** OF **12**

PROJECT **CARDINAL FLY ASH DAM** BORING START _____ BORING FINISH **5/4/99**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	SAMPLE DEPTH IN FEET TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES

AEP CD_FA_DAM.GPJ AEP.GDT 7/20/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 831,215.4 E 2,519,112.4**

GROUND ELEVATION **1005.6** SYSTEM _____

Water Level, ft	▽	▼	▼
TIME			
DATE			

BORING NO. **M-1004D** DATE **7/17/15** SHEET **1** OF **9**

BORING START **3/23/10** BORING FINISH **3/31/10**

PIEZOMETER TYPE **N/A** WELL TYPE **OW**

HGT. RISER ABOVE GROUND **2.65** DIA **2"**

DEPTH TO TOP OF WELL SCREEN **148.4** BOTTOM **198.4**

WELL DEVELOPMENT **YES** BACKFILL **VOLCLAY**

FIELD PARTY **MCR/ZLR** RIG **D-120**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										DECONED 03/23/10 - LIQUI-NOX & HIGH PRESSURE PUMP / NO GROUNDING PROCESS IN USE / DRILL 4" CASING THEN SPLIT SPOON / DRILL & DECON WATER FROM CD FIRE PROTECTION SYSTEM / NO SPT'S TAKEN FROM 0' - 3.0' DUE TO MINE SPOIL PLACED FOR DRILL PAD		
1	SPT	3.0	5.0	7-6-5-9						**VERY HARD MEDIUM GRAY N5 LIMESTONE** dry		
2	SPT	5.0	6.2	5-23-50/.2			5			**VERY HARD MEDIUM GRAY N5 CLAYSHALE** moist		
3	SPT	7.0	7.1	50/1						SPOON REFUSAL @ 7.1' / HW CASING REFUSAL @ 8.1' / STARTED CORING @ 8.1' ON 03/24/10 / SWL DRY ON 03/24/10 / HW CASING TO 8.1'		
1	NQ	8.1	14.4		5.9	52				**HARD MEDIUM BLUISH GRAY 5B 5/1 SILTY FINE GRAIN SANDSTONE** w/high angle fracture @ 1.4'		
							10					
2	NQ	14.4	24.4		10	70						
							15			**HARD MEDIUM BLUISH GRAY 5B 5/1 SILTY FINE GRAIN SANDSTONE**		
										HARD MEDIUM GRAY N5 LIMEY SILTSTONE		
										HARD LIMESTONE		

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
X	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
	AIR HAMMER	8"

Continued Next Page

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER _____

AEP CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **M-1004D** DATE **7/17/15** SHEET **2** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **3/23/10** BORING FINISH **3/31/10**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										SOFT TO MEDIUM CLAYSHALE		
										HARD GREENISH GRAY 5GY 4/1 CLAYSHALE		
3	NQ	24.4	34.4		10	52	25			**MEDIUM LIGHT GRAY N6 SILTY FINE GRAIN SANDSTONE**		
										HARD MEDIUM GRAY N5 CLAYSHALE		
										HARD MEDUIM LIGHT GRAY N6 LIMESTONE		
										HARD GREENISH GRAY 5GY 6/1 CLAYSHALE w/limestone nodules throughout; w/high angle fracture @ 29.5'		
4	NQ	34.4	41.8		3.8	24	30			**SOFT LIGHT GRAY N7 CLAYSHALE**		
										HARD LIGHT GRAY N7 LIMESTONE		
							35			**HARD GREENISH GRAY 5GY 6/1 CLAYSHALE** badly broken		
5	NQ	41.8	49.4		7.5	35	40			**HARD MEDIUM LIGHT GRAY N6 CLAYSHALE** 45.0' - 49.4' badly broken machine break		
							45					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **M-1004D** DATE **7/17/15** SHEET **3** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **3/23/10** BORING FINISH **3/31/10**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
6	NQ	49.4	59.4		8.7	49	50			**HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYSHALE**		
7	NQ	59.4	67.4		5.5	9	55			**HARD MEDIUM LIGHT GRAY N5 SILTSTONE** w/limestone nodules throughout; slickenslide @ 5.6'		
8	NQ	67.4	74.4		7.0	24	60			**MEDIUM HARD TO SOFT DARK GREENISH GRAY 5GY 4/1 CLAYSHALE** w/limestone nodule @ 4.8' to 5.5'		
							65			**HARD GREENISH GRAY 5G 6/1 CLAYSHALE**		
							70					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **M-1004D** DATE **7/17/15** SHEET **4** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **3/23/10** BORING FINISH **3/31/10**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
9	NQ	74.4	84.4		9.9	59	75			**HARD MEDIUM LIGHT GRAY N6 LIMESTONE** **HARD GREENISH GRAY 5G 6/1 CLAYSHALE** w/limestone nodules		
10	NQ	84.4	93.4		6.1	33	80			**MEDIUM TO SOFT MODERATE OLIVE BROWN 5Y 4/4 CLAYSHALE** **HARD MEDIUM LIGHT GRAY N6 LIMESTONE** **MEDIUM TO SOFT MODERATE OLIVE BROWN 5Y 4/4 CLAYSHALE** **HARD MEDIUM LIGHT GRAY N6 LIMESTONE**		
							85			**HARD DARK GREENISH GRAY 5G 4/1 CLAYSHALE**		
							90			**HARD MEDIUM DARK GRAY N4 LIMESTONE**		
11	NQ	93.4	99.4		5.6	41	95			**HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYSHALE** w/limestone nodules throughout		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **M-1004D** DATE **7/17/15** SHEET **5** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **3/23/10** BORING FINISH **3/31/10**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
12	NQ	99.4	109.4		9.9	98	100			**HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYEY SILTSTONE** w/limestone nodules 99.4' - 99.6'		
13	NQ	109.4	119.4		9.4	66	105			**HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYEY SILTSTONE**		
14	NQ	119.4	129.4		10	62	110			**HARD MEDIUM GRAY N5 LIMESTONE**		
							115			**HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYEY SILTSTONE**		
										HARD MEDIUM GRAY N5 LIMESTONE		
										SOFT TO MEDIUM GREENISH GRAY 5G 6/1 CLAYSHALE		
										HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYEY SILTSTONE w/limestone nodules		
							120			**HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYSHALE** w/limestone nodules throughout @ 119.4' - 124.6'; Hard Very Dark Red 5R 2/6 Clayshale mixed w/Hard Medium Bluish Gray 5B 5/1 Clayshale from 125.6' - 126.6'		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **M-1004D** DATE **7/17/15** SHEET **6** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **3/23/10** BORING FINISH **3/31/10**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							125					
15	NQ	129.4	139.4		9.5	64	130			**MEDIUM HARD VERY DARK RED 5R 2/6 W/MEDIUM GRAY N4 CLAYSHALE**		
										HARD MEDIUM GRAY N4 CLAYSHALE		
										VERY HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYSHALE		
							135					
16	NQ	139.4	149.4		10	57	140			**HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYSHALE**		
										HARD DARK GRAY N3 CLAYSHALE w/coal seams @ 144.2' - 144.3', 145.2', & 145.4'		
							145					
										HARD MEDIUM BLUISH GRAY 5B 5/1 SILTY FINE GRAIN SANDSTONE		
										HARD MEDIUM BLUISH GRAY 5B 5/1 WELL CEMENTED FINE GRAIN SANDSTONE		
17	NQ	149.4	159.4		10	100				**HARD MEDIUM BLUISH GRAY 5B 5/1 WELL**		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **M-1004D** DATE **7/17/15** SHEET **7** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **3/23/10** BORING FINISH **3/31/10**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										CEMENTED FINE GRAIN SANDSTONE		
18	NQ	159.4	169.4		9.9	92	155					
							160			**HARD MEDIUM BLUISH GRAY 5B 5/1 WELL CEMENTED MEDIUM TO FINE GRAIN SANDSTONE**		
19	NQ	169.4	179.4		10	98	165					
							170					
							175					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **M-1004D** DATE **7/17/15** SHEET **8** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **3/23/10** BORING FINISH **3/31/10**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										HARD MEDIUM LIGHT GRAY N6 FINE SANDY CLAYSHALE		
										HARD MEDIUM BLUISH GRAY 5B 5/1 WELL CEMENTED FINE GRAIN SANDSTONE		
20	NQ	179.4	189.4		9.9	95	180			**HARD MEDIUM LIGHT GRAY N6 WELL CEMENTED MEDIUM TO FINE GRAIN SANDSTONE**		
										HARD LIGHT GRAY N7 WELL CEMENTED FINE GRAIN SANDSTONE		
										HARD MEDIUM LIGHT GRAY N6 WELL CEMENTED MEDIUM GRAIN SANDSTONE w/Hard Black N1 Clayshale streaks		
21	NQ	189.4	199.4		9.9	99	190			**HARD MEDIUM LIGHT GRAY N6 WELL CEMENTED MEDIUM GRAIN SANDSTONE** w/gravel in bed @ 189.4' - 189.7'		
							195			**HARD MEDIUM LIGHT GRAY N6 SANDY LIMESTONE**		
										HARD MEDIUM LIGHT GRAY N6 FINE SANDY CLAYSHALE		
										HARD MEDIUM LIGHT GRAY N6 SILTY FINE GRAIN SANDSTONE		
22	NQ	199.4	209.4		10	99	200			**HARD MEDIUM LIGHT GRAY N6 FINE GRAIN SANDSTONE**		
										HARD MEDIUM LIGHT GRAY N6 WELL CEMENTED FINE GRAIN SANDY SILTSTONE		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **M-1004D** DATE **7/17/15** SHEET **9** OF **9**

PROJECT **CARDINAL LANDFILL** BORING START **3/23/10** BORING FINISH **3/31/10**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							205					
23	NQ	209.4	214.4		5	100	210			**HARD MEDIUM LIGHT GRAY N6 WELL CEMENTED FINE GRAIN SANDY SILTSTONE**		
										HARD MEDIUM LIGHT GRAY N6 WELL CEMENTED FINE GRAIN SANDSTONE		
										HARD MEDIUM LIGHT GRAY N6 SILTSTONE w/slickenslide @ 212.1'		
										STOPPED BORING @ 214.4' ON 03/30/10 / SWL 13.1' ON 03/31/10 - 18 HR READING / NQ HOLE TO 214.4' / BUILT 2" PVC MONITORING WELL		

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 829,139.1 E 2,516,070.9**

GROUND ELEVATION **933.6** SYSTEM _____

Water Level, ft	▽	▼	▼
TIME			
DATE			

BORING NO. **M-1003** DATE **7/17/15** SHEET **1** OF **7**

BORING START **4/7/10** BORING FINISH **4/7/10**

PIEZOMETER TYPE **N/A** WELL TYPE **OW**

HGT. RISER ABOVE GROUND **2.33** DIA **2"**

DEPTH TO TOP OF WELL SCREEN **59.3** BOTTOM **139.3**

WELL DEVELOPMENT **YES** BACKFILL **VOLCLAY**

FIELD PARTY **ZLR/DLF** RIG **D-120**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										BLIND DRILLED TO 3.7'		NO SPT'S TAKEN DUE TO STARTING DRILLING ON BEDROCK / ELEVATION LOWERED FOR DRILL PAD / DECONED 04/07/10 / LIQUI-NOX HIGH PRESSURE WASH / NO GROUNDING PROCEDURE IN USE / 4" CASING BLIND DRILLED TO 3.7'
1	NQ	3.7	9.0		2.0	0				**HARD LIGHT GRAY N7 LIMESTONE**		
							5			**HARD MODERATE YELLOWISH BROWN 10YR 5/4 CLAYSHALE**		
2	NQ	9.0	14.4		4.7	88						
							10			**SOFT DARK REDDISH BROWN 10R 3/4 CLAYSHALE**		
3	NQ	14.4	24.4		2.7	0						
							15			**HARD LIGHT BLUISH GRAY 5B 7/1 CLAYSHALE** badly broken		

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
	AIR HAMMER	8"

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PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER _____

AEP CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **M-1003** DATE **7/17/15** SHEET **2** OF **7**

PROJECT **CARDINAL LANDFILL** BORING START **4/7/10** BORING FINISH **4/7/10**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
4	NQ	24.4	29.4		3.9	46	25			**HARD TO SOFT LIGHT BLUISH GRAY 5B 7/1 CLAYSHALE**		
5	NQ	29.4	34.4		1.6	38	30			**HARD LIGHT GRAY N7 LIMESTONE** w/iron staining and badly broken		
6	NQ	34.4	39.4		4.6	33	35			**SOFT GREENISH GRAY 5G 6/1 CLAYSHALE** **HARD GRAYISH RED 10R 4/2 CLAYSHALE**		
7	NQ	39.4	44.4		3.1	32	40			**SOFT MODERATE REDDISH BROWN 10R 4/6 CLAYSHALE**		
8	NQ	44.4	49.4		5.0	48	45			**HARD DARK GREENISH GRAY 5G 4/1 CLAYSHALE** w/limestone nodules		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **M-1003** DATE **7/17/15** SHEET **3** OF **7**

PROJECT **CARDINAL LANDFILL** BORING START **4/7/10** BORING FINISH **4/7/10**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
9	NQ	49.4	54.4		4.9	78	50			**HARD DARK GREENISH 5G 4/1 CLAYSHALE** w/limestone nodules @ 52.0' to 54.4'; w/iron staining & calcite		
10	NQ	54.4	64.4		9.9	42	55			**HARD DARK GREENISH GRAY 5G 4/1 CLAYSHALE** w/iron staining throughout		
11	NQ	64.4	74.4		10	100	60			**HARD MEDIUM BLUISH GRAY 5B 5/1 WELL CEMENTED FINE TO MEDIUM GRAIN SANDSTONE** w/high angle fracture @ 58.6' and iron staining throughout		
							65			**HARD MEDIUM BLUISH GRAY 5B 5/1 WELL CEMENTED MEDIUM GRAIN SANDSTONE**		
							70					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **M-1003** DATE **7/17/15** SHEET **4** OF **7**

PROJECT **CARDINAL LANDFILL** BORING START **4/7/10** BORING FINISH **4/7/10**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
12	NQ	74.4	84.4		10	100	75			**HARD MEDIUM BLUISH GRAY 5B 5/1 WELL CEMENTED MEDIUM TO FINE GRAIN SANDSTONE** w/black shale streak @ 99.4' and 100.2'		
13	NQ	84.4	94.4		10	100	80					
14	NQ	94.4	104.4		10	100	85					
							90					
							95					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **M-1003** DATE **7/17/15** SHEET **5** OF **7**

PROJECT **CARDINAL LANDFILL** BORING START **4/7/10** BORING FINISH **4/7/10**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							100					
15	NQ	104.4	114.4		9.8	94	105			**HARD LIGHT GRAY N7 WELL CEMENTED SANDSTONE** w/black shale streaks from 104.7' to 107.0', 107.3', 107.4', 109.1', & 111.0'		
							110					
16	NQ	114.4	124.4		10	83	115			**HARD LIGHT GRAY N7 WELL CEMENTED FINE TO MEDIUM GRAIN SANDSTONE** w/black N1 shale streaks @ 115.0', 115.2' - 115.8', 116.5', 117.2' - 117.6'; black N1 coal lens @ 116.8' - 116.9' & 121.6'; high angle fracture @ 119.6'		
							120					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **M-1003** DATE **7/17/15** SHEET **6** OF **7**

PROJECT **CARDINAL LANDFILL** BORING START **4/7/10** BORING FINISH **4/7/10**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
17	NQ	124.4	134.4		10	98	125			**HARD LIGHT GRAY N7 WELL CEMENTED FINE GRAIN SANDSTONE** w/gravel nodules 124.9' - 125.3'; w/black N1 shale streaks throughout		
18	NQ	134.4	144.4		10	100	130					
19	NQ	144.4	154.4		10	86	135			**HARD MEDIUM BLUISH GRAY 5B 5/1 WELL CEMENTED FINE TO MEDIUM GRAIN SANDSTONE**		
							140			**HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYSHALE** **HARD MEDIUM BLUISH GRAY 5B 5/1 CLAYSHALE** w/limestone nodules throughout		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **M-1003** DATE **7/17/15** SHEET **7** OF **7**

PROJECT **CARDINAL LANDFILL** BORING START **4/7/10** BORING FINISH **4/7/10**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										HARD MEDIUM BLUISH GRAY 5B 5/1 FINE SANDY CLAYSHALE		
										HARD MEDIUM BLUISH GRAY 5B 5/1 FINE GRAIN SANDSTONE		
										STOPPED DRILLING @ 154.4' ON 04/13/10 / INSTALLED 2" PVC MONITORING WELL		

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL FLY ASH DAM**

COORDINATES **N 829,635.1 E 2,516,460.0**

GROUND ELEVATION **918.2** SYSTEM **State Plane using NAD27/29**

Water Level, ft	▽	▼	▼
TIME			
DATE			

BORING NO. **FA-8** DATE **7/20/15** SHEET **1** OF **7**

BORING START **3/8/04** BORING FINISH **3/23/04**

PIEZOMETER TYPE **SS** WELL TYPE **OW**

HGT. RISER ABOVE GROUND **2.8** DIA

DEPTH TO TOP OF WELL SCREEN **40** BOTTOM **50**

WELL DEVELOPMENT BACKFILL **QUICK GROUT**

FIELD PARTY **REB / DLB** RIG **CME-75**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
	AUGER	0.0	15.8				5 10 15			**AUGERED TO 15.8'**		Deconned with alconox and steam ginny before drilling.
1	NQ2	15.8	20.0		1.8	23				**N6 LIGHT GRAY to 5G 6/1 GREENISH GRAY FRACTURED LIMESTONE** High angle fractures		

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
X	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
X	SW CASING	6"
	AIR HAMMER	8"

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PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER **DLB**

AEP_CD_FA_DAM.GPJ AEP.GDT 7/20/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **FA-8** DATE **7/20/15** SHEET **2** OF **7**

PROJECT **CARDINAL FLY ASH DAM** BORING START **3/8/04** BORING FINISH **3/23/04**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
2	NQ2	20.0	25.0		4.7	85				**10YR 4/6 DARK YELLOWISH BROWN CLAYEY SHALE**		
										5YR 5/2 REDDISH GRAY SHALE		
3	NQ2	25.0	35.0		9.4	87	25			**5YR 3/4 DARK REDDISH GRAY CLAYEY SHALE**		
										5B 5/1 MEDIUM BLUISH GRAY CLAYEY SHALE w/ angle fractures @ 27' (120 deg.), 27.5' (60 deg.), & 28.0' (140 deg.)		
										5B 5/1 MEDIUM BLUISH GRAY HARD SHALE w/ large limestone nodules and cross beds, w/ angle fractures @ 31.8' (80 deg.), & 32.2' (80 deg.)		
							30					
							35					
4	NQ2	35.0	45.0		10	89				**5B 5/1 MEDIUM BLUISH GRAY SANDY SHALE**		
							40					
										10YR 5/4 YELLOWISH BROWN SANDY SHALE		Lost water @ 42.5'
										10YR 5/4 YELLOWISH BROWN MEDIUM GRAIN SANDSTONE		
										5B 7/1 LIGHT BLUISH GRAY MEDIUM GRAIN SANDSTONE		
5	NQ2	45.0	55.0		10	96	45			**10YR 5/4 YELLOWISH BROWN MEDIUM GRAIN SANDSTONE**		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **FA-8** DATE **7/20/15** SHEET **3** OF **7**

PROJECT **CARDINAL FLY ASH DAM** BORING START **3/8/04** BORING FINISH **3/23/04**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										w/ angle fractures @ 47.0' (110 deg.) and limonitic vugs @ 46.4'		
										5B 5/1 MEDIUM BLUISH GRAY SHALE w/ limestone cross beds		
							50			**10YR 4/3 BROWN MEDIUM GRAIN SANDSTONE** w/ angle fractures @ 49.0' (115 deg.)		
										5B 5/1 MEDIUM BLUISH GRAY MEDIUM GRAIN SANDSTONE Well cemented		
6	NQ2	55.0	65.0		10	100	55			**10YR 5/6 GRAYISH BROWN MEDIUM GRAIN SANDSTONE**		
										5B 5/1 MEDIUM BLUISH GRAY MEDIUM GRAIN SANDSTONE Well cemented		
							60					
7	NQ2	65.0	75.0		9.8	100	65			**5B 5/1 MEDIUM BLUISH GRAY MEDIUM GRAIN SANDSTONE** w/ black shale streaks throughout		
							70					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **FA-8** DATE **7/20/15** SHEET **4** OF **7**

PROJECT **CARDINAL FLY ASH DAM** BORING START **3/8/04** BORING FINISH **3/23/04**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							75					
8	NQ2	75.0	85.0		10	100				**5B 5/1 MEDIUM BLUISH GRAY MEDIUM to COARSE GRAIN SANDSTONE** w/ coal lenses throughout		Some water return @ 75.0'
							80					
9	NQ2	85.0	95.0		10	100	85			**5B 5/1 MEDIUM BLUISH GRAY MEDIUM GRAIN SANDSTONE** w/ coal lenses throughout, 2" bands of 10YR 4/4 BROWN SANDSTONE in bottom 2.0'		
							90					
10	NQ2	95.0	105.0		10	100	95			**10YR 4/4 DARK YELLOWISH BROWN COARSE GRAIN SANDSTONE** w/ limonitic vugs throughout, well cemented		Lost water @ 95.0'

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **FA-8** DATE **7/20/15** SHEET **5** OF **7**

PROJECT **CARDINAL FLY ASH DAM** BORING START **3/8/04** BORING FINISH **3/23/04**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							100					
										N5 MEDIUM GRAY MEDIUM to COARSE GRAIN SANDSTONE w/ coal streaks		
										N1 BLACK COAL		
11	NQ2	105.0	115.0		10	92	105			**N5 MEDIUM GRAY MEDIUM GRAIN SANDSTONE**		
										N5 MEDIUM GRAY MEDIUM to COARSE GRAIN SANDSTONE w/ coal streaks		
										N1 BLACK COAL		
										N5 MEDIUM GRAY MEDIUM GRAIN SANDSTONE w/ black shale streaks		
										N1 BLACK COAL		
							110			**N5 MEDIUM GRAY MEDIUM GRAIN SANDSTONE** w/ coal streaks and limestone nodules		
										5B 5/1 MEDIUM BLUISH GRAY MEDIUM GRAIN SANDSTONE w/ black coal streaks		
12	NQ2	115.0	125.0		10	100	115			**5B 5/1 MEDIUM BLUISH GRAY MEDIUM GRAIN SANDSTONE** w/ limestone nodules (1 1/2") @ 116.8' to 117.4'		
							120			**10YR 4/4 DARK YELLOWISH BROWN MEDIUM GRAIN SANDSTONE** w/ limonitic vugs		
										5B 5/1 MEDIUM BLUISH GRAY MEDIUM		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **FA-8** DATE **7/20/15** SHEET **6** OF **7**

PROJECT **CARDINAL FLY ASH DAM** BORING START **3/8/04** BORING FINISH **3/23/04**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										GRAIN SANDSTONE w/ coal streaks		
13	NQ2	125.0	135.0		10	100	125			**5B 5/1 MEDIUM BLUISH GRAY MEDIUM GRAIN SANDSTONE**		
										10YR 4/4 DARK YELLOWISH BROWN MEDIUM to COARSE GRAIN SANDSTONE		
							130			**N5 MEDIUM GRAY MEDIUM to COARSE GRAIN SANDSTONE** w/ coal streaks and limestone nodules in bottom 3.0'		
14	NQ2	135.0	145.0		10	97	135			**N6 MEDIUM LIGHT GRAY COARSE to MEDIUM GRAIN SANDSTONE** w/ coal streaks and limestone nodules in bottom 1.5'		
							140			**N4 MEDIUM DARK GRAY FINE GRAIN SHALEY SANDSTONE**		
15	NQ2	145.0	155.0		10	100	145			**N5 MEDIUM GRAY SANDY SHALE**		
										N5 MEDIUM GRAY SHALEY FINE GRAIN SANDSTONE		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **FA-8** DATE **7/20/15** SHEET **7** OF **7**

PROJECT **CARDINAL FLY ASH DAM** BORING START **3/8/04** BORING FINISH **3/23/04**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
												NOTE: Had to set 31.6' of 6" casing before using roller bit in hole.
										N5 MEDIUM GRAY SHALE		
							155					

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL PLANT**

COORDINATES **N 830,050.0 E 2,518,000.0**

GROUND ELEVATION **984.0** SYSTEM **STATE PLANE**

Water Level, ft	▽	▼	▼
TIME			
DATE			

BORING NO. **85W-1D1** DATE **7/17/15** SHEET **1** OF **1**

BORING START _____ BORING FINISH **8/20/85**

PIEZOMETER TYPE _____ WELL TYPE **GM**

HGT. RISER ABOVE GROUND **2.63** DIA **.75**

DEPTH TO TOP OF WELL SCREEN **328.5** BOTTOM **329.5**

WELL DEVELOPMENT _____ BACKFILL **GROUT**

FIELD PARTY **BG=T** RIG **ACKER**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							5					
							10					
							15					

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
	6" x 3.25 HSA	
	9" x 6.25 HSA	
X	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
	AIR HAMMER	8"

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER _____

AEP CD SI.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL PLANT**

COORDINATES **N 829,053.0 E 2,517,845.0**

GROUND ELEVATION **890.0** SYSTEM **STATE PLANE**

Water Level, ft	▽	▼	▼
TIME			
DATE			

BORING NO. **85W-2D2** DATE **7/17/15** SHEET **1** OF **1**

BORING START _____ BORING FINISH **8/26/85**

PIEZOMETER TYPE _____ WELL TYPE **GM**

HGT. RISER ABOVE GROUND **2.0** DIA **.75**

DEPTH TO TOP OF WELL SCREEN **240.3** BOTTOM **241.3**

WELL DEVELOPMENT _____ BACKFILL **GROUT**

FIELD PARTY **BG-T** RIG **ACKER**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							5					
							10					
							15					

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
X	SW CASING	6"
	AIR HAMMER	8"

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER _____

AEP CD SI.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 836,291.1 E 2,514,223.8**

GROUND ELEVATION **1159.2** SYSTEM

Water Level, ft	▽	▼	▼
TIME			
DATE			

BORING NO. **CA-0622** DATE **7/17/15** SHEET **1** OF **16**

BORING START **4/10/06** BORING FINISH **6/1/06**

PIEZOMETER TYPE WELL TYPE

HGT. RISER ABOVE GROUND **2.281** DIA

DEPTH TO TOP OF WELL SCREEN **354.9** BOTTOM **359.9**

WELL DEVELOPMENT BACKFILL

FIELD PARTY **DLB / MCR / MWJ** RIG **D-120**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
		0.0	10.0									**GROUNDING PROCEDURES NOT IN USE ON THIS BORING. BLIND DRILLED FROM GRADE TO 10' WITH 3 7/8" ROLLER BIT & SET 3" PVC CASING. STARTED CORING AT 10.0'**
1	NQ	10.0	13.9		3.3		10			**HARD N8 VERY LIGHT GRAY LIMESTONE** w/ 1/2" clay bands in bottom 0.3'		
2	NQ	13.9	18.9		5.0		15			**HARD N8 VERY LIGHT GRAY LIMESTONE**		
										SOFT 5G 6/1 GREENISH GRAY SHALE		
3	NQ	18.9	23.9		4.7					**HARD 5R 4/2 GRAYISH RED SHALE**		

TYPE OF CASING USED

	NQ-2 ROCK CORE	
	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
	NW CASING	3"
	SW CASING	6"
	AIR HAMMER	8"

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PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER

AEP CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0622** DATE **7/17/15** SHEET **2** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **4/10/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										5G 6/1 GREENISH GRAY LIMESTONE fractured throughout		
										5GY 6/1 GREENISH GRAY SHALE		
4	NQ	23.9	33.9		9.7		25			**5B 5/1 MEDIUM BLUISH GRAY SHALE** fractured		
										N7 LIGHT GRAY LIMESTONE		
										5G 6/1 GREENISH GRAY SHALE		
										5G 6/1 GREENISH GRAY LIMESTONE fractured		
							30			**5G 6/1 GREENISH GRAY SHALE**		
										HARD 5B 5/1 MEDIUM BLUISH GRAY SHALEY LIMESTONE		
5	NQ	33.9	43.9		9.8		35			**HARD 5B 5/1 MEDIUM BLUISH GRAY SHALEY LIMESTONE** fractured in bottom 1.5'		
							40					
6	NQ	43.9	46.9		3.0					**HARD 5B 5/1 MEDIUM BLUISH GRAY SHALEY LIMESTONE**		
							45					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0622** DATE **7/17/15** SHEET **3** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **4/10/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
7	NQ	46.9	53.9		7.0		50					
										5B 5/1 MEDIUM BLUISH GRAY SHALE		
8	NQ	53.9	63.9		9.6		55			**HARD 5B 5/1 MEDIUM BLUISH GRAY SHALEY LIMESTONE**		
										HARD N5 MEDIUM GRAY SHALEY LIMESTONE		
9	NQ	63.9	73.9		10.0		60					
							65			**HARD 5B 5/1 MEDIUM BLUISH GRAY to N6 MEDIUM LIGHT GRAY SHALE**		
										HARD N4 MEDIUM DARK GRAY SHALE small coal band @ 73.8		
							70					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0622** DATE **7/17/15** SHEET **4** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **4/10/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
10	NQ	73.9	83.9		10.0		75			**HARD N6 MEDIUM LIGHT GRAY SHALE** w/ coal band @ 74.4, angle fracture @ 75.7		
										SOFT N4 MEDIUM DARK GRAY SHALE		
							80			**HARD N2 GRAYISH BLACK SHALE**		
										COAL		
										HARD 5B 5/1 MEDIUM BLUISH GRAY SHALE		
11	NQ	83.9	93.9		10.0					**HARD N5 MEDIUM GRAY SHALE**		
							85					
							90			**HARD 5B 7/1 LIGHT BLUISH GRAY MIXED w/ N6 MEDIUM LIGHT GRAY SHALE** w/ limestone nodules		
12	NQ	93.9	103.9		10.0					**HARD 5B 5/1 MEDIUM BLUISH GRAY SHALE**		
							95					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0622** DATE **7/17/15** SHEET **5** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **4/10/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										HARD 5B 7/1 LIGHT BLUISH GRAY SHALE w/ sandstone streaks, angle fracture @ 98.5		
13	NQ	103.9	113.9		10.0		100			**HARD N6 MEDIUM LIGHT GRAY SHALE** w/ sandstone streaks, bottom 0.5 carbonious		
							105					
							110			**N8 VERY LIGHT GRAY LIMESTONE**		
										HARD N3 DARK GRAY SHALE		
										N7 LIGHT GRAY LIMESTONE w/ 0.2 5B 5/1 medium bluish gray shale band @ 111.6		
14	NQ	113.9	123.9		10.0					**N7 LIGHT GRAY LIMESTONE**		
							115			**HARD 5GY 4/1 DARK GREENISH GRAY SHALE**		
										5GY 4/1 DARK GREENISH GRAY SHALE		
							120			**HARD N6 MEDIUM LIGHT GRAY SHALE** w/ sandstone streaks		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0622** DATE **7/17/15** SHEET **6** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **4/10/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
15	NQ	123.9	133.9		10.0		125			**HARD 5B 5/1 MEDIUM BLUISH GRAY SHALE** bottom 0.8 N3 dark gray carbonious		
							130			**N5 MEDIUM GRAY FINE GRAIN SANDSTONE** w/ shale band		
16	NQ	133.9	143.9		10.0					**HARD N5 MEDIUM GRAY SHALE**		
							135			**COAL** w/ hard shale bands		
							140			**N4 MEDIUM DARK GRAY SHALE** w/ 0.5 of carbonious shale at 142.0, bottom 1.9 hard		
17	NQ	143.9	153.9		10.0					**HARD N6 MEDIUM LIGHT GRAY SHALE**		
							145			**N8 VERY LIGHT GRAY LIMESTONE**		
										HARD N6 MEDIUM LIGHT GRAY SHALE		
										N8 VERY LIGHT GRAY LIMESTONE w/ 0.3 shale bands @ 147.8 & 152.4		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0622** DATE **7/17/15** SHEET **7** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **4/10/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
18	NQ	153.9	163.9		6.2	68	155			**HARD N6 MEDIUM LIGHT GRAY LIMESTONE**		**SWL 21.4' on 04/17/06 w/ NQ HOLE TO 153.9'. USED ±4,000 GALS. WATER TO THIS POINT**
										HARD N6 MEDIUM LIGHT GRAY FRACTURED LIMESTONE		
										HARD N5 MEDIUM GRAY SHALE/LIMESTONE		
										SOFT N5 MEDIUM GRAY SHALE/LIMESTONE		**LOST ALL WATER RETURN AT 157.8'. HYD. PUSH - NO ROTATION FROM 163.9' - 165.9' (VOID)**
										HARD N5 MEDIUM GRAY SHALE/LIMESTONE		
19	NQ	163.9	168.9		1.9	84	160			**VOID**		
							165			**SOFT 5B 5/1 MEDIUM BLUISH GRAY SHALE**		
20	NQ	168.9	170.9		1.3	0				**SOFT N5 MEDIUM GRAY SHALE** wet		
21	NQ	170.9	178.9		7.9	67	170			**HARD N6 MEDIUM LIGHT GRAY SHALE**		**Stopped after going through mine void. Started drilling HW casing and cleaning inside of casing w/ 4" roller bit. At 155', roller bit broke off inside casing. It was decided to abandon and grout this boring. Moved east +/- 5" and started drilling new boring w/ 6" air**
										SOFT N4 MEDIUM DARK GRAY SHALE fractures throughout		
										HARD N6 MEDIUM LIGHT GRAY SHALE fractured		
							175					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0622** DATE **7/17/15** SHEET **8** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **4/10/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										HARD N7 LIGHT GRAY SHALE		**hammer and inserted HW casing to bottom old mine floor @ 173.3'. This boring was drilled through mine piller; no camera work done on this boring. Coal seam estimated @ +/- 165.0'-17**
22	NQ	178.9	186.9		6.6	56				**SOFT N7 LIGHT GRAY SHALE** w/ fracture		
							180			**SOFT N6 MEDIUM LIGHT GRAY SHALE**		
										SOFT N6 MEDIUM LIGHT GRAY SHALE w/ fracture, wet		
										HARD N7 LIGHT GRAY SHALE dry		
										N7 LIGHT GRAY CLAY SHALE dry		
										HARD N7 LIGHT GRAY CLAY SHALE		
							185			**N4 MEDIUM DARK GRAY SHALE**		
23	NQ	186.9	189.4		2.5	88				**VERY HARD N6 MEDIUM LIGHT GRAY SHALE** w/ trace of fine limestone		**Resumed coring and logging core @ 186.9'**
24	NQ	189.4	194.4		5.0	40				**N5 MEDIUM GRAY SHALE** fracture, wet		
							190			**N6 MEDIUM LIGHT GRAY SHALE/LIMESTONE**		
										SOFT MEDIUM GRAY SHALE wet		
										MEDIUM LIGHT GRAY SHALE		
										SOFT N5 MEDIUM GRAY SHALE moist		
25	NQ	194.4	204.4		10.0	83				**5B 5/1 MEDIUM BLUISH GRAY SHALE**		
							195			**HARD N5 MEDIUM GRAY SHALE** fracture		
										HARD N5 MEDIUM GRAY SHALE		
							200					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0622** DATE **7/17/15** SHEET **9** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **4/10/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										N5 MEDIUM GRAY SHALE fracture, wet		
										HARD N5 MEDIUM GRAY SHALE		
26	NQ	204.4	214.4		8.7	64	205			**HARD N4 MEDIUM DARK GRAY SHALE**		
										5G 6/1 GREENISH GRAY SHALE w/trace of fine imestone, wet		
										N2 GRAYISH BLACK SHALE fractured		
										SOFT N4 MEDIUM DARK GRAY SHALE		
										N2 GRAYISH BLACK SHALE fracture		
										N5 MEDIUM GRAY SHALE fracture, wet		
							210			**5G 6/1 GREENISH GRAY SHALE**		
										5G 6/1 GREENISH GRAY SHALE wet		
27	NQ	214.4	219.4		5.0	66				**5GY 6/1 GREENISH GRAY SHALE/LIMESTONE**		
							215			**N5 MEDIUM GRAY SHALE**		
										SOFT 5YR 6/1 LIGHT BROWNISH GRAY SANDY SHALE		
28	NQ	219.4	229.4		9.9	81	220			**HARD 5B 5/1 MEDIUM BLUISH GRAY SHALE** w/limestone fractures		
										5B 5/1 MEDIUM BLUISH GRAY SHALE w/limestone		
							225			**N4 MEDIUM DARK GRAY SHALE** fractured, wet		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0622** DATE **7/17/15** SHEET **10** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **4/10/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
29	NQ	229.4	238.8				230			**5B 5/1 MEDIUM BLUISH GRAY SHALE/ LIMESTONE** fracture **N4 MEDIUM DARK GRAY SHALE** fractured **HARD MEDIUM DARK GRAY SHALE** w/limestone		
30	NQ	238.8	244.4				235 240			**MEDIUM DARK GRAY LIMESTONE** shale fractures **HARD DARK GRAY LIMESTONE** **HARD N4 MEDIUM DARK GRAY SHALE**		
31	NQ	244.4	254.4				245 250			**N2 GRAYISH BLACK COAL** fracture **SOFT N4 MEDIUM DARK GRAY SHALE** **HARD N4 MEDIUM DARK GRAY SHALE/LIMESTONE** **5B 5/1 MEDIUM BLUISH GRAY SHALE** **5B 5/1 MEDIUM BLUISH GRAY SHALE** w/limestone fractures **SOFT 5GY 6/1 GREENISH GRAY SHALE** w/limestone, wet **N5 MEDIUM GRAY & 5YR 4/1 BROWNISH GRAY SHALE** **5B 5/1 MEDIUM BLUISH GRAY SHALE**		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0622** DATE **7/17/15** SHEET **11** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **4/10/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
32	NQ	254.4	264.4				255			**SOFT MEDIUM BLUISH GRAY SHALE**		
										HARD 5GY 6/1 GREENISH GRAY SHALE w/fractures of limestone		
							260			**5YR 4/1 BROWNISH GRAY RED SHALE**		
										MEDIUM BLUISH GRAY SHALE w/fractures of limestone		
33	NQ	264.4	274.4				265			**N4 MEDIUM DARK GRAY SHALE**		
										SOFT N4 MEDIUM DARK GRAY SHALE wet		
							270					
34	NQ	274.4	284.4									
							275			**SOFT N4 MEDIUM DARK GRAY SHALE**		
										N7 LIGHT GRAY & N4 MEDIUM DARK GRAY SHALE w/trace of limestone		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0622** DATE **7/17/15** SHEET **12** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **4/10/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										N4 MEDIUM DARK GRAY SHALE/LIMESTONE		
35	NQ	284.4	294.4				285			**HARD SHALE** **N4 MEDIUM DARK GRAY SHALE** w/fractures of limestone		
										HARD N3 DARK GRAY SHALE		
36	NQ	294.4	304.4				290					
							295			**HARD N4 MEDIUM DARK GRAY SHALE**		
							300					
37	NQ	304.4	314.4		10.0	100	305					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0622** DATE **7/17/15** SHEET **13** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **4/10/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							310					
38	NQ	314.4	324.4		10.0		315			**N4 MEDIUM DARK GRAY SHALE**		
										N4 MEDIUM DARK GRAY & N6 MEDIUM LIGHT GRAY SHALE w/fine sandstone		
							320			**N4 MEDIUM DARK GRAY SHALE** w/traces of fine standstone lens		
										N5 MEDIUM GRAY SHALE w/trace of fine sandstone		
39	NQ	324.4	334.4		10.0		325			**HARD MEDIUM GRAY & MEDIUM DARK GRAY SHALE** w/trace of coarse sandstone		
							330			**N5 MEDIUM GRAY COARSE GRAIN SANDSTONE**		
										HARD N3 DARK GRAY SHALE w/trace of sandstone		
										N5 MEDIUM GRAY COARSE GRAIN		**MORGANTOWN**

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0622** DATE **7/17/15** SHEET **14** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **4/10/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										SANDSTONE Morgantown sandstone starts @ 331.5'		**SANDSTONE STARTS @ 331.5'**
40	NQ	334.4	344.4		10.0		335			**N6 MEDIUM LIGHT GRAY SANSDSTONE**		
										HARD N3 DARK GRAY SHALE w/trace of fine sandstone		
										N2 GRAYISH BLACK SHALE		
							340			**N5 MEDIUM GRAY COARSE GRAIN SANDSTONE**		
										HARD N2 GRAYISH BLACK SHALE w/trace of fine sandstone		
41	NQ	344.4	354.4		9.8	92	345			**N5 MEDIUM GRAY COARSE GRAIN SANDSTONE** w/trace of dark shale		
										HARD N4 MEDIUM DARK GRAY SHALE w/trace of fine sandstone		
							350					
										MEDIUM GRAY SANDSTONE w/dark shale fractures		
42	NQ	354.4	364.4		9.7	91	355			**N6 MEDIUM LIGHT GRAY COARSE GRAIN SANDSTONE**		
										GRAYISH BLACK COAL fracture		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0622** DATE **7/17/15** SHEET **15** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **4/10/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										N6 MEDIUM LIGHT GRAY COARSE GRAIN SANDSTONE		
							360			**N5 MEDIUM GRAY SHALE**		
43	NQ	364.4	373.4		10.0	90	365			**N6 MEDIUM LIGHT GRAY SILTSTONE**		
							370			**HARD N5 MEDIUM GRAY SHALE**		
44	NQ	373.4	383.4		10.0	81				**HARD N3 DARK GRAY CLAY SHALE**		
							375			**N2 GRAYISH BLACK CLAY SHALE SEAM**		
										N1 BLACK COAL SEAM		
										HARD N5 MEDIUM GRAY CLAY SHALE		
							380					**STOPPED BORING**

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **CA-0622** DATE **7/17/15** SHEET **16** OF **16**

PROJECT **CARDINAL LANDFILL** BORING START **4/10/06** BORING FINISH **6/1/06**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
												@ 383.4'. SET 1" GEOMON WELL

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **OHIO POWER COMPANY**

PROJECT **TIDD ASH POND SITE INVESTIGATION**

COORDINATES **N 831,918.6 E 2,156,681.5**

GROUND ELEVATION **1008.6** SYSTEM **STATE PLANE**

WATER LEVEL	▽ 52.7	▽	▽
TIME			
DATE	7-30-90		

BORING NO. **90CA22** DATE _____ SHEET **1** OF **4**

BORING START **07/23/90** BORING FINISH **08/09/90**

PIEZOMETER TYPE _____ WELL TYPE **GM**

HGT. RISER ABOVE GROUND **1.9** DIA **1.0**

DEPTH TO TOP OF WELL SCREEN **220.6** BOTTOM **222.6**

WELL DEVELOPMENT _____ BACKFILL **BENSEAL**

FIELD PARTY **MCR-JD** RIG **B-61**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPH LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
1	NQ	0.0	5.9				5					WATER RETURNED AFTER SEATING CASING.
							10					
							15					
							20			GRAY SILTY CLAYSHALE Calcareous, vertical cracks 20.8-21.1, 21.6-21.8		
							25			GRAY SHALEY LIMESTONE Hard.		
2	NQ	25.6	30.4		4.8	59				GRAY SILTY SANDSTONE V-fine grain.		
							30			GRAY LIMESTONE Hard, stain on joints and vertical cracks.		
3	NQ	30.4	40.4		10.0	77				GRAY TO BLACK CLAYSHALE		
							35			GRAY SILTY SANDSTONE F-fine grain. vertical cracks		
4	NQ	40.4	50.4		10.0	45	40			GRAY LIGHT GRAY CLAYSHALE Slightly sandy, calcareous.		
										LIGHT GRAY SANDSTONE Silt crossbedding throughout, thin bedding at 43.1		
							45			GRAY TO LIGHT TO DARK GRAY CLAYSHALE Broken slightly calcareous.		
										LIGHT GRAY LIMESTONE Vertical fracture from 46.0-46.9, calcite filled.		
										GRAY SANDY CLAYSHALE Broken, silty,		

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TYPE OF CASING USED

X	NQ-2 ROCK CORE	
	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
X	NW CASING	3"
	SW CASING	6"

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER **JD**

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **OHIO POWER COMPANY** BORING NO. **90CA22** DATE _____ SHEET **2** OF **4**

PROJECT **TIDD ASH POND SITE INVESTIGATION** BORING START **07/23/90** BORING FINISH **08/09/90**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPH LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
5	NQ	50.4	60.4		9.3	78				slightly calcareous.		
							55			DEEP MAROON PURPLE CLAYSHALE Blocky, slightly calcareous, slightly weathered.		
										LIGHT GREEN TO LIGHT GRAY CLAYSHALE Slightly broken.		
										LIGHT TAN TO LIGHT GRAY SANDSTONE Fine grain, silt bedding throughout.		
6	NQ	60.4	65.4		4.7	37	60					
										RUST BROWN CLAYSHALE Iron precipitate staining throughout, broken, slightly sandy to very sandy, fine grained sand.		
7	NQ	65.4	70.4		5.0	27	65					
										LIGHT GRAY SANDSTONE Very fine grain, silt partings and cross bedding throughout.		
8	NQ	70.4	75.4		5.0	27	70					
										LIGHT GRAY CLAYSHALE Slightly sandy, silty.		
							75			SILTY CLAYSHALE Soft, crack, appears to have been very plastic in the drill bit.		
9	NQ	75.4	80.4		4.7	25				LIGHT TO MEDIUM GRAY LIMESTONE Slightly sandy.		
										MEDIUM GRAY LIMESTONE Slightly shaley.		
10	NQ	80.4	90.4		9.9	79	80			GRAY CLAYSHALE Some silt bedding.		
							85			GRAY SILTY CLAYSHALE Limestone nodules throughout, hard.		
11	NQ	90.4	100.4		10.0	84	90			GRAY CLAYSHALE Hard, with traces of limestone throughout, fine grain sand throughout.		
							95			VERY BROKEN 97.2-97.8		
12	NQ	100.4	110.4		10.0	66	100					
							105					
13	NQ	110.4	120.4		9.5	52	110			LIGHT GRAY SANDSTONE Fine grain, silty, crossbedding.		
										LIGHT GRAY LIMESTONE Highly calcareous,		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **OHIO POWER COMPANY** BORING NO. **90CA22** DATE _____ SHEET **3** OF **4**

PROJECT **TIDD ASH POND SITE INVESTIGATION** BORING START **07/23/90** BORING FINISH **08/09/90**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPH LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										very hard, some silty bedding.		
14	NQ	120.4	130.4		9.8	71	120			**LIGHT GRAY SLIGHTLY SANDY SHALEY LIMESTONE** SOME THIN SANDSTONE LENSES., VERY CALCAREOUS STREAKS THROUGHOUT,LIMESTONE BECOMING V=VERY SANDY WITH DEPTH, LIMESTONE IS VERY SILTY.		
							125					
15	NQ	130.4	140.4		10.0	83	130					
							135					135.5 TOP OF SEAL.
16	NQ	140.4	150.4		10.0	100	140			**GRAY LIGHT GRAY SILTY SHALE** Silt cross bedding throughout.		
							145					144.2 TOP OF SAND.
17	NQ	150.4	160.4		10.0	100	150			**LIGHT GRAY SANDSTONE** Coarse grain, siltstone lenses at 148.4-148.6 and 151.1-151.3 some micaceous partings throughout.		
							155					
18	NQ	160.4	170.4		10.0	100	160					
							165					
19	NQ	170.4	180.4		10.0	100	170					
							175					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **OHIO POWER COMPANY** BORING NO. **90CA22** DATE _____ SHEET **4** OF **4**

PROJECT **TIDD ASH POND SITE INVESTIGATION** BORING START **07/23/90** BORING FINISH **08/09/90**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPH LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
20	NQ	180.4	190.4		9.5	95	185					
21	NQ	190.4	200.4		10.0	100	190			SOME MICACEOUS PARTINGS		
23	NQ	200.4	210.4		8.7	87	195					
							200					
							205			THIN COAL LENSES AT 205.1-205.5 BECOMING MORE BROKEN BELOW 205.5		
24	NQ	210.4	215.4		4.6	92	210			BOTTOM OF MORGANTOWN SANDSTONE		
25	NQ	215.7	225.7		10.0	100	215			SANDY LIMESTONE CONGLOMERATE		
							220			SANDSTONE Fine grain, calcareous.		220.4 CHECL VALVE. 221.0 TOP OF SCREEN. 223.0 BOTTOM OF SCREEN. 224.0 BOTTOM OF SAND.
26	NQ	225.7	230.2		4.5	100	225			SANDSTONE V-fine grain, calcareous, silt crossbedding throughout.		
							230					230.0 BOTTOM OF SEAL.

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER**

PROJECT **CARDINAL PLANT**

COORDINATES **N 829,994.0 E 2,518,683.2**

GROUND ELEVATION **1031.0** SYSTEM **STATE PLANE**

Water Level, ft	▽ 249.0'	▼ 117.0'	▼
TIME			
DATE	8-9-85	8-10-85	

BORING NO. **85W-3** DATE **7/20/15** SHEET **1** OF **11**

BORING START **8/9/85** BORING FINISH **8/13/85**

PIEZOMETER TYPE _____ WELL TYPE **GM**

HGT. RISER ABOVE GROUND **2.42** DIA **.75**

DEPTH TO TOP OF WELL SCREEN **229.5** BOTTOM **230.5**

WELL DEVELOPMENT _____ BACKFILL **GROUT**

FIELD PARTY **B. KGOLLIHUE & TOBY** RIG **ACKER**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
1		0.0	1.0		0.0					**BROWN TOPSOIL**		
2		1.0	40.0		0.0					**COAL AND SHALE**, FILL		
							5					
							10					
							15					

TYPE OF CASING USED

X	NQ-2 ROCK CORE	
	6" x 3.25 HSA	
	9" x 6.25 HSA	
	HW CASING ADVANCER	4"
X	NW CASING	3"
X	SW CASING	6"
	AIR HAMMER	8"

Continued Next Page

PIEZOMETER TYPE: PT = OPEN TUBE POROUS TIP, SS = OPEN TUBE SLOTTED SCREEN, G = GEONOR, P = PNEUMATIC

WELL TYPE: OW = OPEN TUBE SLOTTED SCREEN, GM = GEOMON

RECORDER _____

AEP CD SI.GPJ AEP.GDT 7/20/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **85W-3** DATE **7/20/15** SHEET **2** OF **11**

PROJECT **CARDINAL PLANT** BORING START **8/9/85** BORING FINISH **8/13/85**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							25					
							30					
							35					
							40			**BROWN WEATHERED SHALE**		
3	NW	40.0	45.0		5.0					**BROWN AND GRAY SANDY SHALE**, BROKEN		
4	NW	45.0	55.0		10.0		45					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **85W-3** DATE **7/20/15** SHEET **3** OF **11**

PROJECT **CARDINAL PLANT** BORING START **8/9/85** BORING FINISH **8/13/85**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							50			**GRAY FINE SANDSTONE**,SHALE SEAMS, BROKEN		
										DARK GRAY SANDY SHALE, BROKEN		
5	NW	55.0	65.0		10.0		55					
							60					
										GRAY FINE SANDSTONE, BROKEN		
6	NW	65.0	75.0		10.0		65					
							70			**GRAY SANDY SHALE**, WITH SMALL CLAY SEAMS		

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **85W-3** DATE **7/20/15** SHEET **4** OF **11**

PROJECT **CARDINAL PLANT** BORING START **8/9/85** BORING FINISH **8/13/85**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							75					
7	NW	75.0	85.0		10.0					**LIGHT GRAY FINE SANDSTONE** BROKEN		
							80			**DARK GRAY CLAYSTONE**		
8	NW	85.0	95.0		10.0		85					
							90					
9	NW	95.0	105.0		10.0		95					

AEP CD SI.GPJ AEP.GDT 7/20/15

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **85W-3** DATE **7/20/15** SHEET **5** OF **11**

PROJECT **CARDINAL PLANT** BORING START **8/9/85** BORING FINISH **8/13/85**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							100					
										GRAY AND RED SILTY SHALE, BROKEN		
10	NW	105.0	115.0		10.0		105					
										GRAY SILTY SHALE		
							110					
11	NW	115.0	125.0		10.0		115			**GRAY LIMESTONE**, HARD		
							120					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **85W-3** DATE **7/20/15** SHEET **6** OF **11**

PROJECT **CARDINAL PLANT** BORING START **8/9/85** BORING FINISH **8/13/85**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
12	NW	125.0	135.0		10.0		125					
							130					
13	NW	135.0	145.0	.	10.0		135					
							140					
14	NW	145.0	155.0		10.0		145					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **85W-3** DATE **7/20/15** SHEET **7** OF **11**

PROJECT **CARDINAL PLANT** BORING START **8/9/85** BORING FINISH **8/13/85**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
										GRAY AND RED SILTY SHALE		
15	NW	155.0	165.0		10.0		155					
							160					
16	NW	165.0	175.0		10.0		165					
							170			**GRAY COARSE SANDSTONE**		171.5 TOP OF SEAL.
17	NW	175.0	185.0		10.0		175					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **85W-3** DATE **7/20/15** SHEET **8** OF **11**

PROJECT **CARDINAL PLANT** BORING START **8/9/85** BORING FINISH **8/13/85**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
												178.0 TOP OF SAND.
							180					
18	NW	185.0	195.0		10.0		185					
							190					
19	NW	195.0	205.0		10.0		195					
							200					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **85W-3** DATE **7/20/15** SHEET **9** OF **11**

PROJECT **CARDINAL PLANT** BORING START **8/9/85** BORING FINISH **8/13/85**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
20	NW	205.0	215.0		10.0		205					
21	NW	215.0	225.0		10.0		210					
22	NW	225.0	235.0		10.0		215					
							220					
							225					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **85W-3** DATE **7/20/15** SHEET **10** OF **11**

PROJECT **CARDINAL PLANT** BORING START **8/9/85** BORING FINISH **8/13/85**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
							230					228.9 CHECK VALVE. 229.5 TOP OF SCREEN. 230.5 BOTTOM OF SCREEN.
23	NW	235.0	245.0		10.0		235					237.0 BOTTOM OF SAND.
							240			**GRAY LIMEY SHALE**, VERY HARD, BROKEN		
24	NW	245.0	255.0		10.0		245					
							250					

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AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

LOG OF BORING

JOB NUMBER _____

COMPANY **AMERICAN ELECTRIC POWER** BORING NO. **85W-3** DATE **7/20/15** SHEET **11** OF **11**

PROJECT **CARDINAL PLANT** BORING START **8/9/85** BORING FINISH **8/13/85**

SAMPLE NUMBER	SAMPLE	SAMPLE DEPTH IN FEET FROM	TO	STANDARD PENETRATION RESISTANCE BLOWS / 6"	TOTAL LENGTH RECOVERY	RQD %	DEPTH IN FEET	GRAPHIC LOG	U S C S	SOIL / ROCK IDENTIFICATION	WELL	DRILLER'S NOTES
25	NW	255.0	265.0		10.0		255					
							260					
		265.0	265.0				265					

AEP CD SI.GPJ AEP.GDT 7/20/15

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Client: AEP-Cardinal
Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-1
Page: 1 of 10

Drilling Start Date:	03/11/2016 14:00	Boring Depth (ft):	198	Well Depth (ft):	132
Drilling End Date:	03/17/2016 15:00	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	988.68	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	991.87	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 832,687.2 E 2,518,763.6	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
0									Overburden: No sample recovered with coring wireline rig.		0
5											5
10											10
15									(15') ROCK: No sample recovered with coring wireline rig.		15
20											20

NOTES:

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Client: AEP-Cardinal
Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-1
Page: 2 of 10

Drilling Start Date:	03/11/2016 14:00	Boring Depth (ft):	198	Well Depth (ft):	132
Drilling End Date:	03/17/2016 15:00	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	988.68	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	991.87	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 832,687.2 E 2,518,763.6	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
20				Run 1			153/ 156	41	(20') CLAYSTONE: moderately strong to weak, greenish gray (5G 6/1), massive to slightly fissile, clay infillings in fractures, moderately to highly decomposed, slightly disintegrated, intensely fractured.		20
25									(23.5') SANDSTONE: strong to very strong, medium light gray (N6), fine grained, slightly micaceous, minor cross bedding to massive, competent, fresh, unfractured, bottom 0.5 ft of sandstone - intensely fractured, moderately decomposed, clay infillings in fractures, few small limestone nodules at bottom of unit.		25
30									(27.4') CLAYSTONE: moderately strong to weak, greenish gray (5G 6/1), massive to slightly fissile, clay infillings in fractures, moderately decomposed, intensely disintegrated, intensely fractured.		30
									(30.6') Silty SHALE: strong, greenish gray (5G 6/1), fissile, slightly decomposed, competent, moderately fractured.		
35				Run 2			110/ 180	20	(33') Silty SHALE: strong, greenish gray (5G 6/1), fissile, slightly decomposed, competent, intensely fractured. (34.8') Very fissile, highly decomposed, moderately disintegrated, weak.		35
									(37') Clayey LIMESTONE: moderately strong to strong, dark greenish gray (5G 4/1), massive to nodular, moderately fractured, microcrystalline, slightly decomposed, moderately disintegrated.		
40											40

NOTES:

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Client: AEP-Cardinal
Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-1
Page: 3 of 10

Drilling Start Date:	03/11/2016 14:00	Boring Depth (ft):	198	Well Depth (ft):	132
Drilling End Date:	03/17/2016 15:00	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	988.68	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	991.87	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 832,687.2 E 2,518,763.6	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
40											40
									(41.4') Sandy CLAYSTONE: weak to very weak, dark greenish gray (5G 4/1), massive, highly decomposed, intensely fractured.		
45											45
				Run 3			65/96	15	(48') CLAYSTONE: strong, dark greenish gray (5G 4/1), massive, fissile for first 0.5 ft, slightly decomposed, slightly disintegrated, intensely fractured, very intensely fractured for frist 0.5 ft.		
50									(51.3') Highly decomposed (4 inch thick).		50
									(52.3') Highly decomposed (3 inch thick).		
									(52.9') Highly decomposed (3 inch thick).		
55				Run 4			70/84	42	(56') CLAYSTONE: moderately strong to strong, variegated colors of dark reddish brown (10YR 3/4), light olive brown (5Y 5/6) and light olive gray (5Y 5/2), massive, slightly decomposed, slightly disintegrated, slightly to moderately fractured, sandy lenses occasionally.		55
									(57') Color changes to dark greenish gray (5G 4/1).		
60											60

NOTES:

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Client: AEP-Cardinal
Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-1
Page: 4 of 10

Drilling Start Date:	03/11/2016 14:00	Boring Depth (ft):	198	Well Depth (ft):	132
Drilling End Date:	03/17/2016 15:00	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	988.68	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	991.87	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 832,687.2 E 2,518,763.6	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
60									(59.8') Changes to moderately strong, slickensides, moderately decomposed, sand grades out, intensely fractured. (61.2') 1 inch limestone band.		60
				Run 5			109/ 120	48	(63') CLAYSTONE: strong to moderately strong, dark greenish gray (5G 4/1), massive, slightly decomposed, slightly disintegrated, moderately fractured, 2 inch limestone band 0.3 ft from top of Run 5. (63-65') Small, brownish gray nodules (5YR 4/1).		
65									(64.2') Carbonaceous SHALE: strong to moderately strong, dark greenish gray (5G 4/1), with limestone nodules, massive, moderately fractured with few intensely fractured zones, slightly decomposed, slightly disintegrated. (65-73') Large, medium light gray (N6) nodules.		65
70				Run 6			176/ 180	57	(73.7') Fissile, weak, intensely fractured, highly decomposed (0.5 ft layer).		70
75									(74.7') CLAYSHALE: strong, dark greenish gray (5GY 4/1), massive, competent, moderately fractured, slightly disintegrated.		75
									(76.6') Carbonaceous SHALE: strong to moderately strong, dark greenish gray (5G 4/1), with less limestone nodules, with calcite veining, massive, moderately fractured with few intensely fractured zones, slightly decomposed, slightly disintegrated. (79') Becomes weak, moderately		
80											80

NOTES:

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Client: AEP-Cardinal
Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-1
Page: 5 of 10

Drilling Start Date:	03/11/2016 14:00	Boring Depth (ft):	198	Well Depth (ft):	132
Drilling End Date:	03/17/2016 15:00	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	988.68	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	991.87	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 832,687.2 E 2,518,763.6	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
80									decomposed, fissile, clay infillings in fractures, intensely fractured.		80
									(79.7') Silty CLAYSHALE: strong, dark greenish gray (5G 4/1), massive, fresh to slightly decomposed, competent, slightly fractured.		
									(82.7') 1 ft vertical fracture.		
85											85
				Run 7			168/ 180	34	(88') Sandy SHALE: strong, medium bluish gray (5B 5/1), fissile, fresh, competent, intensely fractured.		
									(89') Changes to massive.		
90											90
									(92.8') LIMESTONE: strong to very strong, medium bluish gray (5B 5/1), massive, microcrystalline to fine grained, some silty parts, moderately fractured to intensely fractured, fresh, slightly disintegrated. (may be calcareous siltstone with interbedded limestone)		
95									(95.3') MUDSTONE: very weak to weak, greenish gray (5GY 6/1), moderately to highly decomposed, very intensely fractured.		95
									(96.3') Calcareous SILTSTONE: 0.5 vertical fracture 15 ft from bottom of run, massive to nodular. (see previous limestone description)		
100											100

NOTES:

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Client: AEP-Cardinal
Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-1

Drilling Start Date:	03/11/2016 14:00	Boring Depth (ft):	198	Well Depth (ft):	132
Drilling End Date:	03/17/2016 15:00	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	988.68	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	991.87	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 832,687.2 E 2,518,763.6	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
100											100
									(101.4') MUDSTONE: very weak to weak, greenish gray (5GY 6/1), calcareous, moderately to highly decomposed, very intensely fractured.		
				Run 8			119/ 120	55	(103') CLAYSHALE: strong to moderately strong, dark greenish gray (5G 4/1), moderately fractured, slightly to moderately decomposed, slightly to moderately disintegrated, massive, small limestone nodules throughout.		
105											105
110											110
									(112') CLAYSTONE: moderately strong to weak, dark greenish gray (5G 4/1), very intensely fractured, massive, highly decomposed.		
				Run 9			176/ 180	82	(113') CLAYSHALE: limestone veining also present, locally fissile, fresh to slightly decomposed, competent, slightly to moderately fractured.		
115									(114.4') Thin coal veins occasionally appear.		115
120											120

NOTES:

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Client: AEP-Cardinal
Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-1
Page: 7 of 10

Drilling Start Date:	03/11/2016 14:00	Boring Depth (ft):	198	Well Depth (ft):	132
Drilling End Date:	03/17/2016 15:00	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	988.68	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	991.87	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 832,687.2 E 2,518,763.6	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
120									(120.9') Coal-bearing SHALE: very strong, grayish black (N2) to black (N1), massive, micaceous, fresh, competent, moderately fractured.		120
									(122.5') SANDSTONE: strong, medium gray (N5), minor cross bedding, micaceous, competent, fresh, medium grained, slightly fractured to unfractured. [MORGANTOWN]		
125											125
				Run 10			180/ 180	96	(122.5') SANDSTONE: strong, medium gray (N5), few cross beds, micaceous, mostly massive, competent, fresh, medium grained, slightly fractured to unfractured. [MORGANTOWN]		
130											130
135											135
140											140

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Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	988.68	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	991.87	Seal Material(s):	Bentonite Pellets
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DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
140									(142.5') Intensely fractured.		140
				Run 11			180/ 180	91	(143') SANDSTONE: strong, medium gray (N5), few cross beds, micaceous, massive, competent, fresh, fine to medium grained, slightly fractured to unfractured. [MORGANTOWN]		
145									(144.5') Coal veins increase in appearance, moderately to intensely fractured.		145
									(146.5') Coal veins disappear, slightly fractured.		
150									(151.5') Coal veins appear again, slightly to moderately fractured for rest of Run 11.		150
									(153.4') Changes to light gray (N7).		
155											155
				Run 12			176/ 180	88	(158') SANDSTONE: strong, medium gray (N5), few cross beds, micaceous, massive, competent, fresh, fine to medium grained, slightly to moderately fractured, coal veining		
160											160

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BORING LOG
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Driller:	Bill Womack	Top of Casing Elev. (ft):	991.87	Seal Material(s):	Bentonite Pellets
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DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
160									for top 2 ft of Run 12. [MORGANTOWN] (160.3') Becomes unfractured.		160
165									(164.1') Sandy silty SHALE: moderately strong, medium gray (N5), fresh, competent, laminated, minor coal inclusions, micaceous, massive.		165
170									(166.5') Conglomerate SANDSTONE: very light gray (N8) and medium gray (N5) with medium yellowish brown (10YR 5/4) conglomerate, medium gray (N5) clay inclusions and coal veining, fine grained, massive, slightly decomposed to fresh, competent, intensely fractured. [MORGANTOWN] (168') SANDSTONE: strong, medium dark gray (N5), massive, occasional coal veining, fresh, competent, micaceous, moderately fractured, fine to medium grained. [MORGANTOWN]		170
175				Run 13			180/ 180	98	(173') SANDSTONE: strong, medium dark gray (N5), massive, occasional coal veining, fresh, competent, micaceous, slightly to moderately fractured, medium grained, 1 inch coal bed 2 ft from top of run. [MORGANTOWN] (175.5-181.5') Veining disappears. (176.5') Changes to fine grained for 7 ft.		175
180											180

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Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	988.68	Screen Material:	Pre-packed Sch 40 PVC
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DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
180									(181.5-188') Extensive coal veining.		180
185									(184') Conglomerate SANDSTONE: strong, medium light gray (N6), calcareous, medium grained, coal veins and inclusions, conglomerate (up to 2" long), slightly decomposed, competent, moderately fractured, massive. [MORGANTOWN]		185
									(186.6') Silty SHALE: strong, greenish gray (5GY 6/1), fresh, competent, massive, moderately to intensely fractured.		
				Run 14			120/ 120	90	(187.8') Limestone nodules.		
190									(188') Silty SHALE: strong, greenish gray (5GY 6/1), fresh, competent, massive, slightly fractured, no limestone nodules.		190
195											195
200									End of borehole at 198 ft bgs. Well installed on 04/13/2016, centralizer at 65 ft bgs.		200

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Client: AEP-Cardinal
Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-2
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Drilling Start Date:	03/22/2016 08:30	Boring Depth (ft):	209	Well Depth (ft):	140
Drilling End Date:	03/23/2016 09:45	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	987.62	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	990.81	Seal Material(s):	Bentonite Pellets
Logged By:	Chad Gregory	Location (X,Y):	N 832,174.6 E 2,519,357.6	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
0									Overburden: No Recovery with core rig.		0
5											5
10									(7.5') ROCK: No Recovery - drillers use roller bit down to 15 ft.		10
15				Run 1			27/36	0	(15') SILTSTONE: strong, light gray to medium dark gray (N4 to N7), moderately decomposed, intensely fractured, few yellowish gray (5Y 8/1) calcareous veins, few fine sandy lenses with minor cross bedding.		15
20				Run 2			89/ 108	17	(18') CLAYSTONE: strong, medium gray to grayish black (N5 to N2), yellowish gray limestone nodules, moderately decomposed, intensely fractured.		20

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Drilling Start Date:	03/22/2016 08:30	Boring Depth (ft):	209	Well Depth (ft):	140
Drilling End Date:	03/23/2016 09:45	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	987.62	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	990.81	Seal Material(s):	Bentonite Pellets
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DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
20									(21-24') Changing to medium gray, crumbled, soft, not calcareous.		20
25									(24-26') Changing to moderately strong, silty, white, calcareous veins.		25
				Run 3			143/144	38	(26') SANDSTONE: moderately strong, very light to light gray (N8/N7), very fine grained, silty, massive, intensely fractured, moderately decomposed.		
									(27') SANDSTONE: moderately strong, very light to light gray (N8/N7), very fine grained, silty, massive, intensely fractured, moderately decomposed, with yellowish gray (5Y 8/1) sand inclusions.		
30									(28.5') Sandy CLAYSHALE: moderately strong, medium gray to grayish black, intensely fractured, slightly decomposed.		30
									(30') SANDSTONE: moderately strong, very light to light gray (N8/N7), very fine grained, silty, massive, intensely fractured, moderately decomposed, clay infillings in fractures.		
									(30.8') Silty CLAYSHALE: moderately strong, medium gray to grayish black, intensely fractured, moderately decomposed, with yellowish gray sandy inclusions.		
35									(37.5') Fracture with ~1" of soft claystone infilling.		35
				Run 4			74/120	51	(39') LIMESTONE: strong, medium light gray (N6) to dark greenish gray (5GY 4/1),		
40											40

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Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	987.62	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	990.81	Seal Material(s):	Bentonite Pellets
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DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
40									massive, slightly fractured.		40
									(39.5-40') Intensely fractured, moderately decomposed.		
									(42.5-44') Intensely fractured, moderately decomposed.		
45											45
				Run 5			86/ 108	45	(48.8') CLAYSTONE: dark greenish gray, calcareous, very soft, easily crumbled.		
50									(49') LIMESTONE: strong, medium dark gray (N4), nodular, massive, slightly fractured.		50
									(52') CLAYSHALE: moderately strong, dark gray (N3), moderately fractured, limestone nodules.		
55									(55') Changing to intensely fractured/crumbled.		55
				Run 6			84/84	64	(58') CLAYSTONE: strong, dark gray, yellowish gray calcareous veins.		
60									(58.5') Sandy SILTSTONE: moderately strong, medium dark gray, sandy zones light		60

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Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	987.62	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	990.81	Seal Material(s):	Bentonite Pellets
Logged By:	Chad Gregory	Location (X,Y):	N 832,174.6 E 2,519,357.6	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
60									gray, moderately fractured, yellowish gray sandy inclusions/veins.		60
									(63') Sandy CLAYSHALE: moderately strong to weak, dark gray (N3), slightly pyritic at 63 ft, intensely fractured.		
65				Run 7			86/96	21			65
									(68') LIMESTONE: strong, dark gray, large light gray nodules (~1" diameter), intensely fractured, moderately decomposed, some clayey infillings in fractures.		
70				Run 8			64/72	36			70
75									(75') Silty CLAYSTONE: strong, medium dark gray (N4), intensely fractured, pyritic, limestone nodules, moderately decomposed.		75
				Run 9			162/ 168	77			
80											80

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DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
80									(82-84.5') White to yellowish gray calcareous veins.		80
85									(84.5') Shaly SILTSTONE: moderately strong, medium bluish gray (5B 5/1), slightly fractured, few calcareous veins - lenses, fresh.		85
90				Run 10			178/ 180	75	(93') Changing to strong.		90
95									(95') Changing to moderately to intensely fractured, clay infillings, moderately decomposed 97-98 ft.		95
100									(98') Shaly LIMESTONE: strong, massive, microcrystalline, nodular, medium bluish gray (5B 5/1), moderately fractured, slightly decomposed.		100

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100									(101.5') CLAYSTONE: dark greenish gray (5G 4/1), weak, soft.		100
									(102') Shaly LIMESTONE: strong, massive, microcrystalline, nodular, medium bluish gray (5B 5/1), moderately fractured, slightly decomposed.		
105											105
				Run 11			118/ 120	83			
110											110
									(113') CLAYSHALE: strong, medium dark gray (N4), calcareous, limestone nodules, moderately to intensely fractured, slightly pyritic, less calcareous towards end of run.		
115									(116.5') Changing to grayish black (N2), intensely fractured/crumbled.		115
				Run 12			165/ 180	93	(118') Changing to medium bluish gray (5B 5/1), yellowish gray to white calcareous veins.		
120											120

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120											120
									(124') Changing to less calcareous.		
125											125
									(128.8') Coal-bearing SHALE: strong, grayish black (N2), coal lenses black (N1), slightly fractured, slightly decomposed.		
130									(130.8') SANDSTONE: strong, light gray to medium dark gray, slightly fractured, fine to medium grained, thin to medium bedded, micaceous, few black carbonaceous seams. [MORGANTOWN]		130
				Run 13			192/ 192	100			
135											135
140											140

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140											140
145											145
150				Run 14			180/ 180	98			150
155									(157-159') Mud inclusions.		155
160											160

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DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
160									(161') Changing to very light gray (N8).		160
				Run 15			180/ 180	96			
165											165
170									(170') Alternating between medium gray (N5), massive, and light gray with thinly interbedded black seams.		170
175											175
				Run 16			179/ 180	98			
180									(179.5') Some interbedded conglomerate, few		180

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Drilling Start Date:	03/22/2016 08:30	Boring Depth (ft):	209	Well Depth (ft):	140
Drilling End Date:	03/23/2016 09:45	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	987.62	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	990.81	Seal Material(s):	Bentonite Pellets
Logged By:	Chad Gregory	Location (X,Y):	N 832,174.6 E 2,519,357.6	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
180									interbedded siltstone seams, conglomerate dusky brown (5YR 2/2), grayish orange-pink (10R 8/2) to gray. Sandstone primarily massive with some black, very thin coal seams/veins.		180
185											185
190									(188') Conglomerate SANDSTONE: grading into medium grained sandstone and very conglomeratic, including coal seams and pieces, few calcareous nodules. (191') Fracture with coal and pyrite.		190
195				Run 17			178/ 180	93	(193.5') Changing to dark greenish gray (5G 4/1). (196.3') Silty SHALE: strong, medium dark gray (N4), slightly fractured, few thin coal seams.		195
200											200

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Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-2

Drilling Start Date:	03/22/2016 08:30	Boring Depth (ft):	209	Well Depth (ft):	140
Drilling End Date:	03/23/2016 09:45	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	987.62	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	990.81	Seal Material(s):	Bentonite Pellets
Logged By:	Chad Gregory	Location (X,Y):	N 832,174.6 E 2,519,357.6	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
200											200
205									(208') Changing to intensely fractured, claystone infillings. (208.8') CLAYSTONE: moderately strong to weak, dark gray (N3), crumbled. End of borehole at 209 ft bgs. Well installed on 04/13/2016, centralizer at 70 ft bgs.		205
210											210
215											215

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Client: AEP-Cardinal
Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-3
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Drilling Start Date:	03/10/2016 10:25	Boring Depth (ft):	203.5	Well Depth (ft):	146
Drilling End Date:	03/11/2016 12:20	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	997.42	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,000.33	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 830,875.6 E 2,518,721.9	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
0									Overburden: No sample recovered with coring wireline rig.		0
5											5
10									(10.5') ROCK: No sample recovered with coring wireline rig.		10
15				Run 1			49/60	65	(15') SILTSTONE: moderately strong, medium gray (N5), locally fissile, slightly decomposed, moderately fractured. (15.8') SANDSTONE: strong to very strong, medium gray (N4), minor cross bedding, micaceous, medium grained, fresh, competent, slightly fractured. (17.7') CLAYSTONE to CLAYSHALE: weak, medium gray (N5), slightly decomposed, moderately fractured, bottom of unit may be coal-bearing.		15
20											20

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Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-3
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Drilling Start Date:	03/10/2016 10:25	Boring Depth (ft):	203.5	Well Depth (ft):	146
Drilling End Date:	03/11/2016 12:20	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	997.42	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,000.33	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 830,875.6 E 2,518,721.9	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
20				Run 2			106/ 168	32	(20.5') MUDSTONE: very weak, medium light gray (N6), highly decomposed.		20
									(21') SANDSTONE: moderately strong, medium gray (N5), locally silty, massive, unfractured, competent, fresh, fine grained, limestone nodules.		
25									(24.3') SILTSTONE: moderately strong, greenish gray (5GY 6/1), massive, fresh to slightly decomposed, competent, moderately fractured, 0.3 ft into unit - 0.8 ft vertical fracture.		25
									(26.7') CLAYSTONE: strong, very dusky purple (5RP 2/2) and dark greenish gray (5G 4/1), slightly decomposed, slightly disintegrated, intensely fractured, slickensides.		
30									(28.4') SILTSTONE: moderately strong, greenish gray (5GY 6/1), massive, fresh to slightly decomposed, competent, moderately fractured.		30
35				Run 3			176/ 180	80	(34') CLAYSTONE: moderately strong, medium gray (N4), sandy lenses, massive, minor limestone lenses and veining, fresh, competent, slightly fractured.		35
40											40

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Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-3
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Drilling Start Date:	03/10/2016 10:25	Boring Depth (ft):	203.5	Well Depth (ft):	146
Drilling End Date:	03/11/2016 12:20	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	997.42	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,000.33	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 830,875.6 E 2,518,721.9	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
40											40
45									(45.7') Becomes moderately to intensely fractured, slightly fissile. (46') Highly decomposed MUDSTONE (0.5 ft thick). (47.2') Highly decomposed MUDSTONE for 0.5 ft, very weak, medium dark gray.		45
50				Run 4			162/180	65	(49') LIMESTONE: very strong to strong, medium light gray (N6), microcrystalline, slightly fractured, fresh to slightly decomposed, competent.		50
55									(55.5') Carbonaceous SHALE: strong, dark greenish gray (5G 4/1), calcareous veins that are very light gray (N8), slightly decomposed, competent to slightly disintegrated, slightly to moderately fractured. (56.3') Changes to moderately to highly decomposed for 0.5 ft.		55
60											60

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BORING LOG
Boring/Well No. M-GS-3
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Drilling Start Date:	03/10/2016 10:25	Boring Depth (ft):	203.5	Well Depth (ft):	146
Drilling End Date:	03/11/2016 12:20	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	997.42	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,000.33	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 830,875.6 E 2,518,721.9	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
60											60
									(61.2') LIMESTONE: strong, medium light gray (N6), microcrystalline, intensely fractured, moderately decomposed, competent, clay infillings in fractures.		
				Run 5			58/ 114	4	(64') LIMESTONE: strong, medium light gray (N6), microcrystalline, massive to nodular, intensely fractured, moderately decomposed, competent, clay infillings in fractures.		
65									(65') CLAYSTONE to MUDSTONE: moderately strong to weak, grayish red (5R 4/2) and dusky yellow to dark greenish gray (5G 4/1), moderately to intensely decomposed, moderately to intensely disintegrated, intensely to very intensely fractured, slickensides.		65
70											70
				Run 6			78/ 120	15	(73.5') SILTSTONE: moderately strong to strong, greenish gray (5GY 6/1), calcareous nodules, massive, intensely fractured, 80° vertical fracture (0.7 ft long) starting 0.3 ft into unit, slightly decomposed.		
75									(74.5') CLAYSTONE: dark greenish gray (5G 4/1), grades to grayish red purple (5RP 4/2) 1.7 ft into unit, back to (5G 4/1) 4.5 ft into unit, intensely fractured, slightly to moderately decomposed, slickensides.		75
									(77.6') Becomes highly decomposed, very intensely fractured.		
80											80

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Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-3

Drilling Start Date:	03/10/2016 10:25	Boring Depth (ft):	203.5	Well Depth (ft):	146
Drilling End Date:	03/11/2016 12:20	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	997.42	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,000.33	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 830,875.6 E 2,518,721.9	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
80											80
				Run 7			29/60	25	(83.5') Carbonaceous SHALE: strong, dark greenish gray (5G 4/1), calcareous nodules, slightly decomposed, competent to slightly disintegrated, moderately to intensely fractured, 0.5 ft vertical fracture at top of unit.		
85									(85.5') MUDSTONE: dark greenish gray (5G 4/1), highly decomposed.		85
				Run 8			180/ 180	96	(88.5') SILTSTONE: strong, greenish gray (5G 6/1), massive, slightly decomposed, competent, slightly to moderately fractured.		
90											90
									(91.5') Silty SANDSTONE: strong, greenish gray (5G 6/1), massive, fresh, competent, unfractured to slightly fractured, fine grained.		
95											95
100											100

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Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-3
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Drilling Start Date:	03/10/2016 10:25	Boring Depth (ft):	203.5	Well Depth (ft):	146
Drilling End Date:	03/11/2016 12:20	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	997.42	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,000.33	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 830,875.6 E 2,518,721.9	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS
100									(100.5') Sandy SHALE to SILTSTONE: strong, greenish gray (5G 6/1), massive, fresh, competent, unfractured to slightly fractured, fine grained, less sand content.	
				Run 9			91/ 120	67	(103.5') Sandy SHALE: strong, greenish gray (5G 6/1), massive, fresh, competent, unfractured to slightly fractured, fine grained, less sand content, 2-3 0.5 ft zones of fissile, intensely fractured, moderately decomposed SHALE in unit.	3 units in Run 9 (sandy shale, limestone, reddish shale)
105										
									(108.8') LIMESTONE: strong, light gray (N7), microcrystalline to fine grained, massive, competent, fresh, unfractured to slightly fractured, 1 ft vertical fracture at top of unit.	
110									(111.4') SHALE: grayish red (10R 4/2), dark greenish gray and dusky yellow (5Y 6/4), massive, variegated in color, limestone nodules, unfractured, fresh, competent.	
				Run 10			178/ 180	84	(113.5') SHALE: grayish red (10R 4/2), dark greenish gray and dusky yellow (5Y 6/4), massive, variegated in color, limestone nodules, unfractured, fresh, competent, 1.8 ft from top of Run 10, limestone nodules grade out.	
115										
									(119') Intensely fractured, moderately decomposed.	
120										

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Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-3
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Drilling Start Date:	03/10/2016 10:25	Boring Depth (ft):	203.5	Well Depth (ft):	146
Drilling End Date:	03/11/2016 12:20	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	997.42	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,000.33	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 830,875.6 E 2,518,721.9	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
120									(120') Silty SHALE to CLAYSHALE: strong, medium gray (N5), fresh, competent, unfractured, occasional areas with some fine grained sand, massive, limestone veins 4.7 ft from top of unit for ~0.5 ft.		120
125											125
130				Run 11			180/ 180	82	(128.5') Silty SHALE to CLAYSHALE: strong, medium gray (N5), fresh, competent, unfractured, occasional areas with some fine grained sand, massive, intensely fractured for top 1.7 ft of run.		130
135									(134.5') COAL: moderately strong to weak, black (N1), very intensely fractured, slightly decomposed, slightly disintegrated. (135') Coal-bearing SHALE: strong, black (N1), micaceous, massive, slightly to moderately fractured, fresh, competent.		135
140									(137.9') SANDSTONE: strong, medium dark gray (N4), medium grained, very micaceous, minor cross bedding, fresh, competent, unfractured. [MORGANTOWN]		140

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BORING LOG
Boring/Well No. M-GS-3
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Drilling Start Date:	03/10/2016 10:25	Boring Depth (ft):	203.5	Well Depth (ft):	146
Drilling End Date:	03/11/2016 12:20	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	997.42	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,000.33	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 830,875.6 E 2,518,721.9	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
140									(138.5') 1.3 ft of moderate yellowish brown (10YR 5/4) color. (141.2') Grades to slightly micaceous.		140
				Run 12			180/ 180	96	(143.5') SANDSTONE: strong, medium dark gray (N4), medium grained, very to slightly micaceous, minor cross bedding, fresh, competent, slightly fractured to unfractured. [MORGANTOWN]		
145											145
150											150
155									(157.7') Thin (1-2 cm) coal vein/seam.		155
				Run 13			180/ 180	87	(158.5') SANDSTONE: strong, medium dark gray (N4), medium grained, very to slightly micaceous, increased cross bedding, fresh,		
160											160

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BORING LOG
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Drilling Start Date:	03/10/2016 10:25	Boring Depth (ft):	203.5	Well Depth (ft):	146
Drilling End Date:	03/11/2016 12:20	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	997.42	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,000.33	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 830,875.6 E 2,518,721.9	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
160									competent, slightly fractured, coal veins/seams (1-2 cm). [MORGANTOWN]		160
165											165
170									(173') 0.2 ft layer of COAL.		170
175				Run 14			179/ 180	97	(173.5') SANDSTONE: strong, medium gray (N5), cross bedding, micaceous, fine to medium grained, fresh to slightly decomposed, slightly disintegrated, slightly fractured, coal veins (up to 1" thick), conglomerate imbedded (up to 1" thick), limestone nodules. [MORGANTOWN] (174.5') Limestone nodules disappear. (176.3') Becomes massive, coarse grained, changes to light olive gray (5Y 5/2), no coal or conglomerate, competent, fresh, unfractured.		175
180											180

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Drilling Start Date:	03/10/2016 10:25	Boring Depth (ft):	203.5	Well Depth (ft):	146
Drilling End Date:	03/11/2016 12:20	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	997.42	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,000.33	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 830,875.6 E 2,518,721.9	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
180									(180.3') Becomes fine grained, medium light gray (N6).		180
									(183.1') Becomes very micaceous, minor cross bedding, coal veins/beds (up to 3 inch thick), slightly to moderately fractured, slightly decomposed.		
185									(186.4') 0.3 ft of imbedded conglomerate.		185
				Run 15			180/ 180	73	(188.5') SANDSTONE: strong, medium gray (N5), cross bedding, micaceous, fine to medium grained, fresh to slightly decomposed, slightly disintegrated, slightly fractured, interbedded coal veins, imbedded conglomerate, quickly grading to silty. [MORGANTOWN]		
190									(189.2') CLAYSTONE: moderately strong, dark bluish greenish gray, intensely fractured, moderately decomposed, moderately disintegrated, clay infillings in fractures, massive.		190
									(192.2') LIMESTONE: moderately strong to strong, dark greenish gray (5G 4/1), fresh, competent, slightly fractured, microcrystalline, massive.		
195									(196.5') CLAYSHALE: strong, greenish gray (5G 6/1), massive, slickensides, slightly decomposed, competent, slightly fractured, with carbonaceous prominent nodules and veins.		195
200											200

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Drilling Start Date:	03/10/2016 10:25	Boring Depth (ft):	203.5	Well Depth (ft):	146
Drilling End Date:	03/11/2016 12:20	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	997.42	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,000.33	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 830,875.6 E 2,518,721.9	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
200											200
									End of borehole at 203.5 ft bgs. Well installed on 04/12/2016, centralizer at 70 ft bgs.		
205											205
210											210

NOTES:

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Client: AEP-Cardinal
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Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
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Drilling Start Date:	03/13/2016 07:45	Boring Depth (ft):	228	Well Depth (ft):	202
Drilling End Date:	03/14/2016 12:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,025.65	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,028.73	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 834,146.7 E 2,517,597.8	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
0									Overburden: No sample recovered with wireline coring rig.		0
5											5
10											10
15											15
20											20

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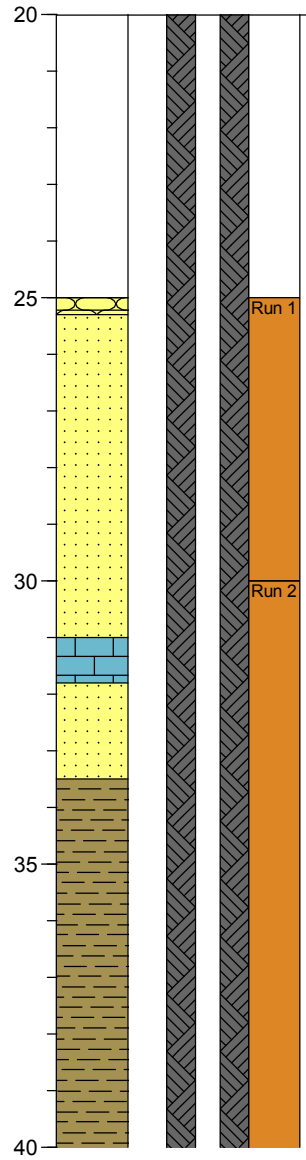
Drilling Start Date:	03/13/2016 07:45	Boring Depth (ft):	228	Well Depth (ft):	202
Drilling End Date:	03/14/2016 12:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,025.65	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,028.73	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 834,146.7 E 2,517,597.8	Filter Pack:	#5 Medium Coarse Sand



DEPTH (ft)	Sample Type	Date & Time	Blow Counts	Recovery (in)	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS
20							
25	Run 1			18/60	0	(25') CHERT: very strong, grayish black (N2), moderately red (5R 5/4) secondary staining, slightly to moderately disintegrated, competent, intensely fractured, massive, heavily pitted.	Bill thinks rods were not on rock when started coring. Rock may start ~26-28 ft.
						(25.3') SANDSTONE: very strong, medium light gray (N6), fine grained, massive to slightly laminated, micaceous, intensely to very intensely fractured, also light olive gray (5Y 5/2) with light brown (5YR 5/6) significant secondary staining, slightly decomposed, slightly disintegrated.	
30	Run 2			62/ 138	18		
						(31') LIMESTONE: very strong, brownish black (5YR 2/1), microcrystalline, fresh, competent, unfractured.	
						(31.8') SANDSTONE: strong, medium gray (N5), fine grained, massive with slight laminations, moderately fractured, slightly decomposed, slightly disintegrated, clay infillings in fractures.	
35						(33.5') MUDSTONE: very weak, light gray (N7), planar structure, intensely fractured, highly decomposed, highly disintegrated.	
40							

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Drilling Start Date:	03/13/2016 07:45	Boring Depth (ft):	228	Well Depth (ft):	202
Drilling End Date:	03/14/2016 12:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,025.65	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,028.73	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 834,146.7 E 2,517,597.8	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
40				Run 3			14/18	0	(41.5') SANDSTONE: very strong, medium light gray (N6), fine grained, massive to slightly laminated, micaceous, intensely to very intensely fractured, also light olive gray (5Y 5/2) with light brown (5YR 5/6) significant secondary staining, slightly decomposed, slightly disintegrated.		40
				Run 4			52/ 108	0	(41.9') MUDSTONE and CHERT: very weak, light gray (N7) and light gray (N8), planar structure, very intensely fractured, highly decomposed, highly disintegrated.		
45									(43') SANDSTONE: very strong, significant olive gray (5Y 3/2) and light brown (5YR 5/6) secondary staining, massive, fine grained, well-cemented, very intensely fractured, slightly decomposed, moderately disintegrated, micaceous, pitted.		45
									(45.7') MUDSTONE: very weak, light gray (N7), planar structure, very intensely fractured, highly decomposed, highly disintegrated.		
50				Run 5			75/ 132	17	(52') SANDSTONE: very strong, medium light gray (N6), fine grained, massive to slightly laminated, micaceous, intensely fractured, also light olive gray (5Y 5/2) with light brown (5YR 5/6) significant secondary staining, slightly decomposed, slightly disintegrated.		50
55									(52.5') CLAYSTONE: very weak, greenish gray (5G 6/1), massive, imbedded conglomerate, unfractured, moderately decomposed, moderately disintegrated.		55
									(53.1') SANDSTONE: very strong, medium light gray (N6), fine grained, massive to slightly laminated, micaceous, intensely fractured, also light olive gray (5Y 5/2) with light brown (5YR 5/6) significant secondary staining, slightly decomposed, slightly disintegrated.		
60									(53.8') CLAYSTONE: very weak, greenish		60

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Drilling Start Date:	03/13/2016 07:45	Boring Depth (ft):	228	Well Depth (ft):	202
Drilling End Date:	03/14/2016 12:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,025.65	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,028.73	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 834,146.7 E 2,517,597.8	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
60									gray (5G 6/1), massive, imbedded conglomerate, unfractured, moderately decomposed, moderately disintegrated, becomes fissile in bottom 0.5 ft.		60
				Run 6			49/60	0	(56.7') CLAYSTONE: strong, light gray (N7), massive, significant secondary staining of medium yellow (5Y 7/6) and dark gray (N3), moderately to highly decomposed, moderately to highly disintegrated, intensely fractured, 4 inch layer of sandstone.		
65									(63') CLAYSTONE: strong, light gray (N7), massive, minimal secondary staining of medium yellow (5Y 7/6) and dark gray (N3), moderately to highly decomposed, moderately to highly disintegrated, intensely fractured, 4 inch layer of sandstone.		65
									(64') Becomes fissile, weak.		
				Run 7			51/60	19	(64.5') MUDSTONE: very weak, light gray (N7), planar structure, very intensely fractured, highly decomposed, highly disintegrated.		
70									(65.7') LIMESTONE.		70
									(66.1') MUDSTONE: very weak, light gray (N7), planar structure, very intensely fractured, highly decomposed, highly disintegrated.		
									(68') LIMESTONE: strong, olive gray (5Y 4/1), massive, microcrystalline, intensely fractured, slightly decomposed, slightly disintegrated.		
				Run 8			28/60	0	(69.5') 1 ft vertical fracture.		
75									(73') LIMESTONE: strong, olive gray (5Y 4/1), massive, microcrystalline, intensely fractured, slightly decomposed, slightly disintegrated.		75
									(73.5') CLAYSHALE: very strong, dark greenish gray (5G 4/1), massive, slickensides, intensely fractured, slightly decomposed, slightly disintegrated, calcareous nodules.		
									(74.4') CLAYSTONE: moderately strong to weak, dark greenish gray (5G 4/1) to greenish gray (5G 6/1), massive to planar structure, highly decomposed, intensely fractured.		
				Run 9			180/ 180	48	(78') CLAYSHALE: very strong to strong, dark greenish gray (5G 4/1), massive, fresh to slightly decomposed, competent to slightly		
80											80

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Drilling Start Date:	03/13/2016 07:45	Boring Depth (ft):	228	Well Depth (ft):	202
Drilling End Date:	03/14/2016 12:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,025.65	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,028.73	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 834,146.7 E 2,517,597.8	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
80									disintegrated, moderately fractured, minor calcareous veins/nodules.		80
									(79.5') 0.8 ft vertical fracture.		
									(80.6') Grade medium dark gray (N4), fissile.		
									(81.4') Changes to massive, dark greenish gray (5G 4/1) with brownish gray secondary staining (5YR 4/1), very intensely fractured.		
									(82.9') Changes to moderately fractured, medium bluish gray (5B 5/1) with large limestone nodules.		
85									(84') 2.5 ft vertical fracture, significant staining in fracture.		85
									(86.5') Changes to slightly fractured, minor limestone nodules/veins.		
90									(91') Changes to intensely fractured, moderately decomposed.		90
				Run 10			112/ 120	49			
95									(96.1') Clayey LIMESTONE: very strong to strong, greenish black (5GY 2/1), massive, microcrystalline, alternating 2-3 inches of mudstone, moderately to intensely fractured, fresh, competent.		95
									(98.8') CLAYSHALE: strong, dark greenish gray (5G 4/1), massive, intensely fractured,		
100											100

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Drilling Start Date:	03/13/2016 07:45	Boring Depth (ft):	228	Well Depth (ft):	202
Drilling End Date:	03/14/2016 12:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,025.65	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,028.73	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 834,146.7 E 2,517,597.8	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
100									slightly decomposed, slightly disintegrated, small limestone nodules.		100
				Run 11			96/ 120	20	(103') CLAYSHALE: strong, dark greenish gray (5G 4/1), massive, very intensely fractured, slightly decomposed, slightly disintegrated, small limestone nodules.		
105									(104.6') Grades to dark gray (N3).		105
									(105.4') LIMESTONE: strong, medium gray (N5), massive, microcrystalline, slightly fractured, competent, fresh.		
									(106.4') CLAYSHALE: strong, dark greenish gray (5G 4/1), massive, moderately fractured, slightly decomposed, slightly disintegrated, small limestone nodules.		
110									(109.4') Becomes weak, very intensely fractured, highly decomposed.		110
				Run 12			180/ 180	79	(113') CLAYSHALE: strong, grayish red (5R 4/2), massive, fresh, competent, moderately fractured, slickensides, light olive gray (5Y 5/2) limestone veins.		
115									(114.2') Changes to variegated colors of grayish red (5R 4/2) and medium dark gray (N4).		115
									(116') Changes to dark greenish gray (5G 4/1), limestone veins grade out, laminated, slightly fractured.		
120											120

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Drilling Start Date:	03/13/2016 07:45	Boring Depth (ft):	228	Well Depth (ft):	202
Drilling End Date:	03/14/2016 12:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,025.65	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,028.73	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 834,146.7 E 2,517,597.8	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
120											120
									(123.9') CLAYSTONE: weak to very weak, massive, planar structure, intensely fractured, dark greenish gray (5G 4/1), some limestone nodules, highly decomposed.		
125											125
				Run 13			176/ 180	77	(126.9') LIMESTONE: very strong, brownish black (5YR 2/1), massive, microcrystalline, moderately fractured, fresh, competent.		
130											130
									(130.5') CLAYSHALE: moderately strong to strong, dark greenish gray (5G 6/1), limestone nodules, massive, slightly to moderately fractured, fresh to slightly decomposed, competent.		
135									(134.5-136') Changes to grayish red (5R 4/2).		135
									(136-137') Changes to dark greenish gray (5G 4/1).		
									(137-138') Changes to grayish red (5R 4/2).		
									(138-140') Changes to dark greenish gray (5G 4/1).		
140											140

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Drilling Start Date:	03/13/2016 07:45	Boring Depth (ft):	228	Well Depth (ft):	202
Drilling End Date:	03/14/2016 12:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,025.65	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,028.73	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 834,146.7 E 2,517,597.8	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
140									(140-143') Changes to pale brown (5YR 5/2), limestone veins also appear.		140
				Run 14			131/ 132	76	(143') CLAYSHALE: moderately strong to strong, dark greenish gray (5G 4/1), limestone nodules/veins, massive, intensely fractured, moderately decomposed, competent.		
145									(146.8') Changes to medium dark gray (N4), no limestone nodules or veins, slightly fractured, fresh.		145
									(149.2') Sandy SHALE: strong, medium gray (N5) and grayish black (N2), massive for top 1.5 ft of unit, laminated for bottom 3.2 ft of unit, fine grained sandy areas, sand content increases towards bottom, well cemented, micaceous, slightly fractured, fresh, competent.	May be equivalent to coal-bearing shale at M-GS-1 and M-GS-3	
150											150
				Run 15			164/ 166	90	(154') Sandy SHALE: strong, grayish black and light gray (N6), massive shale to alternating laminations of shale and sandstone, fine grained sandy areas, sand content increases towards bottom, well cemented, micaceous, slightly fractured, fresh, competent.		
155											155
160											160

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Drilling Start Date:	03/13/2016 07:45	Boring Depth (ft):	228	Well Depth (ft):	202
Drilling End Date:	03/14/2016 12:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,025.65	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,028.73	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 834,146.7 E 2,517,597.8	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
160											160
									(161') SANDSTONE: strong, medium light gray (N6), some grayish black laminations (shale or coal), micaceous, slightly fractured, fine grained, fresh, competent.		
									(162.7') Sandy SHALE to Shaly SANDSTONE: strong, grayish black and light gray (N6), massive shale to alternating laminations of shale and sandstone, fine grained sandy areas, sand content increases towards bottom, well cemented, micaceous, slightly fractured, fresh, competent, 2 inch layer of previous sandstone 2.8 ft from top of unit.		
165									(165.2') 0.3 ft vertical fracture.		165
				Run 16			176/ 180	97	(168') Sandy SHALE to Shaly SANDSTONE: strong, grayish black and light gray (N6), massive shale to alternating laminations of shale and sandstone, fine grained sandy areas, sand content increases towards bottom, well cemented, micaceous, slightly fractured, fresh, competent, 2 inch layer of previous sandstone 2.8 ft from top of unit, becomes fissile at bottom.		
170									(171.8') SANDSTONE: strong, medium gray (N5), fine grained, micaceous, massive, weak coal veins, slightly fractured, fresh, competent, mud inclusions.		170
175											175
180											180

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Drilling Start Date:	03/13/2016 07:45	Boring Depth (ft):	228	Well Depth (ft):	202
Drilling End Date:	03/14/2016 12:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,025.65	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,028.73	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 834,146.7 E 2,517,597.8	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
180											180
				Run 17			180/ 180	93	(183') SANDSTONE: strong, medium gray (N5), fine grained, micaceous, massive, weak coal veins, slightly fractured, fresh, competent.		
185									(187.4') Becomes medium grained.		185
									(188.8') Becomes moderately fractured.		
190									(192.5') Coal veins increase for rest of run.		190
195									(196.3') Mud inclusions begin to appear.		195
				Run 18			179/ 180	89	(198.3') Conglomerate SANDSTONE: strong, very light gray (N6), massive, micaceous, abundant imbedded conglomerates (up to 1.5 inch thick), mud inclusions, slightly fractured,		
200											200

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Drilling Start Date:	03/13/2016 07:45	Boring Depth (ft):	228	Well Depth (ft):	202
Drilling End Date:	03/14/2016 12:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,025.65	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,028.73	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 834,146.7 E 2,517,597.8	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
200									fresh, competent, fine grained, conglomerates are brownish gray (5YR 4/1) and very pale orange (10YR 8/2).		200
									(200.8') SANDSTONE: strong, medium gray (N5) to medium dark gray (N4), massive to minor cross bedding, occasional zones of imbedded conglomerate, fine grained, slightly fractured, fresh, competent, minor coal veins.		
205											205
									(208.3') COAL: moderately strong, black (N1), fissile to cubic structure, sandstone inclusions (up to 1.5 inch thick), moderately fractured.		
210									(208.8') Coal-bearing, sandy conglomerate CLAYSHALE: strong, medium dark gray (N4), massive, slightly fractured, fresh, competent.		210
									(210.2') SANDSTONE: strong, medium gray (N5) to medium dark gray (N4), massive to minor cross bedding, occasional zones of imbedded conglomerate, medium grained, slightly fractured, fresh, competent.		
				Run 19			180/ 180	93			
215											215
									(218') End of MORGANTOWN.		
									(218.1') Silty SHALE: strong, dark greenish gray (5G 4/1), massive, slightly to moderately fractured, fresh, competent.		
220											220

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BORING LOG
Boring/Well No. M-GS-4
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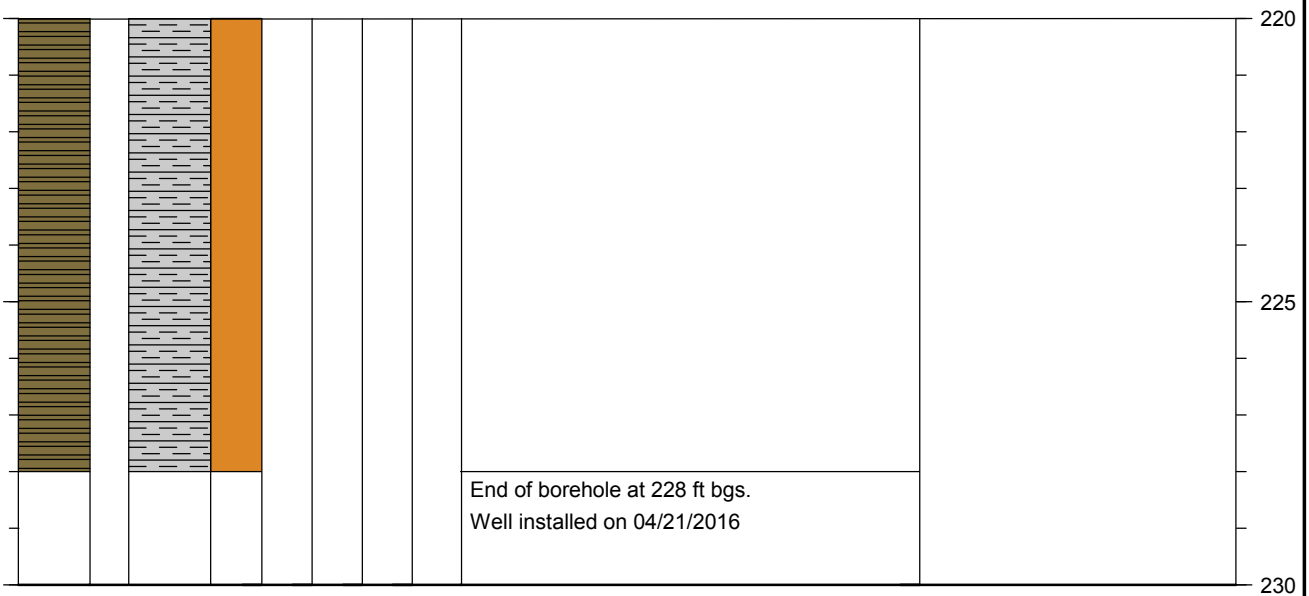
Drilling Start Date:	03/13/2016 07:45	Boring Depth (ft):	228	Well Depth (ft):	202
Drilling End Date:	03/14/2016 12:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,025.65	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,028.73	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 834,146.7 E 2,517,597.8	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
220											220
225									End of borehole at 228 ft bgs. Well installed on 04/21/2016		225
230											230



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Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-5
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Drilling Start Date:	03/14/2016 14:45	Boring Depth (ft):	233	Well Depth (ft):	224
Drilling End Date:	03/16/2016 09:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,036.92	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,039.54	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 835,739.3 E 2,511,662.3	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
0									Overburden: No sample recovered with wireline coring rig.		0
5											5
10											10
15											15
20											20

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Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

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Boring/Well No. M-GS-5
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Drilling Start Date:	03/14/2016 14:45	Boring Depth (ft):	233	Well Depth (ft):	224
Drilling End Date:	03/16/2016 09:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,036.92	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,039.54	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 835,739.3 E 2,511,662.3	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
20				Run 1			31/ 156	13	(20') Overburden: Some limestone boulders encountered. (see remarks)	Started coring at 20 ft bgs. Overburden: Driller (B. Womack) figured this material was overburden because of change in drilling speed (faster through limestone boulders and slow through clay). Rods were violently shaking, as well, as if trying to drill through unstable rock material is boxed.	20
25											25
30									(30') Overburden: LIMESTONE encountered - strong, light gray (N7), microcrystalline, intensely fractured, slightly decomposed, slightly disintegrated.		30
35				Run 2			30/ 156	4	(33') Overburden: 2.5 ft of previous LIMESTONE encountered through course of Run 2.		35
40											40

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BORING LOG
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Drilling Start Date:	03/14/2016 14:45	Boring Depth (ft):	233	Well Depth (ft):	224
Drilling End Date:	03/16/2016 09:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,036.92	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,039.54	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 835,739.3 E 2,511,662.3	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
40									End of overburden, begin bedrock.		40
45				Run 3			84/84	69	(44.7') LIMESTONE: strong, greenish black (5GY 2/1), microcrystalline, moderately fractured, slightly decomposed, slightly disintegrated, clay in fractures.		45
50				Run 4			175/180	78	(52.6') CLAYSTONE: very weak, medium dark gray (N4), massive, highly decomposed, highly disintegrated, intensely fractured.		50
55									(53.6') Sandy silty SHALE: strong, medium light gray (N6), massive, laminated from 4-5.5 ft from top of unit, competent, fresh, slightly fractured, micaceous, sand content increases at bottom of unit.		55
60									(59.5') CLAYSHALE: strong, medium dark		60

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Drilling Start Date:	03/14/2016 14:45	Boring Depth (ft):	233	Well Depth (ft):	224
Drilling End Date:	03/16/2016 09:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,036.92	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,039.54	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 835,739.3 E 2,511,662.3	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
60									gray (N4), massive, slightly decomposed to fresh, competent, moderately fractured.		60
									(60.8') LIMESTONE: strong, medium light gray (N4), microcrystalline to fine grained, massive, fresh, competent, unfractured.		
									(62.6') Silty SHALE: strong, medium light gray (N6), massive, laminated from 4-5.5 ft from top of unit, competent, fresh, slightly fractured, slightly micaceous, few sandy parts.		
65									(65.1') CLAYSTONE: very weak, medium dark gray (N4), massive, highly decomposed, highly disintegrated, intensely fractured.		65
									(66.1') CLAYSHALE: strong, dark greenish gray (5G 4/1), massive, slightly decomposed to fresh, competent, moderately fractured.		
				Run 5			172/ 180	71	(68') CLAYSHALE to silty SHALE: strong, dark greenish gray (5G 4/1) to medium light gray (N5), massive, moderately to intensely fractured, slightly decomposed, competent, clay infillings in fractures, some limestone nodules, some sandy parts in silty shale.		
70									(71.5') Highly decomposed.		70
75									(78.8') Sandy SHALE: laminated.		75
80											80

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Drilling Start Date:	03/14/2016 14:45	Boring Depth (ft):	233	Well Depth (ft):	224
Drilling End Date:	03/16/2016 09:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,036.92	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,039.54	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 835,739.3 E 2,511,662.3	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
80									(81') Limestone nodules increase.		80
				Run 6			144/ 144	54	(83') CLAYSHALE: strong, dark greenish gray (5G 4/1), massive, fissile 1.5 ft from top of run, intensely fractured, slightly decomposed, competent, clay infillings in fractures.		
85									(84.5') Becomes fissile, weak, moderately to highly decomposed, moderately to highly disintegrated.		85
									(85.3') LIMESTONE: strong, olive black (5Y 2/1) with medium light gray nodules (N6), massive, fresh, competent, moderately fractured.		
90									(88.3') CLAYSHALE: strong, dark greenish gray (5G 4/1), massive, fissile 1.5 ft from top of run, intensely fractured, slightly decomposed, competent, clay infillings in fractures, with limestone nodules.		90
									(91.3') LIMESTONE: strong, olive black (5Y 2/1) with medium light gray nodules (N6), massive, fresh, competent, moderately fractured.		
95				Run 7			156/ 156	90	(92.2') CLAYSHALE to CLAYSTONE: moderately strong to very weak, dark greenish gray (5G 4/1) with yellowish gray quartz veins to olive gray (5Y 4/1), slightly to intensely decomposed, intensely fractured.		95
									(95') CLAYSHALE: strong, dark greenish gray (5G 4/1) with yellowish gray (5Y 7/2), quartz veins, fresh, competent, moderately fractured.		
									(98') Changes to intensely fractured, moderately decomposed.		
100									(98.8') Changes to slightly fractured.		100

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Drilling Start Date:	03/14/2016 14:45	Boring Depth (ft):	233	Well Depth (ft):	224
Drilling End Date:	03/16/2016 09:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,036.92	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,039.54	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 835,739.3 E 2,511,662.3	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
100									(100') Changes to Silty CLAYSHALE.		100
105											105
				Run 8			175/ 180	79	(108') CLAYSHALE: strong, dark greenish gray (5G 4/1) with yellowish gray (5Y 7/2), quartz veins, fresh, competent, moderately fractured.		
110											110
115									(113.6') Shaly SANDSTONE: strong, medium gray (N5), interbedded sandstone with shale (possibly cross-bedding), micaceous, fine grained, competent, fresh, moderately fractured, some mud inclusions, shale is grayish black (N2).		115
120									(118.6') Sandy CLAYSHALE: strong, grayish black (N2), massive, sandy for top 1.7 ft of unit, fine grained, mud inclusions for top 1.7		120

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Drilling Start Date:	03/14/2016 14:45	Boring Depth (ft):	233	Well Depth (ft):	224
Drilling End Date:	03/16/2016 09:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,036.92	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,039.54	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 835,739.3 E 2,511,662.3	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
120									ft, competent, fresh, moderately fractured, may be coal-bearing for top 1.7 ft.		120
				Run 9			180/ 180	93	(123') CLAYSHALE: strong, medium dark gray (N4), massive, competent, fresh, moderately fractured, no mud inclusions, coal or sandy areas, abundant limestone nodules.		
125											125
130									(131.5') 1" band of small limestone nodules.		130
135									(134.5') SANDSTONE: strong, medium gray (N5), minor cross bedding, fine grained, fresh, competent, micaceous, slightly fractured.		135
				Run 10			176/ 180	87	(136.8') Silty SHALE: strong, medium dark gray (N4), massive, competent, fresh, moderately fractured, abundant limestone nodules.		
140									(138') Silty SHALE: strong, medium dark gray (N4) to dark gray (N3), massive, competent, fresh, slightly to moderately fractured,		140

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Drilling Start Date:	03/14/2016 14:45	Boring Depth (ft):	233	Well Depth (ft):	224
Drilling End Date:	03/16/2016 09:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,036.92	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,039.54	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 835,739.3 E 2,511,662.3	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
140									abundant limestone nodules.		140
									(140.6') Becomes intensely fractured.		
									(141') LIMESTONE: strong, olive gray (5Y 4/1), massive, microcrystalline, competent, fresh, unfractured.		
									(141.6') Silty SHALE: strong, medium dark gray (N4) to dark gray (N3), massive, competent, fresh, slightly to moderately fractured, limestone nodules throughout.		
145											145
150				Run 11			162/ 180	49			150
									(153.3') CLAYSHALE: strong, dark greenish gray (5G 4/1), massive, moderately fractured, slightly decomposed, slightly disintegrated, 0.5 ft vertical fracture at top of unit.		
155											155
									(156.3') CLAYSTONE: moderately strong, medium dark gray (N4), massive, intensely fractured, clay infillings in fractures, moderately decomposed, moderately disintegrated.		
									(157.3') LIMESTONE: strong, olive black (5Y 2/1) to dark greenish gray (5G 4/1), light gray (N7), limestone nodules, nodular to massive,		
160											160

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Drilling Start Date:	03/14/2016 14:45	Boring Depth (ft):	233	Well Depth (ft):	224
Drilling End Date:	03/16/2016 09:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,036.92	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,039.54	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 835,739.3 E 2,511,662.3	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
160									microcrystalline, moderately fractured, slightly disintegrated, fresh.		160
									(162.3') CLAYSTONE: moderately strong, medium dark gray (N4), massive, intensely fractured, clay infillings in fractures, moderately decomposed, moderately disintegrated.		
165									(163.3') LIMESTONE: strong, dark greenish gray (5G 4/1), massive, microcrystalline, unfractured, fresh, competent.		165
									(163.8') CLAYSTONE: moderately strong, medium dark gray (N4), massive, intensely fractured, clay infillings in fractures, moderately decomposed, moderately disintegrated.		
				Run 12			178/ 180	97	(168') Silty SHALE: strong, dark greenish gray (5G 4/1), massive, slightly fractured, fresh, competent, minor limestone nodules.		
170									(170') Intensely fractured, moderately disintegrated.		170
									(173.4') Sandy silty SHALE: strong, grayish black (N2), massive, slightly fractured, fresh, competent, minor limestone nodules, occasional sandstone lenses, fine grained, micaceous, medium light gray.		
175											175
									(178.4') SANDSTONE: strong, medium light gray (N6), fine grained, micaceous, cross-bedded, competent, fresh, mud		
180											180

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Drilling Start Date:	03/14/2016 14:45	Boring Depth (ft):	233	Well Depth (ft):	224
Drilling End Date:	03/16/2016 09:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,036.92	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,039.54	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 835,739.3 E 2,511,662.3	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
180									inclusions/lenses, slightly fractured. [MORGANTOWN]		180
									(180.6') Sandy silty SHALE: strong, grayish black (N2), massive, slightly fractured, fresh, competent, occasional sandstone lenses, fine grained, micaceous, medium light gray.		
				Run 13			180/ 180	98	(183') Sandy SHALE: strong, dark gray (N3) [shale], medium dark gray (N5) [sandstone], laminations/lenses of sandstone, lenses up to 6" thick, fresh, competent, slightly fractured.		
185											185
190											190
									(191.7') SANDSTONE: strong, medium light gray (N6) to medium gray (N5), cross-bedded, fine grained, micaceous, slightly fractured, fresh, competent. [MORGANTOWN]		
									(193.8') Shale lenses, mud inclusions/lenses appear (up to 1 inch thick).		
195											195
									(196.7') Becomes moderately fractured.		
				Run 14			178/ 180	90	(191.7') SANDSTONE: strong, medium light gray (N6) to medium gray (N5), cross-bedded, fine grained, micaceous to very micaceous, slightly to moderately fractured, fresh,		
200											200

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Drilling Start Date:	03/14/2016 14:45	Boring Depth (ft):	233	Well Depth (ft):	224
Drilling End Date:	03/16/2016 09:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,036.92	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,039.54	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 835,739.3 E 2,511,662.3	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
200									competent, some coal veining, some imbedded conglomerate, shale lenses, mud inclusions. [MORGANTOWN]		200
205											205
210									(212.2') Becomes massive.		210
215				Run 15			152/ 156	80	(213') SANDSTONE: strong, medium light gray (N6) to medium gray (N5), cross-bedded, fine grained, micaceous to very micaceous, slightly fractured, fresh, competent, some coal veining, some imbedded conglomerate, shale lenses, mud inclusions. [MORGANTOWN]		215
220											220

NOTES:

Geosyntec consultants
engineers | scientists | innovators

Client: AEP-Cardinal
Project: CHE8126L
Address: 3202 Twp Rd 163, Brilliant, OH

BORING LOG
Boring/Well No. M-GS-5
Page: 12 of 12

Drilling Start Date:	03/14/2016 14:45	Boring Depth (ft):	233	Well Depth (ft):	224
Drilling End Date:	03/16/2016 09:30	Boring Diameter (in):	6	Well Diameter (in):	2
Drilling Company:	Layne Drilling	Sampling Method(s):	Rock Core	Screen Slot (in):	0.010
Drilling Method:	Rock Core	DTW During Drilling (ft):		Riser Material:	Sch 40 PVC
Drilling Equipment:	CS1500 Wireline Rig	Ground Surface Elev. (ft):	1,036.92	Screen Material:	Pre-packed Sch 40 PVC
Driller:	Bill Womack	Top of Casing Elev. (ft):	1,039.54	Seal Material(s):	Bentonite Pellets
Logged By:	Doug Mateas	Location (X,Y):	N 835,739.3 E 2,511,662.3	Filter Pack:	#5 Medium Coarse Sand

DEPTH (ft)	LITHOLOGY	WATER LEVEL	WELL COMPLETION	COLLECT: Sample Type	COLLECT: Date & Time	COLLECT: Blow Counts	COLLECT: Recovery (in)	COLLECT: N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	DEPTH (ft)
220											220
									(221.8') 0.4 ft thick lense of sandstone with prevalent mud inclusions, conglomerate, coal veining.		
									(222.2') COAL: strong, black (N1), massive to cubic structure, slightly fractured, slightly decomposed, competent, sandstone lense, mud inclusions.		
225									(222.7') SANDSTONE: strong, medium light gray (N6) to medium gray (N5), massive, cross-bedded, fine grained, micaceous to very micaceous, slightly fractured, fresh, competent, some coal veining. [MORGANTOWN]		225
				Run 16			84/84	92			
									(223.3') CLAYSHALE: strong, dark greenish gray (5G 4/1), massive, intensely fractured, moderately decomposed, slightly disintegrated, calcareous nodules/veining.		
230									(225.3') CLAYSTONE: weak to very weak, medium light gray (N6), massive, intensely fractured, highly decomposed, highly disintegrated.		230
									(226') CLAYSHALE: strong, dark greenish gray (5G 4/1), massive, intensely fractured, moderately decomposed, slightly disintegrated, calcareous nodules/veining.		
									(226.5') Changes to slightly fractured, fresh, competent.		
									End of borehole at 233 ft bgs.		
235									Well installed on 04/05/2016		235
240											240

NOTES:

APPENDIX D

WELL CONSTRUCTION LOGS

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

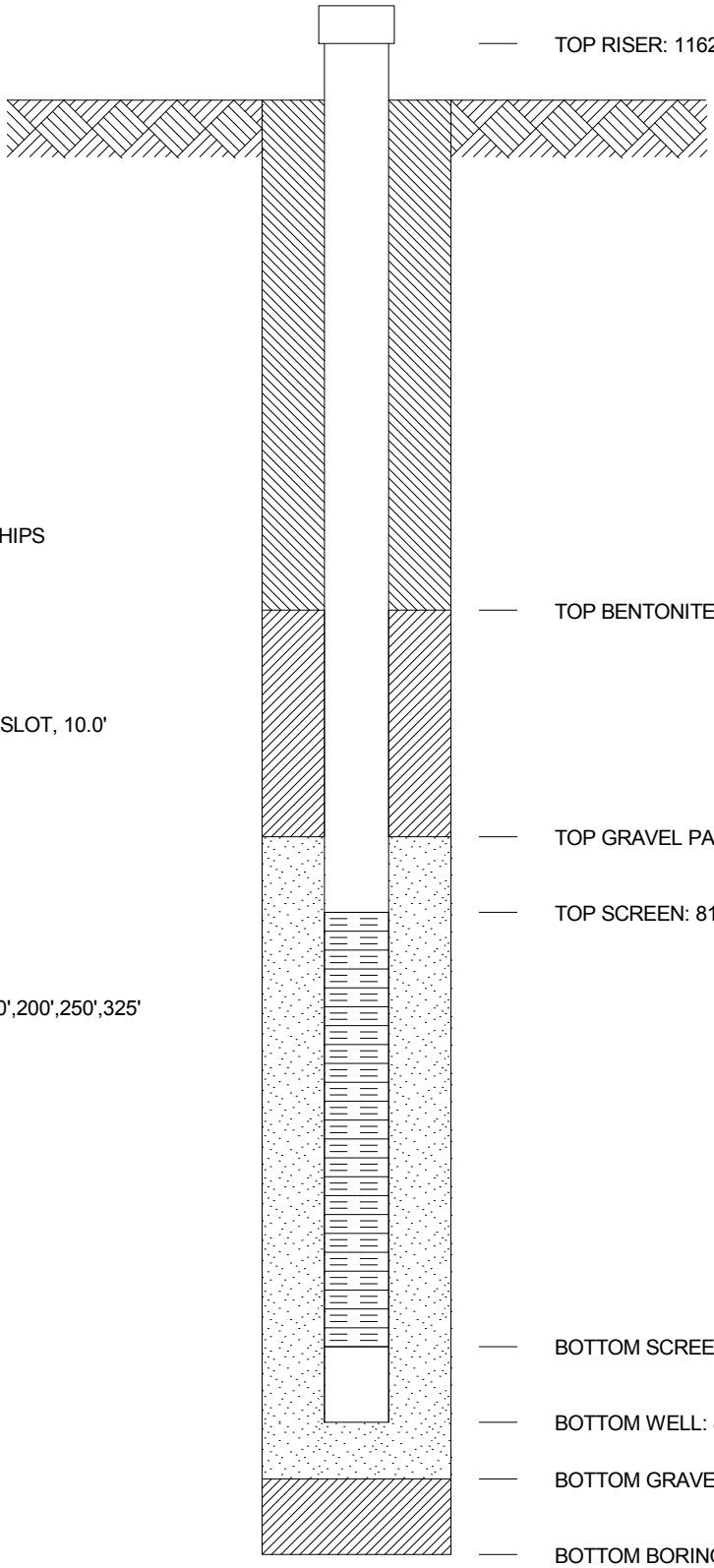
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **CA-0622A** BORING No. **CA-0622A** INSTALLED **8/16/16**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 836,291.4 E 2,514,219.5**

SYSTEM **State Plane using NAD27/29**

GROUND ELEVATION 1159.38 FT.



GROUT SEAL: BENTONITE CHIPS

BENTONITE SEAL: PELLETS

SCREEN: 2" dia., U-PACK .10 SLOT, 10.0'

GRAVEL PACK:

RISER PIPE: 2", dia., PVC

SPACERS, DEPTH: 20',80',140',200',250',325'

GEOMCNST CD_FGD_LANDFILL BORINGS & WELLS.GPJ AEP.GDT 8/22/16

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

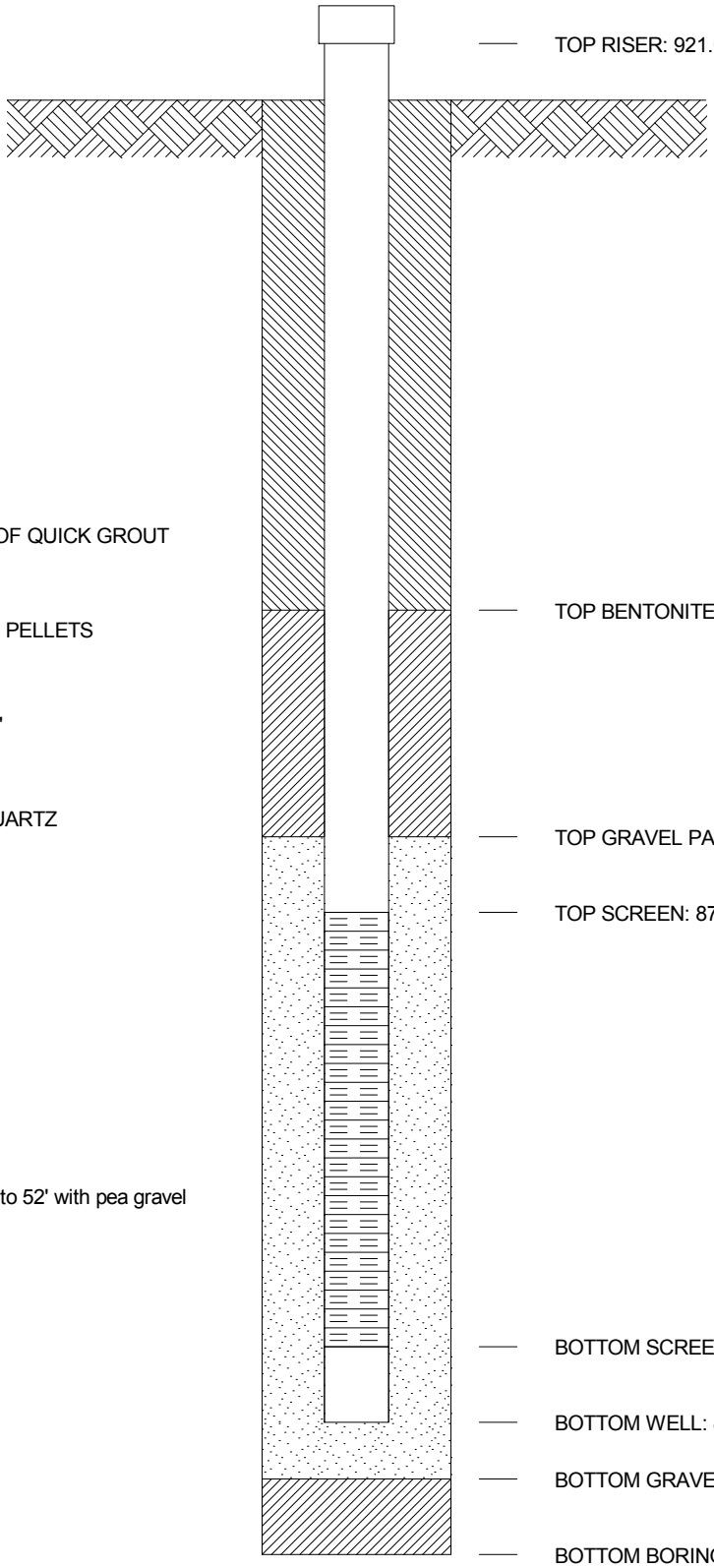
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **FA-8** BORING No. **FA-8** INSTALLED **3/23/04**

PROJECT **CARDINAL FLY ASH DAM**

COORDINATES **N 829,635.1 E 2,516,460.0**

SYSTEM **State Plane using NAD27/29**

GROUND ELEVATION 918.23 FT.



GROUT SEAL: 90 GALLONS OF QUICK GROUT

BENTONITE SEAL: 50 lbs 3/8" PELLETS

SCREEN: 2" dia., 50 SLOT, 10'

GRAVEL PACK: 225 lbs #4 QUARTZ

RISER PIPE: 2", dia., PVC

SPACERS, DEPTH: None

Note: Backfilled hole from 156' to 52' with pea gravel

GEOMCNST CD_FA_DAM.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

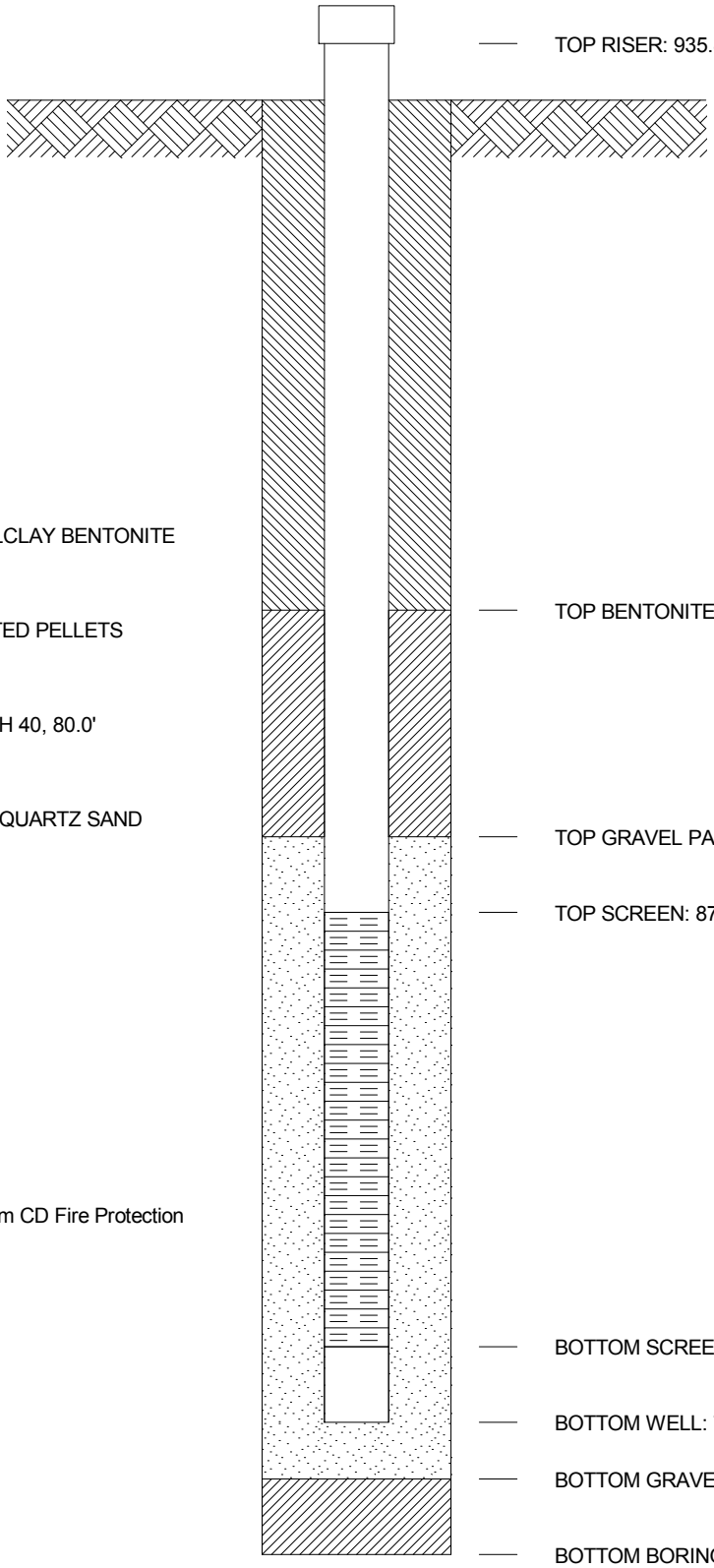
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **M-1003** BORING No. **M-1003** INSTALLED **4/7/10**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 829,139.1 E 2,516,070.9**

SYSTEM

GROUND ELEVATION 933.55 FT.



GROUT SEAL: 100 GALS VOLCLAY BENTONITE

BENTONITE SEAL: 3/8" COATED PELLETS

SCREEN: 2" dia., 20 SLOT SCH 40, 80.0'

GRAVEL PACK: 1550 LBS #4 QUARTZ SAND

RISER PIPE: 2", dia., SCH 40

SPACERS, DEPTH: 50', 10'

NOTES:
-Drill & decon water coming from CD Fire Protection System
-Decon rig & tools 04/13/10
-Drilled w/6" air hammer
-SWL @ 73.8' @ install

GEOMCNST CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

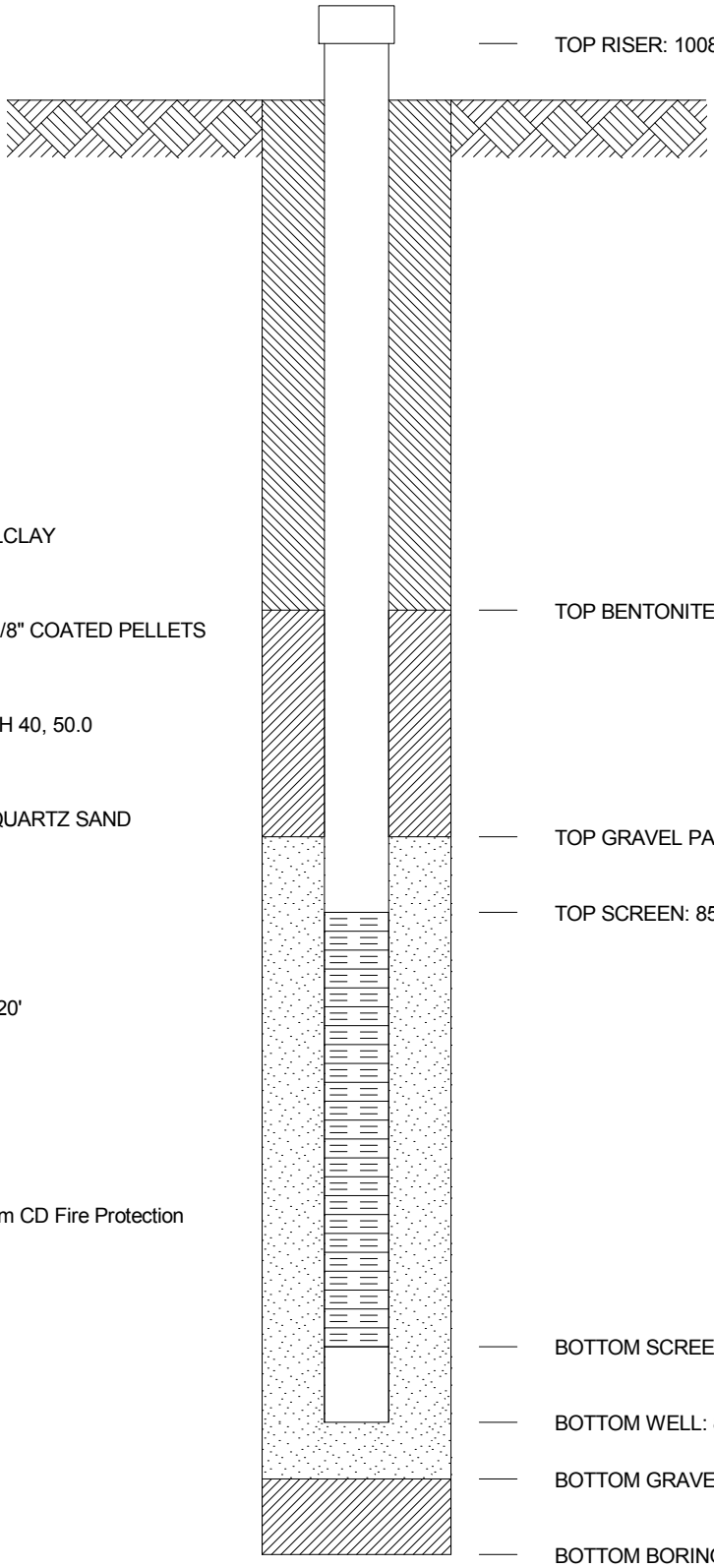
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **M-1004** BORING No. **M-1004D** INSTALLED **3/31/10**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 831,215.4 E 2,519,112.4**

SYSTEM

GROUND ELEVATION 1005.64 FT.



GROUT SEAL: 250 GALS VOLCLAY

BENTONITE SEAL: 100 LBS 3/8" COATED PELLETS

SCREEN: 2" dia., 20 SLOT SCH 40, 50.0

GRAVEL PACK: 975 LBS #4 QUARTZ SAND

RISER PIPE: 2", dia., SCH 40

SPACERS, DEPTH: 140', 80', 20'

NOTES:
-Drill & decon water coming from CD Fire Protection System
-Decon rig & tools 3/31/10
-Drilled w/6" air hammer
-SWL @ 15.1'

GEOMCNST CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

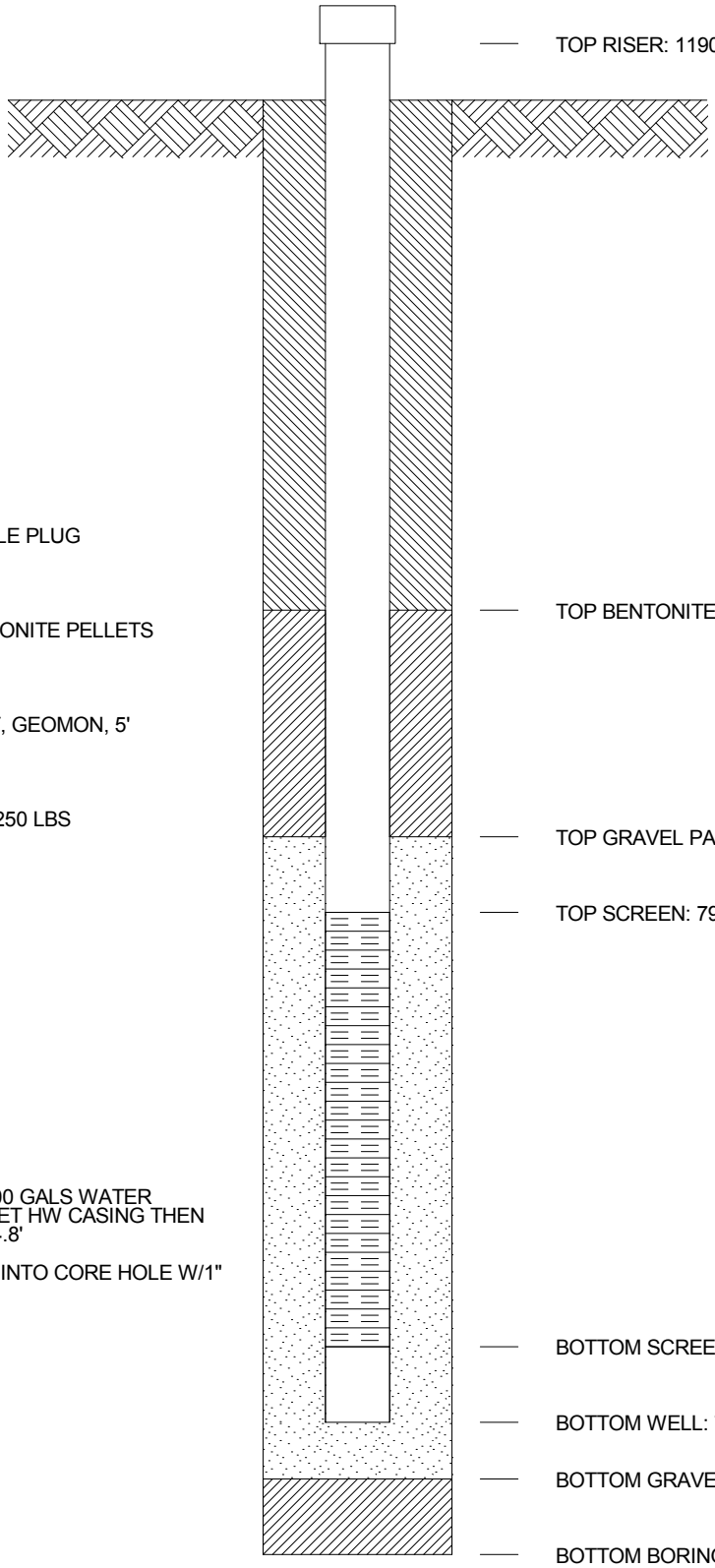
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **M-12** BORING No. **CA-0608** INSTALLED **12/13/06**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 833,112.2 E 2,516,013.2**

SYSTEM

GROUND ELEVATION 1187.65 FT.



GROUT SEAL: 3,000 LBS HOLE PLUG

BENTONITE SEAL: 30# BENTONITE PELLETS

SCREEN: 1.5" dia., 0.20 SLOT, GEOMON, 5'

GRAVEL PACK: #4 QUARTZ 250 LBS

RISER PIPE: 1", dia.,

SPACERS, DEPTH: N/A

-FLUSHED BORE HOLE W/700 GALS WATER
-6" AIR HAMMER TO 188.6' SET HW CASING THEN NQ ROCK CORE TO 404.8'
-SWL @ INSTALL 186.0'
-TREMIED SAND & PELLETS INTO CORE HOLE W/1" PIPE
-DECONNED TOOLS 11/7/06

GEOMCNST CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

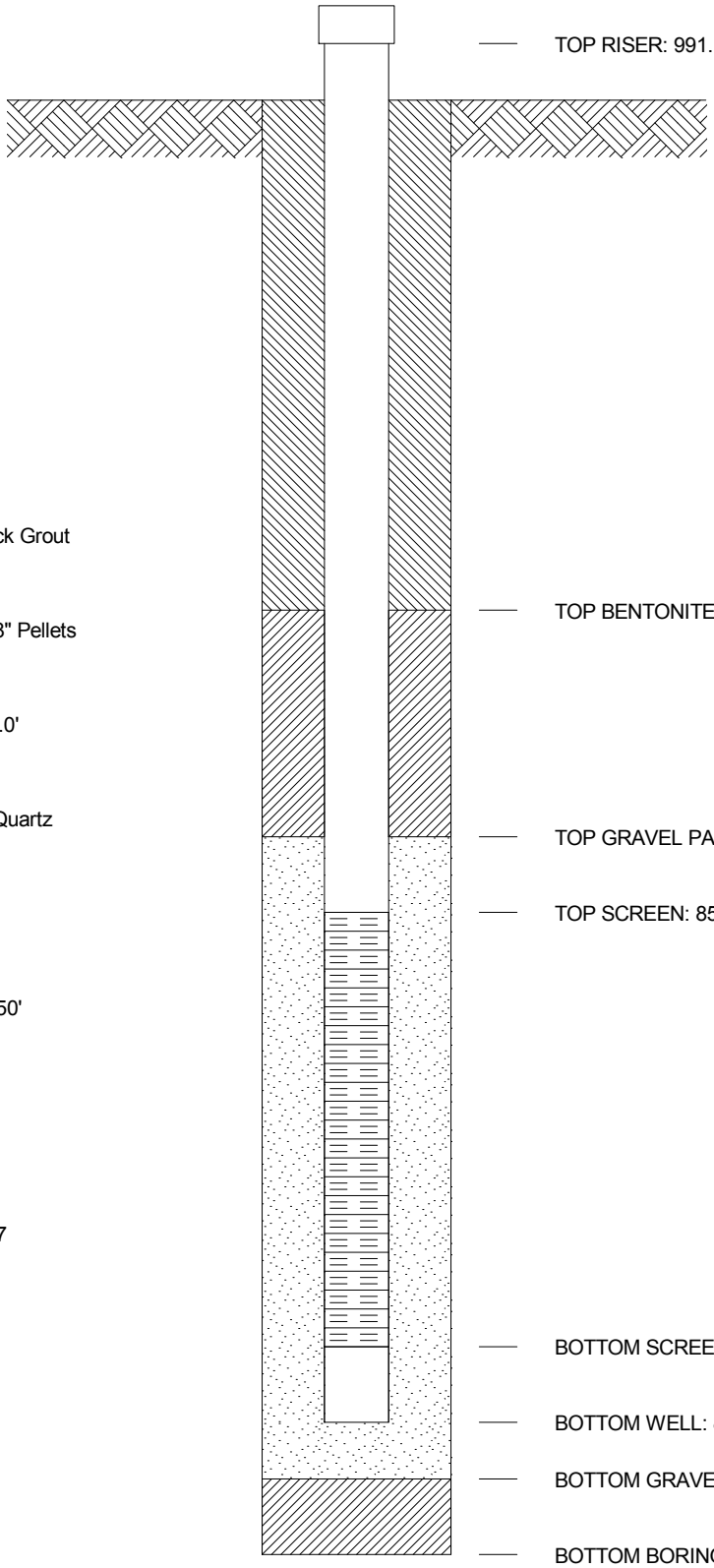
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **M-13** BORING No. **CA-0610** INSTALLED **4/3/07**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 831,697.9 E 2,518,374.3**

SYSTEM

GROUND ELEVATION 988.42 FT.



GROUT SEAL: ~200 Gals Quick Grout

BENTONITE SEAL: 100 lbs 3/8" Pellets

SCREEN: 2" dia., .020 Slot, 57.0'

GRAVEL PACK: 1,050 lbs #4 Quartz

RISER PIPE: 2", dia., PVC

SPACERS, DEPTH: 150',100',50'

NOTES:
-Drilled w/6" Air Hammer
-Deconned Tolls & Rig 04/05/07
-SWL @ Install 134.2'

-3' SS Pump Type
-Pump intake @ 185'

GEOMCNST CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

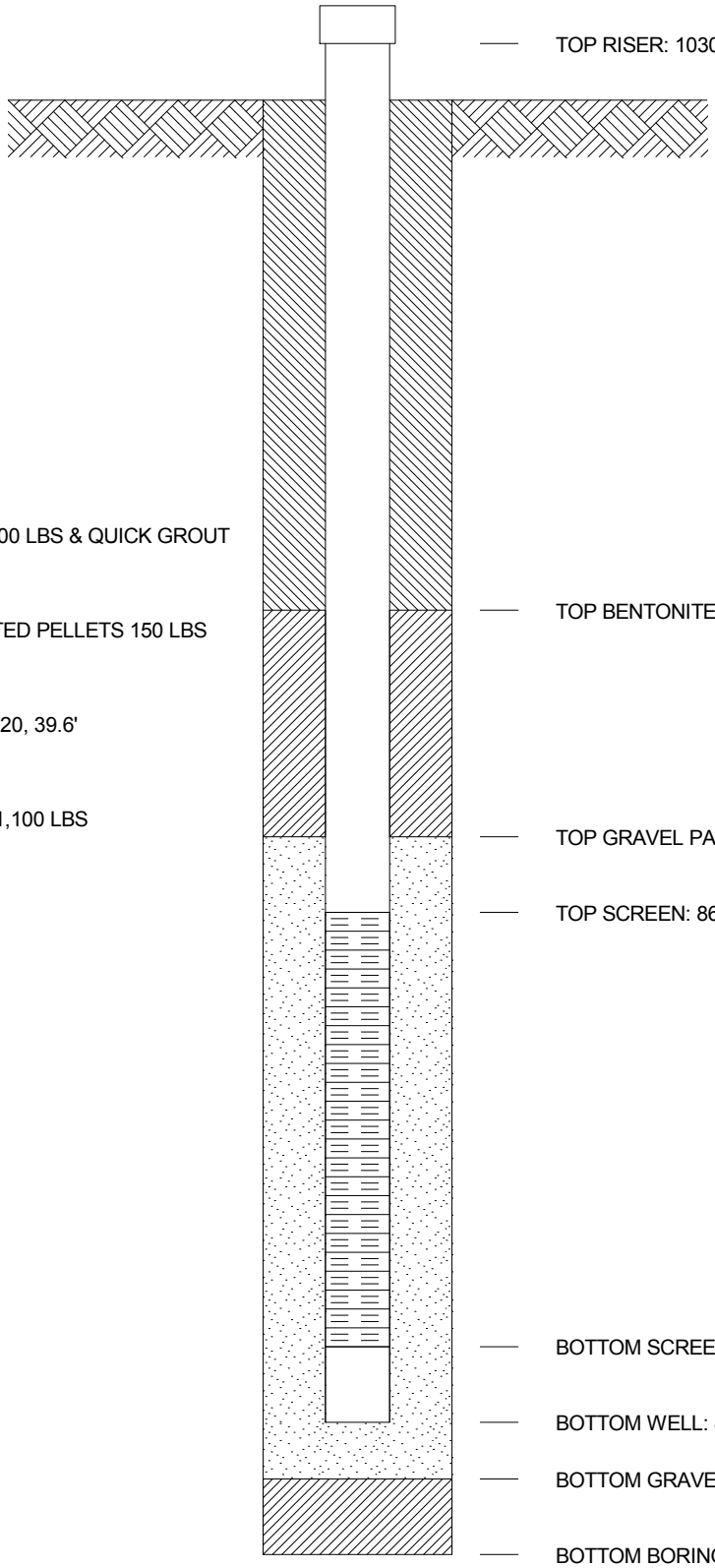
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **M-1302** BORING No. **B-1302M** INSTALLED **5/30/13**

PROJECT **CARDINAL FLY ASH DAM**

COORDINATES **N 836,201.9 E 2,515,432.0**

SYSTEM **State Plane using NAD27/29**

GROUND ELEVATION 1028.92 FT.



GROUT SEAL: HOLE PLUG 600 LBS & QUICK GROUT 50 GALS

BENTONITE SEAL: 3/8" COATED PELLETS 150 LBS

SCREEN: 2" dia., SLOTTED .020, 39.6'

GRAVEL PACK: #4 QUARTZ 1,100 LBS

RISER PIPE: 2", dia., PVC

SPACERS, DEPTH: 130 & 50

NOTES:
-Pump installed

GEOMCNST CD_FA_DAM.GPJ AEP.GDT 7/20/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

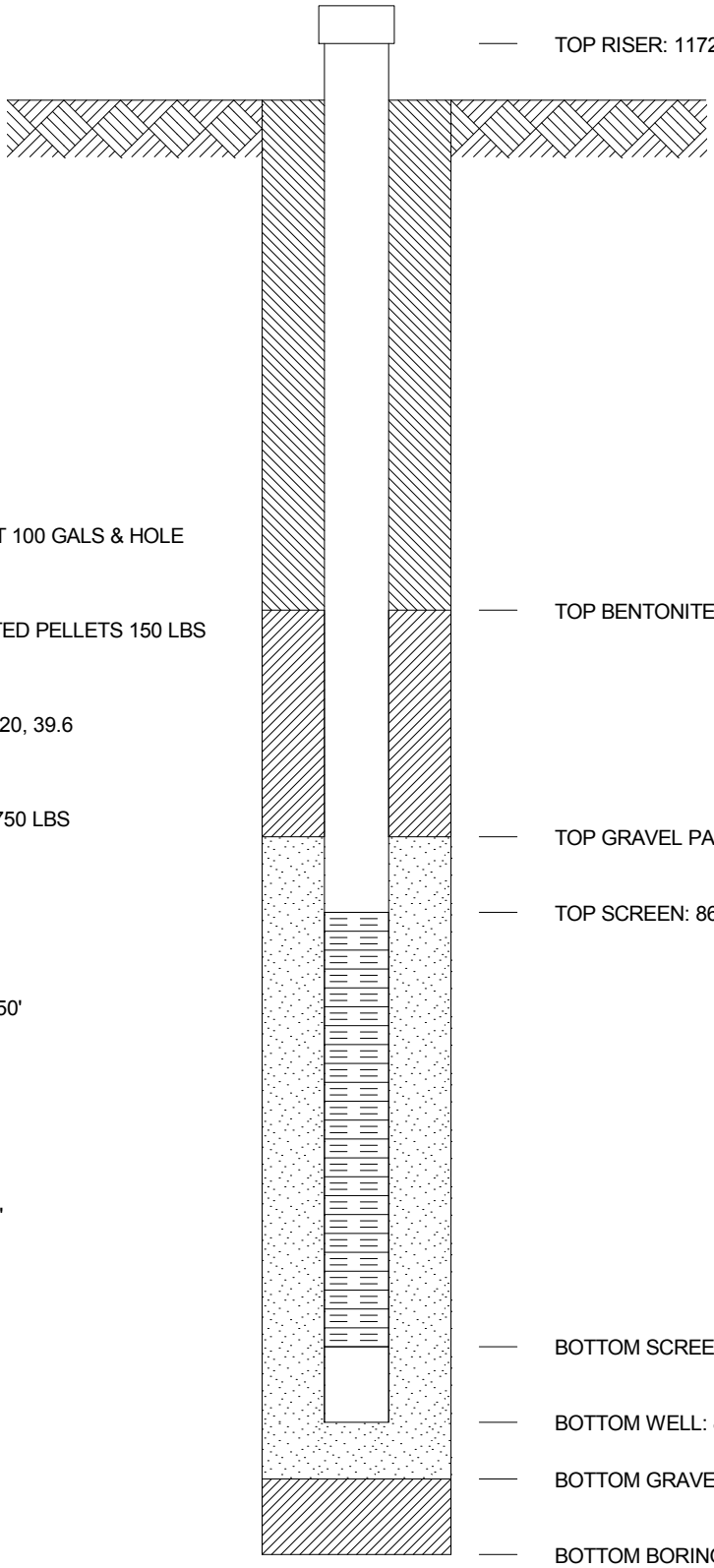
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **M-1309** BORING No. **B-1309D** INSTALLED **5/30/13**

PROJECT **CARDINAL FLY ASH DAM**

COORDINATES **N 835,558.0 E 2,517,396.3**

SYSTEM **State Plane using NAD27/29**

GROUND ELEVATION 1170.24 FT.



GROUT SEAL: QUICK GROUT 100 GALS & HOLE PLUG 500 LBS

BENTONITE SEAL: 3/8" COATED PELLETS 150 LBS

SCREEN: 2" dia., SLOTTED .020, 39.6

GRAVEL PACK: #4 QUARTZ 750 LBS

RISER PIPE: 2", dia., PVC

SPACERS, DEPTH: 250',150',50'

NOTES:
-Hole plug from 209.2' to 130.0'
-Pump installed

GEOMCNST CD_FA_DAM.GPJ AEP.GDT 7/20/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

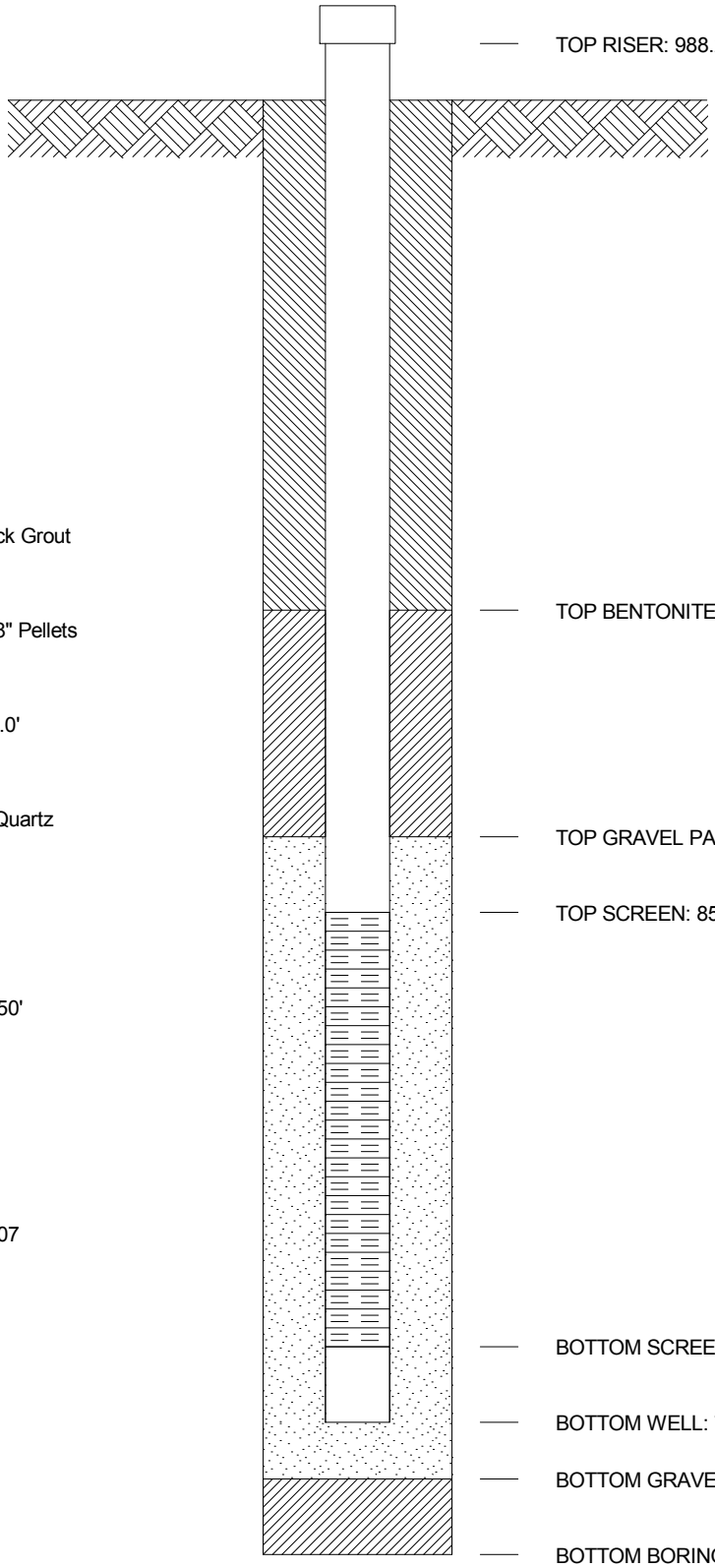
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **M-14** BORING No. **CA-0612** INSTALLED **3/21/07**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 832,901.9 E 2,519,661.8**

SYSTEM

GROUND ELEVATION 984.91 FT.



GROUT SEAL: ~150 Gals Quick Grout

BENTONITE SEAL: 100 lbs 3/8" Pellets

SCREEN: 2" dia., .020 Slot, 57.0'

GRAVEL PACK: 1,150 lbs #4 Quartz

RISER PIPE: 2", dia., PVC

SPACERS, DEPTH: 150',100',50'

NOTES:
-Drilled w/6" Air Hammer
-Deconned Tools & Drill 03/21/07
-SWL @ 43.8'

-3' SS Pump Type
-Pump intake @ 182'

GEOMCNST CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

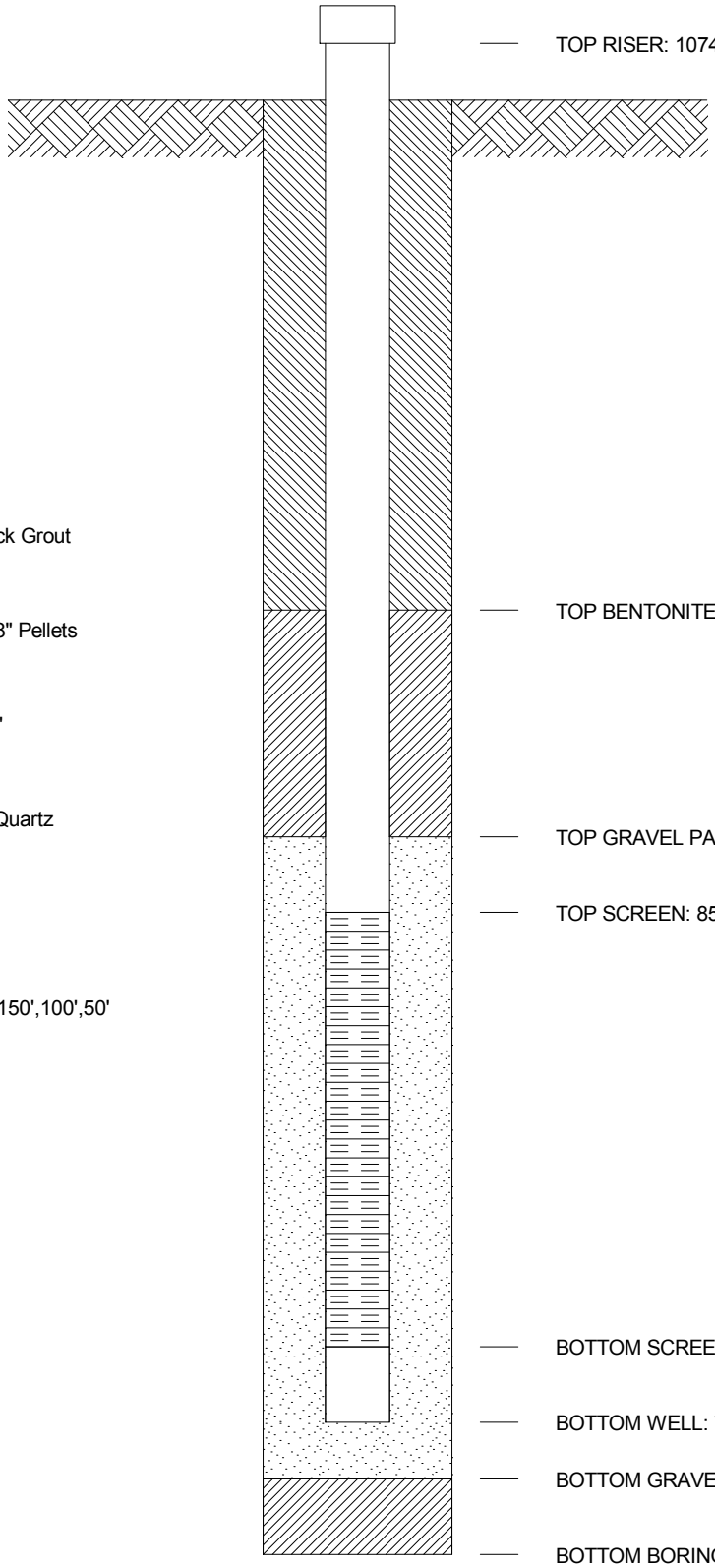
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **M-15** BORING No. **CA-0614** INSTALLED **7/25/07**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 833,569.0 E 2,518,172.3**

SYSTEM

GROUND ELEVATION 1071.83 FT.



GROUT SEAL: ~600 Gals Quick Grout

BENTONITE SEAL: 100 lbs 3/8" Pellets

SCREEN: 2" dia., .020 Slot, 60'

GRAVEL PACK: 1,275 lbs #4 Quartz

RISER PIPE: 2", dia., PVC

SPACERS, DEPTH: 250',200',150',100',50'

NOTES:
-Drilled w/6" Air Hammer
-SWL @ Install 72.5'
-Decon Tools 07/23/07

-3' SS Pump Type
-Pump intake @ 273'

GEOMCNST CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

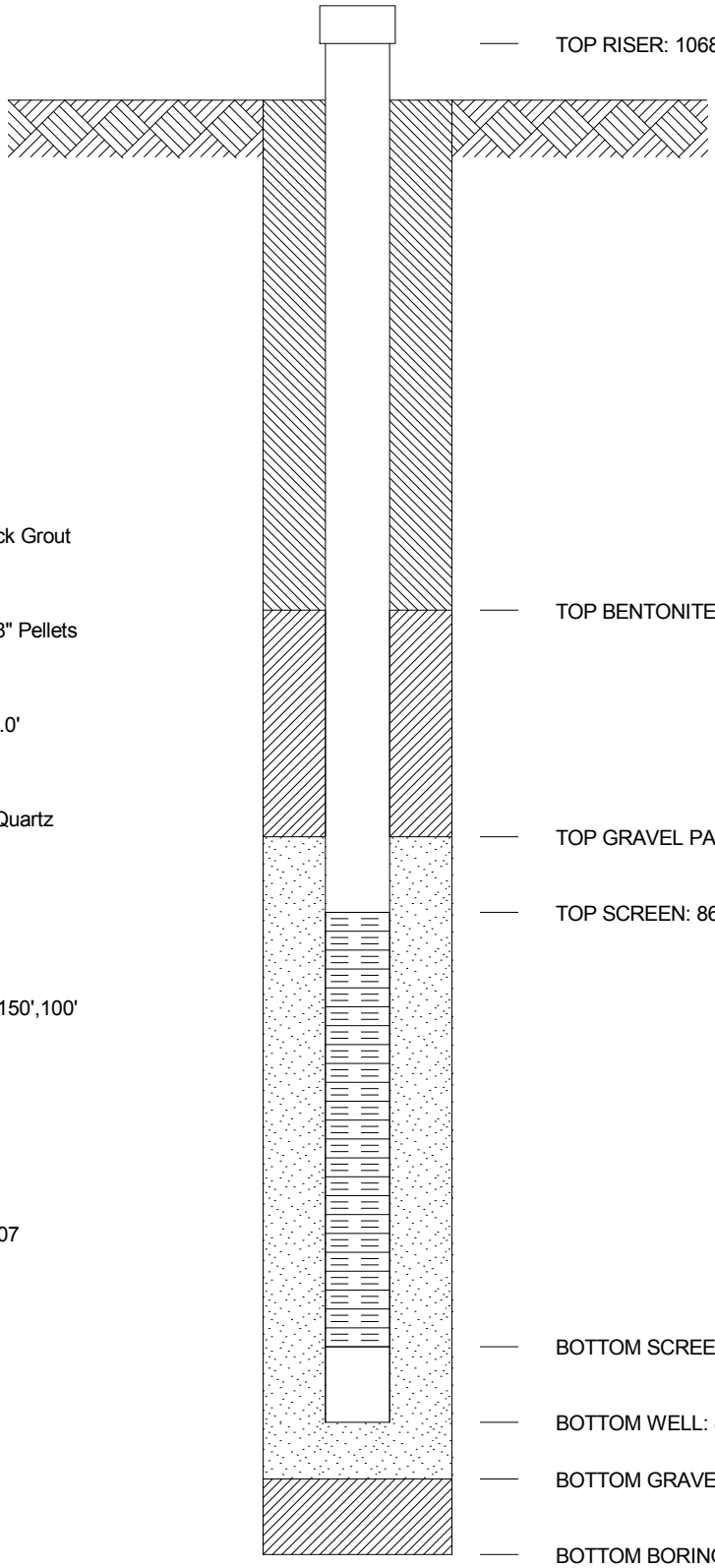
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **M-16** BORING No. **CA-0616** INSTALLED **1/24/07**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 835,565.0 E 2,516,519.0**

SYSTEM

GROUND ELEVATION 1065.75 FT.



GROUT SEAL: ~850 Gals Quick Grout

BENTONITE SEAL: 100 lbs 3/8" Pellets

SCREEN: 2" dia., .020 Slot, 49.0'

GRAVEL PACK: 1,950 lbs #4 Quartz

RISER PIPE: 2", dia., PVC

SPACERS, DEPTH: 250',200',150',100'

NOTES:
-Drilled w/6" Air Hammer
-Deconned Tools & Drill 02/01/07
-SWL @ Install 101.4'

-3' SS Pump Type
-Pump intake @ 248'

GEOMCNST CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

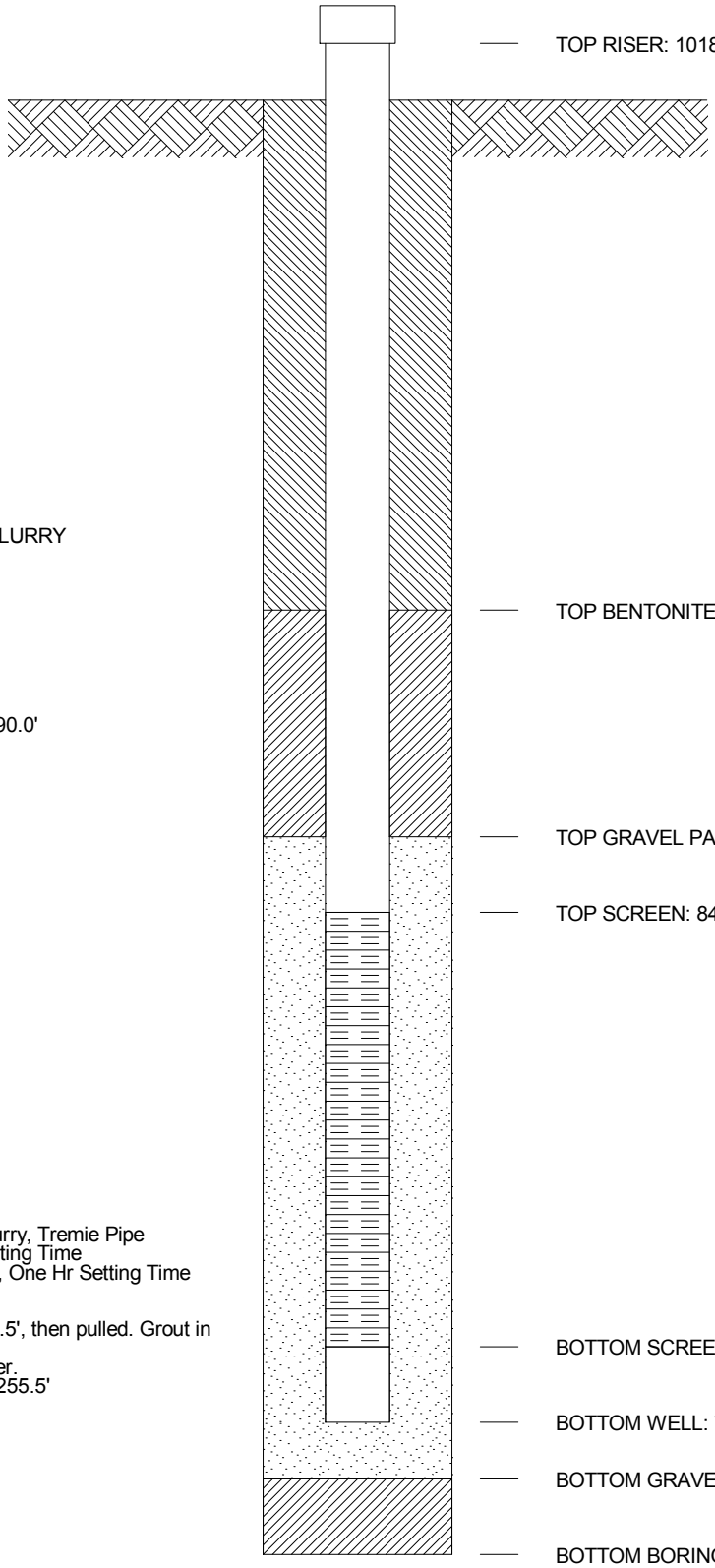
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **M-21** BORING No. **CA-0620** INSTALLED **6/1/06**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 830,426.7 E 2,516,358.1**

SYSTEM

GROUND ELEVATION 1016.16 FT.



GROUT SEAL: BENTONITE SLURRY

BENTONITE SEAL: PELLETS

SCREEN: 1" dia., .020 SLOT, 90.0'

GRAVEL PACK: FILTER PRO

RISER PIPE: 2", dia., PVC

SPACERS, DEPTH:

NOTES:
-Surface Seal: Cement
-Annular Sealant: Bentonite Slurry, Tremie Pipe Installation, Overnight Setting Time
-Bentonite Seal: Poured Slowly, One Hr Setting Time
-Sand Pack: Poured Slowly

-Original pump installed @ 258.5', then pulled. Grout in water sample.
-Well redeveloped with reclaimer.
-Pump reinstalled w/ intake @ 255.5'

GEOMCNST CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

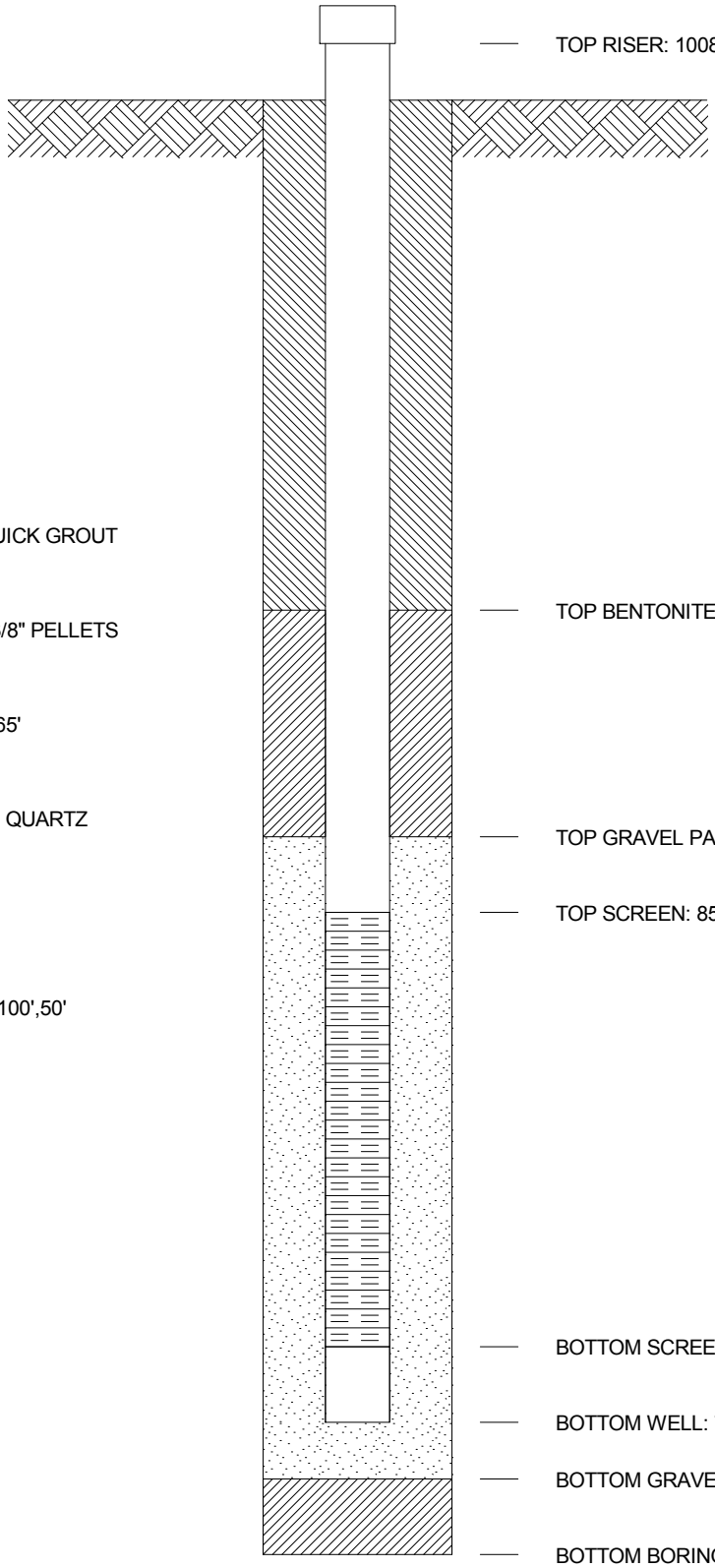
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **M-22** BORING No. **CA-0702** INSTALLED **5/21/07**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 830,925.1 E 2,519,495.8**

SYSTEM

GROUND ELEVATION 1005.68 FT.



GROUT SEAL: ~250 GALS QUICK GROUT

BENTONITE SEAL: 100 LBS 3/8" PELLETS

SCREEN: 2" dia., .020 SLOT, 65'

GRAVEL PACK: 1,100 LBS #4 QUARTZ

RISER PIPE: 2", dia., PVC

SPACERS, DEPTH: 200',150',100',50'

NOTES:
-Decon 05/22/07
-Drilled w/6" Air Hammer
-SWL @ Install 139.4'

-3' SS Pump Type
-Pump intake @ 214.5'

GEOMCNST CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

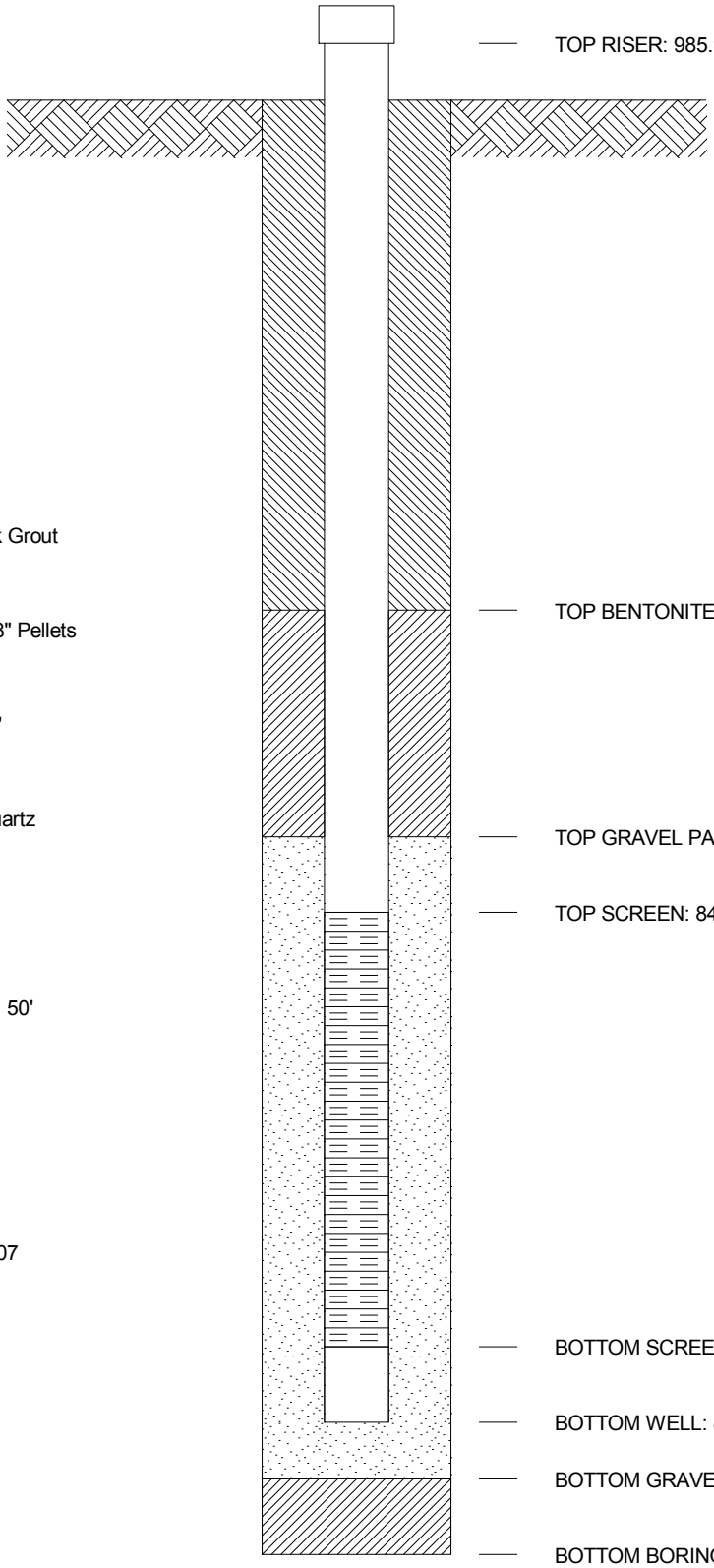
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **M-23** BORING No. **CA-0703** INSTALLED **4/23/07**

PROJECT **CARDINAL LANDFILL**

COORDINATES **N 830,051.2 E 2,518,092.0**

SYSTEM

GROUND ELEVATION 983.44 FT.



GROUT SEAL: 150 Gals Quick Grout

BENTONITE SEAL: 100 lbs 3/8" Pellets

SCREEN: 2" dia., .020 Slot, 45'

GRAVEL PACK: 750 lbs #4 Quartz

RISER PIPE: 2", dia., PVC

SPACERS, DEPTH: 150', 100', 50'

NOTES:
-Replacement well for 8501/1S
-Drilled w/6" Air Hammer
-Deconned Tools & Drill 04/18/07
-SWL @ Install 98.4'

-3' SS Pump Type
-Pump intake @ 175'

GEOMCNST CD_FGD_LANDFILL.GPJ AEP.GDT 7/17/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

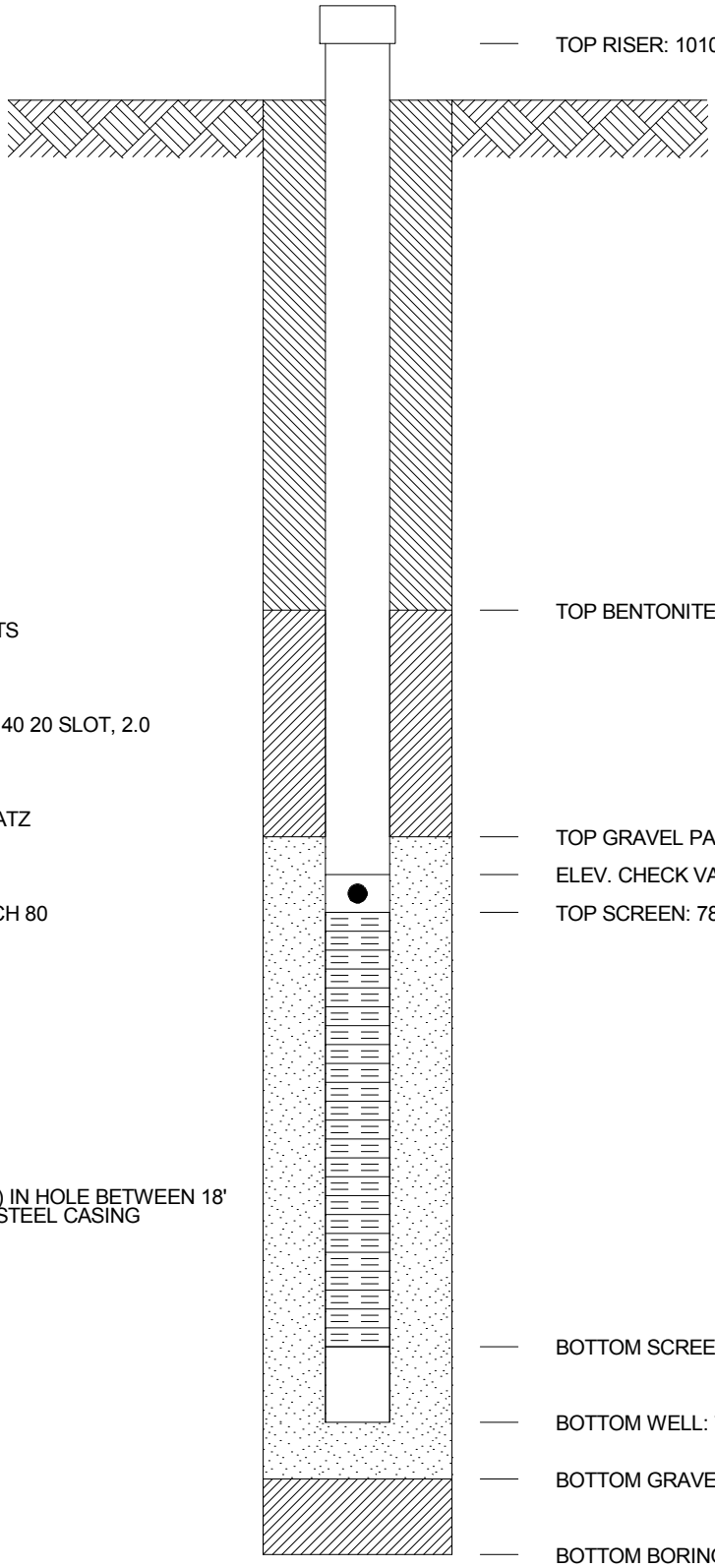
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **M-6** BORING No. **90CA22** INSTALLED **8/9/90**

PROJECT **CARDINAL PLANT**

COORDINATES **N 831,918.6 E 2,156,681.5**

SYSTEM **STATE PLANE**

GROUND ELEVATION 1008.56 FT.



GROUT SEAL: BENSEAL

BENTONITE SEAL: PI PELLETS

SCREEN: 1.25 dia., PVC SCH 40 20 SLOT, 2.0

GRAVEL PACK: #4 OHIO QUATZ

RISER PIPE: 1.0, dia., PVC SCH 80

SPACERS, DEPTH:

20' OF CASING LOST (3" NW) IN HOLE BETWEEN 18' TO 50'? GEOMON A-36 STEEL CASING

GEOMCNST CD SI.GPJ AEP.GDT 7/20/15

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AEP CIVIL ENGINEERING LABORATORY

MONITORING WELL CONSTRUCTION

JOB NUMBER

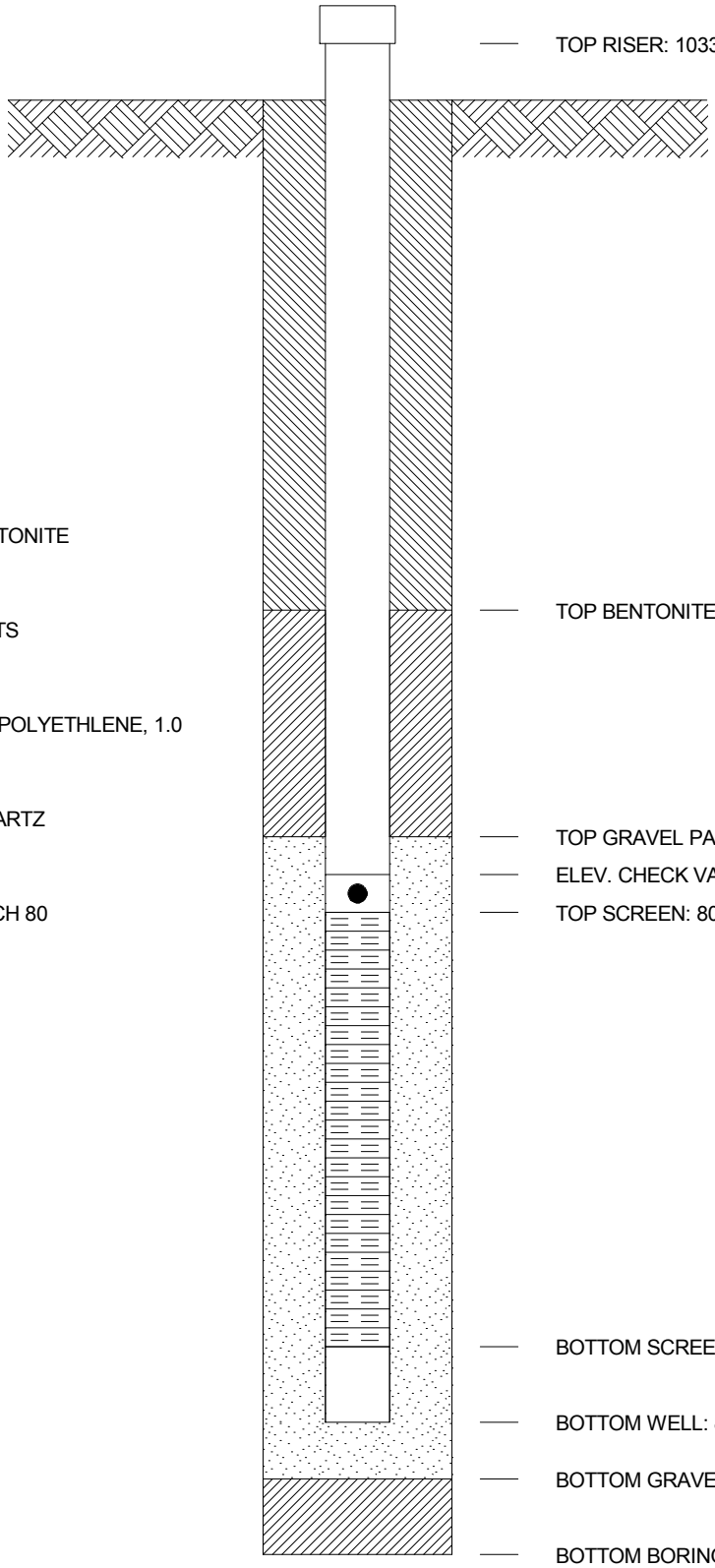
COMPANY **AMERICAN ELECTRIC POWER** WELL No. **M-10** BORING No. **85W-3** INSTALLED **8/13/85**

PROJECT **CARDINAL PLANT**

COORDINATES **N 829,994.0 E 2,518,683.2**

SYSTEM **STATE PLANE**

GROUND ELEVATION 1031.00 FT.



GROUT SEAL: CEMENT\BENTONITE

BENTONITE SEAL: PI PELLETS

SCREEN: 1.25 dia., PORPUS POLYETHLENE, 1.0

GRAVEL PACK: #4 OHIO QUARTZ

RISER PIPE: 0.8, dia., PVC SCH 80

SPACERS, DEPTH:

GEOMON 12"GEOMON

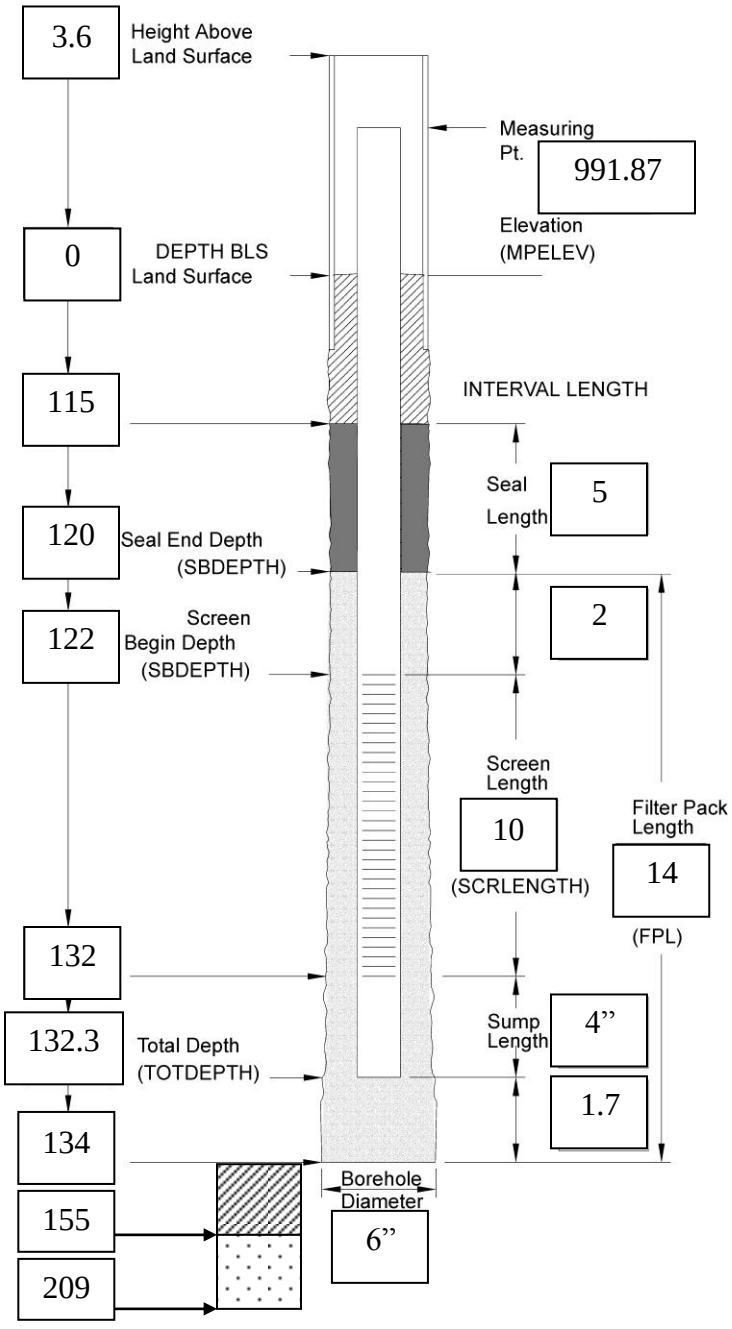
GEOMCNST CD SI.GPJ AEP.GDT 7/20/15

Geosyntec consultants

WELL CONSTRUCTION LOG
ABOVE GROUND COMPLETION

Well I.D. (LOCID): M-GS-1
Drilling Company: Layne
Drillers: Danny Allen
Geologist/Engineer: D. Mateas / M. Muenich
Signature: _____

Site: AEP – Cardinal Project Number: CHE8126L
Installation Method: HAS/Rotary
Casing Installation Date (INSDATE): 4/13/16
Well Type (WTCCODE): Monitoring Well
Well Completion Method (WCMCODE): Above Grade
Geologic Completion Zone (GZCODE): _____



Comments
Total drilled depth = 209'; backfilled with sand and chips to 134'; centralizer at 65'

Well Completion
2 Guard Posts (Y / N) Date: _____
Surface Pad Size: 2 ft x 2 ft x 6"
Protective Casing or Cover
Diameter/Type: 4" locking flip-top
Depth BGS: 2 Weep Hole (Y / N)
Grout
Composition/Proportions: 150 lbs Haliburton Bentonite Quick Grout / 100 gal. H_2O
Placement Method: pressure tremie

Seal Date: 4/13/16
Type: 3/8" coated bentonite pellets
Source: Pel-Plug Western Bentonite
Set-up/Hydration Time: 30 mins
Placement Method: poured gravity
Vol. Fluid Added: N/A - submerged
Filter Pack
Type: #5 med. coarse sand
Source: Flat Rock, Sparta, MI
Amount Used: 8 x 50 lb bags
Placement Method: poured gravity

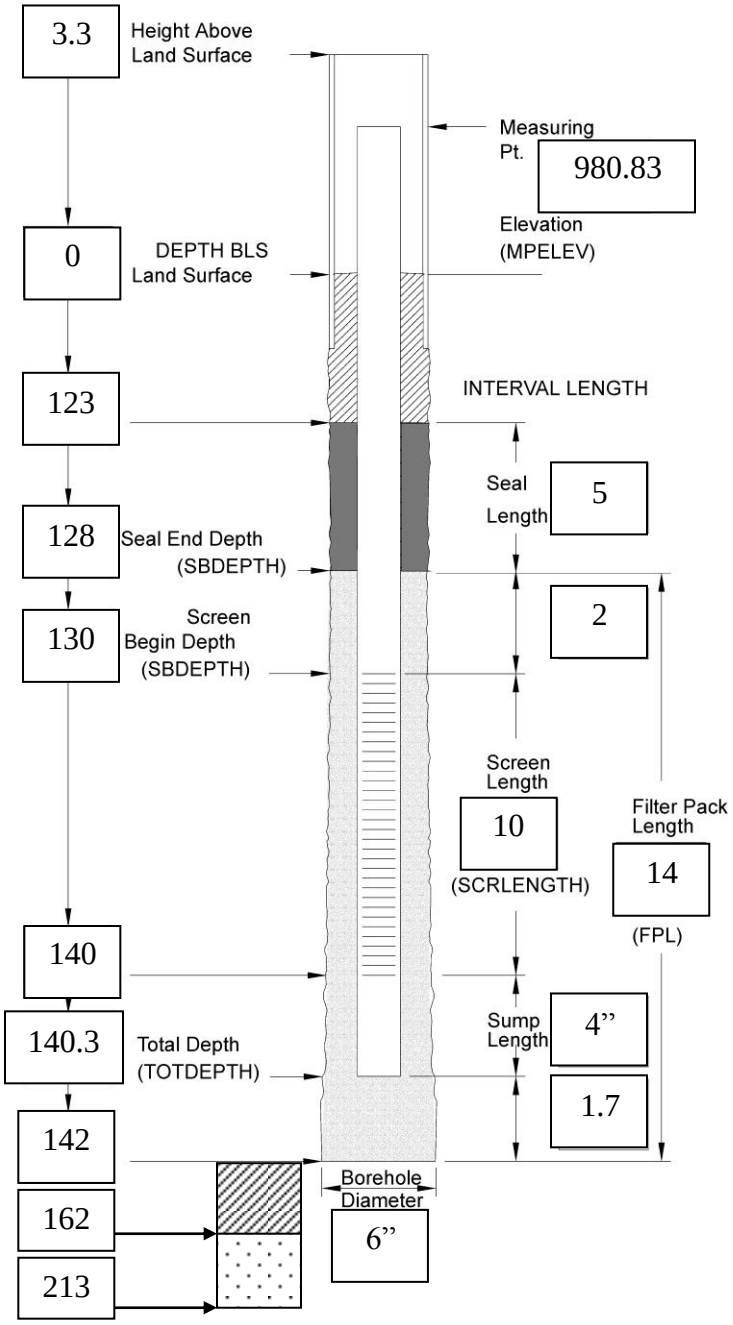
Well Riser Pipe
Casing Material (CMACODE): Sch. 40 PVC
Casing Inside Diameters (CASDIAM): 2.0 in.
Screen
Material: Pre-packed Sch. 40 PVC
Inside Diameter (SCRDIAM): 2.0 in.
Screen Slot Size: (SOUA): 0.010 10-slot in.
Percent Open Area (PCTOPEN): _____
Sump or Bottom Cap (Y / N)
Type/Length: 4" Sch. 40 PVC
Backfill Plug (Y / N)
Material: 3/8" med. crushed bentonite chips
Placement Method: poured gravity
Set-up/Hydration Time: _____
Total Water Volume During Construction
Introduced (Gal): 0 Recovered (Gal): -
Reviewed By: J. Neil Couch Date: 4/22/2016

Geosyntec consultants

WELL CONSTRUCTION LOG
ABOVE GROUND COMPLETION

Well I.D. (LOCID): M-GS-2
Drilling Company: Layne
Drillers: Danny Allen
Geologist/Engineer: D. Mateas / M. Muenich
Signature: _____

Site: AEP – Cardinal Project Number: CHE8126L
Installation Method: HSA
Casing Installation Date (INSDATE): 4/13/16
Well Type (WTCCODE): Monitoring Well
Well Completion Method (WCMCODE): Above Grade
Geologic Completion Zone (GZCODE): _____



Comments
Total drilled depth = 213'; backfilled to 142' with sand and chips (20' seal); 1 centralizer used at 70'

Well Completion
2 Guard Posts (Y / N) Date: _____
Surface Pad Size: 2 ft x 2 ft x 6"
Protective Casing or Cover
Diameter/Type: 4" locking flip-top
Depth BGS: 2 Weep Hole (Y / N)
Grout
Composition/Proportions: 150 lbs Haliburton Bentonite Quick Grout / 100 gal. H_2O
Placement Method: pressure tremie

Seal Date: 4/13/16
Type: 3/8" coated bentonite pellets
Source: Pel-Plug Western Bentonite
Set-up/Hydration Time: 30 mins
Placement Method: poured gravity
Vol. Fluid Added: N/A - submerged
Filter Pack
Type: #5 med. coarse sand
Source: Flat Rock, Sparta, MI
Amount Used: 6 x 50 lb bags
Placement Method: poured gravity

Well Riser Pipe
Casing Material (CMACODE): Sch. 40 PVC
Casing Inside Diameters (CASDIAM): 2.0 in.
Screen
Material: Pre-packed Sch. 40 PVC
Inside Diameter (SCRDIAM): 2.0 in.
Screen Slot Size: (SOUA): 0.010 10-slot in.
Percent Open Area (PCTOPEN): _____
Sump or Bottom Cap (Y / N)
Type/Length: 4" Sch. 40 PVC
Backfill Plug (Y / N)
Material: 3/8" med. crushed bentonite chips
Placement Method: poured gravity
Set-up/Hydration Time: _____
Total Water Volume During Construction
Introduced (Gal): 0 Recovered (Gal): -
Reviewed By: J. Neil Couch Date: 4/22/2016

Geosyntec consultants

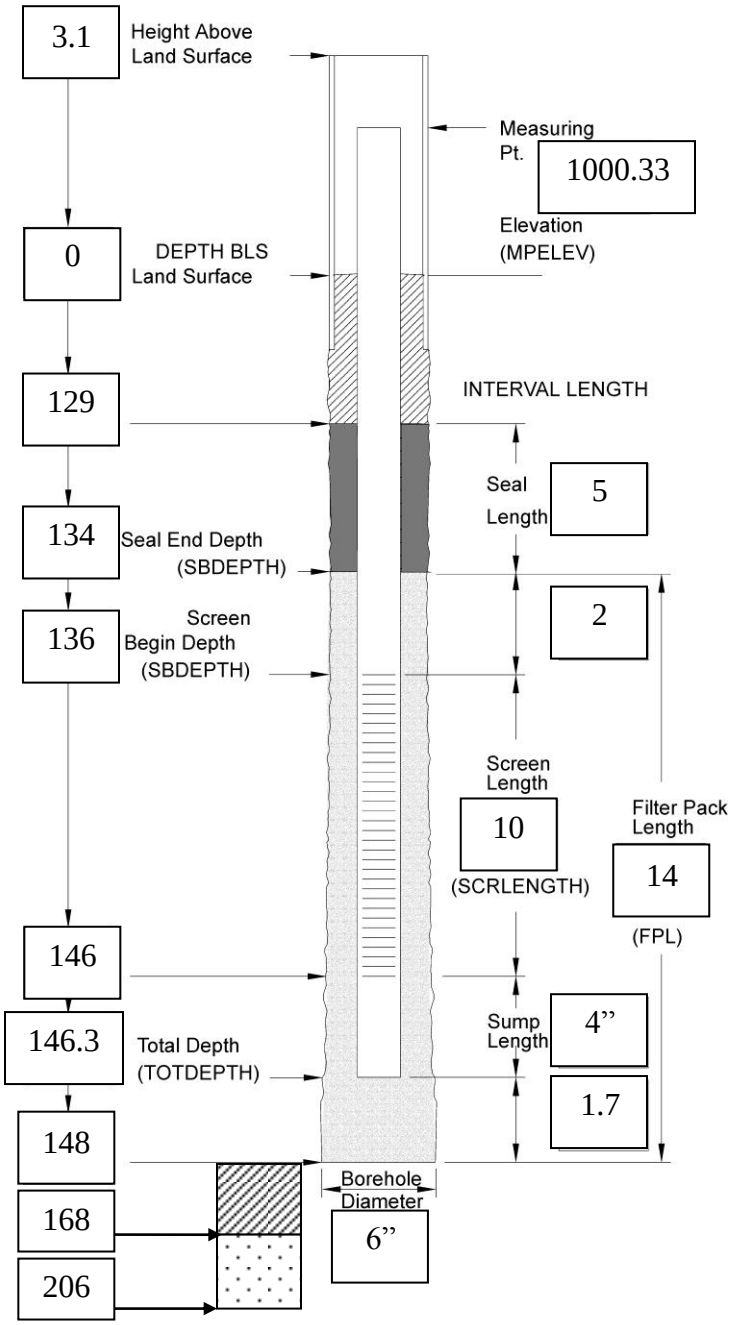
WELL CONSTRUCTION LOG
ABOVE GROUND COMPLETION

Well I.D. (LOCID): M-GS-3
Drilling Company: Layne

Drillers: Danny Allen
Geologist/Engineer: D. Mateas / M. Muenich
Signature:

Site: AEP – Cardinal Project Number: CHE8126L
Installation Method: HSA/Rotary

Casing Installation Date (INSDATE): 4/12/16
Well Type (WTCCODE): Monitoring Well
Well Completion Method (WCMCODE): Above Grade
Geologic Completion Zone (GZCODE):



Comments
Total boring depth = 206’; backfilled with sand then chips To 148’; centralizer used at 70’

Well Completion
2 Guard Posts (Y / N) Date:
Surface Pad Size: 2 ft x 2 ft x 6”
Protective Casing or Cover
Diameter/Type: 4” locking flip-top
Depth BGS: 2 Weep Hole (Y / N)
Grout
Composition/Proportions: 150 lbs Haliburton Bentonite Quick Grout / 100 gal. H_2O
Placement Method: pressure tremie

Seal Date: 4/12/16
Type: 3/8” coated bentonite pellets
Source: Pel-Plug Western Bentonite
Set-up/Hydration Time: 30 mins
Placement Method: poured gravity
Vol. Fluid Added: N/A - submerged
Filter Pack
Type: #5 med. filter pack
Source: Flat Rock Bagging, Sparta, MI
Amount Used:
Placement Method: poured gravity

Well Riser Pipe
Casing Material (CMACODE): Sch. 40 PVC
Casing Inside Diameters (CASDIAM): 2.0 in.
Screen
Material: Pre-packed Sch. 40 PVC
Inside Diameter (SCRDIAM): 2.0 in.
Screen Slot Size: (SOUA): 0.010 10-slot in.
Percent Open Area (PCTOPEN):
Sump or Bottom Cap (Y / N)
Type/Length: 4” Sch. 40 PVC
Backfill Plug (Y / N)
Material: 3/8” crushed bentonite hole plug
Placement Method: poured gravity
Set-up/Hydration Time:
Total Water Volume During Construction
Introduced (Gal): 0 Recovered (Gal): -
Reviewed By: J. Neil Couch Date: 4/22/2016

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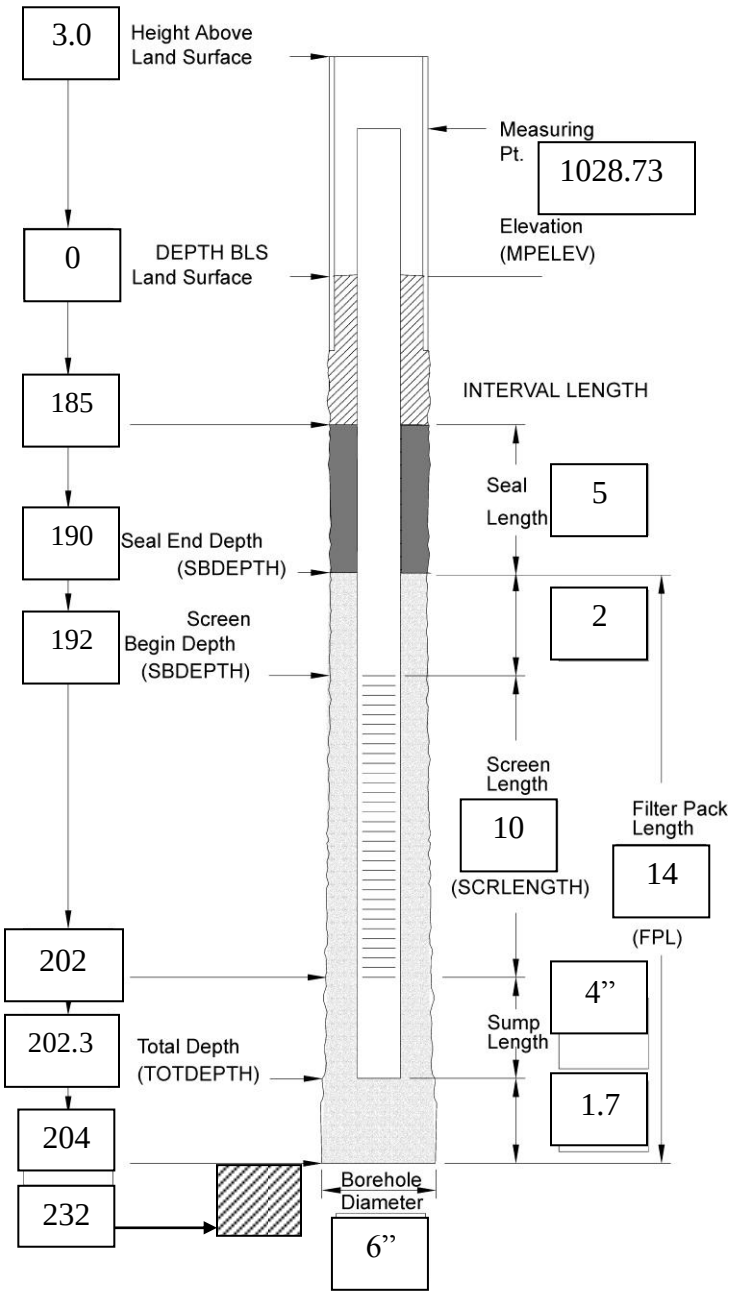
WELL CONSTRUCTION LOG
ABOVE GROUND COMPLETION

Well I.D. (LOCID): M-GS-4
Drilling Company: Layne
Drillers: Danny Allen
Geologist/Engineer: D. Mateas
Signature: _____

Site: AEP – Cardinal Project Number: CHE8126L
Installation Method: HAS/Rotary
Casing Installation Date (INSDATE): 04/21/2016
Well Type (WTCCODE): Monitoring Well
Well Completion Method (WCMCODE): Above Grade
Geologic Completion Zone (GZCODE): _____



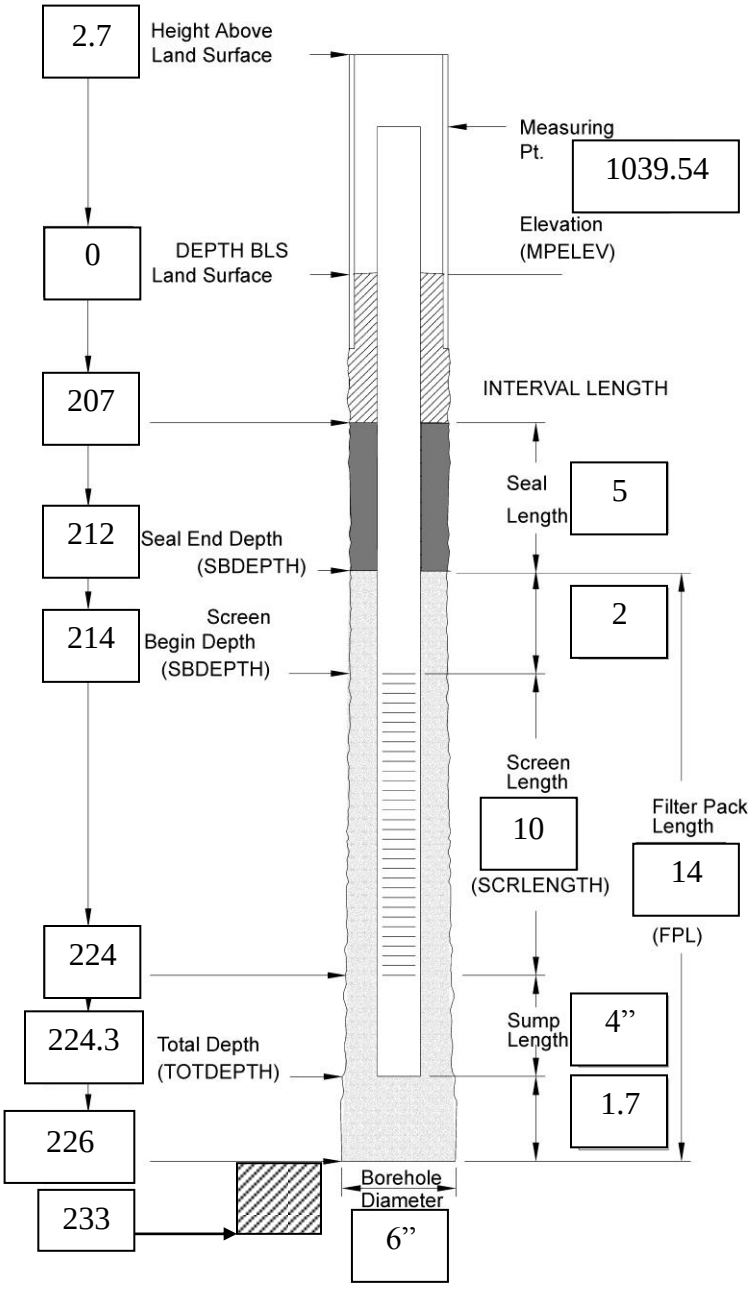
Comments
Total drilled depth = 232'; backfilled with chips to 204'.

Well Completion
2 Guard Posts (Y / N) Date: _____
Surface Pad Size: 2 ft x 2 ft
Protective Casing or Cover
Diameter/Type: 4" steel
Depth BGS: _____ Weep Hole ((Y) / N)
Grout
Composition/Proportions: 15 bags Bentonite grout
Placement Method: pressure tremie
Seal Date: 04/21/16
Type: 3/8" coated bentonite pellets
Source: Pel-Plug Western Bentonite
Set-up/Hydration Time: 30 mins
Placement Method: poured gravity
Vol. Fluid Added: N/A - submerged
Filter Pack
Type: #5 medium coarse sand
Source: Flat Rock, Sparta, MI
Amount Used: 14 x 50 lb bags
Placement Method: poured gravity
Well Riser Pipe
Casing Material (CMACODE): Sch. 40 PVC
Casing Inside Diameters (CASDIAM): 2.0 in.
Screen
Material: Pre-packed Sch. 40 PVC
Inside Diameter (SCRDIAM): 2.0 in.
Screen Slot Size: (SOUA): 0.010 10-slot in.
Percent Open Area (PCTOPEN): _____
(Sump) or Bottom Cap ((Y) / N)
Type/Length: 4" Sch. 40 PVC
Backfill Plug ((Y) / N)
Material: 3/8" medium crushed bentonite chips
Placement Method: poured gravity
Set-up/Hydration Time: _____
Total Water Volume During Construction
Introduced (Gal): _____ Recovered (Gal): _____
Reviewed By: J. Neil Couch Date: 5/03/2016

WELL CONSTRUCTION LOG
ABOVE GROUND COMPLETION

Well I.D. (LOCID): M-GS-5
Drilling Company: Layne
Drillers: Danny Allen
Geologist/Engineer: J. Bannantine
Signature: _____

Site: AEP – Cardinal Project Number: CHE8126L
Installation Method: HSA/Rotary
Casing Installation Date (INSDATE): 4/5/16
Well Type (WTCCODE): Monitoring Well
Well Completion Method (WCMCODE): Above Grade
Geologic Completion Zone (GZCODE): _____



Well Completion
2 Guard Posts (Y / N) Date: _____
Surface Pad Size: 2 ft x 2 ft x 6"
Protective Casing or Cover
Diameter/Type: 4" locking flip-top
Depth BGS: 2 Weep Hole (Y / N)
Grout
Composition/Proportions: 150 lbs Haliburton Bentonite
Quick Grout / 100 gal. H_2O
Placement Method: pressure tremie

Seal Date: 4/5/16
Type: 3/8" coated bentonite pellets
Source: Pel-Plug Western Bentonite
Set-up/Hydration Time: 30 mins
Placement Method: poured gravity
Vol. Fluid Added: N/A - submerged
Filter Pack
Type: #5 med. coarse sand
Source: Flat Rock, Sparta, MI
Amount Used: 8 x 50 lb bags
Placement Method: poured gravity

Well Riser Pipe
Casing Material (CMACODE): Sch. 40 PVC
Casing Inside Diameters (CASDIAM): 2.0 in.
Screen
Material: Pre-packed Sch. 40 PVC
Inside Diameter (SCRDIAM): 2.0 in.
Screen Slot Size: (SOUA): 0.010 10-slot in.
Percent Open Area (PCTOPEN): _____
Sump or Bottom Cap (Y / N)
Type/Length: 4" Sch. 40 PVC
Backfill Plug (Y / N)
Material: 3/8" med. crushed bentonite chips
Placement Method: poured gravity
Set-up/Hydration Time: _____
Total Water Volume During Construction
Introduced (Gal): 0 Recovered (Gal): -
Reviewed By: J. Neil Couch Date: 5/3/2016

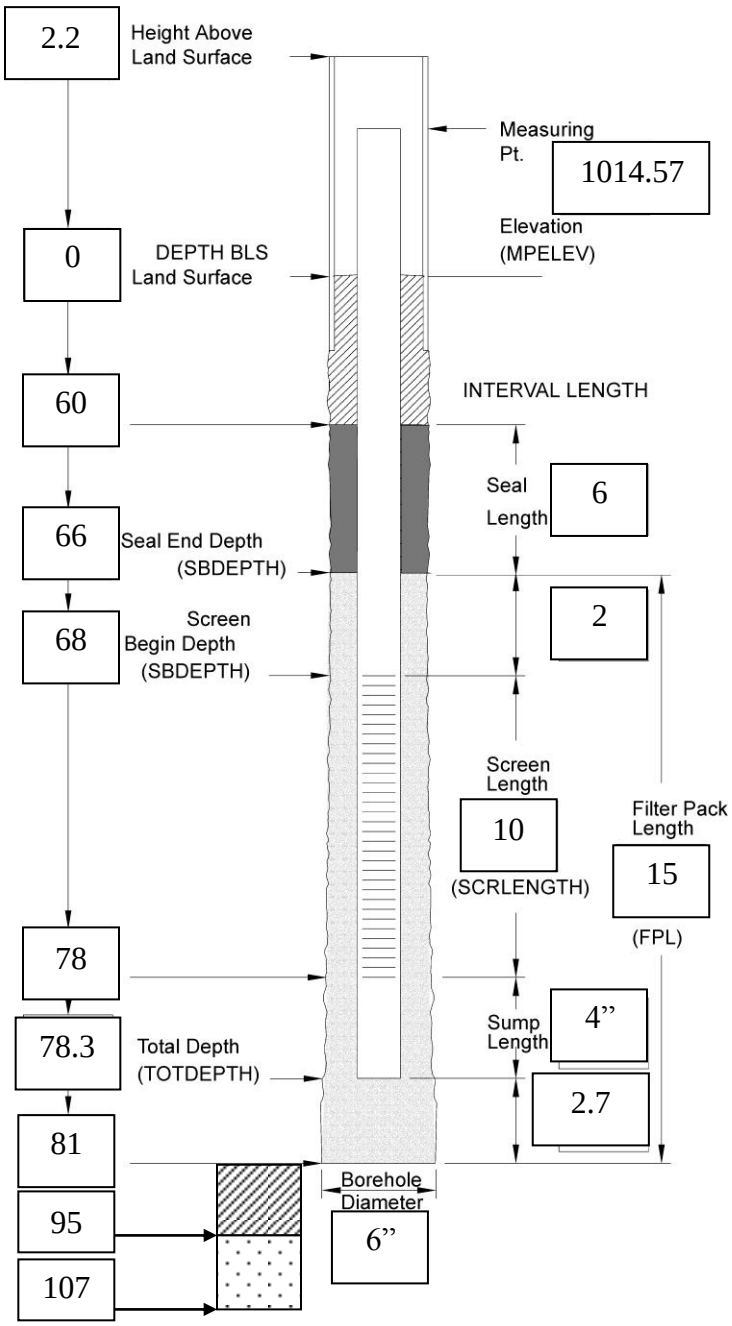
Comments
Total drilled depth = 233.3'; backfilled with chips to 226'

Geosyntec consultants

WELL CONSTRUCTION LOG
ABOVE GROUND COMPLETION

Well I.D. (LOCID): S-GS-1
Drilling Company: Layne
Drillers: Danny Allen
Geologist/Engineer: D. Mateas / M. Muenich
Signature: _____

Site: AEP – Cardinal Project Number: CHE8126L
Installation Method: HSA
Casing Installation Date (INSDATE): 4/12/16
Well Type (WTCCODE): Monitoring Well
Well Completion Method (WCMCODE): Above Grade
Geologic Completion Zone (GZCODE): _____



Well Completion
2 Guard Posts (Y / N) Date: _____
Surface Pad Size: 2 ft x 2 ft x 6"
Protective Casing or Cover
Diameter/Type: 4" locking flip-top
Depth BGS: 2.5 Weep Hole (Y / N)
Grout
Composition/Proportions: 150 lbs Haliburton Bentonite Quick Grout / 100 gal. H_2O; 15 x 50 lb bags
Placement Method: pressure tremie

Seal Date: 4/12/16
Type: 3/8" coated bentonite pellets; 2 x 5 gal buckets
Source: Pel-Plug Western Bentonite
Set-up/Hydration Time: 30 mins
Placement Method: poured gravity
Vol. Fluid Added: N/A - submerged
Filter Pack
Type: #5 filter sand
Source: Flat Rock Bagging, Sparta, MI
Amount Used: 30 x 50 lb bags
Placement Method: Poured gravity
Well Riser Pipe
Casing Material (CMACODE): Sch. 40 PVC
Casing Inside Diameters (CASDIAM): 2.0 in.
Screen
Material: Sch. 40 PVC
Inside Diameter (SCRDIAM): 2.0 in.
Screen Slot Size: (SOUA): 0.010 10-slot in.
Percent Open Area (PCTOPEN): _____
Sump or Bottom Cap ((Y) N)
Type/Length: 4" Sch. 40 PVC
Backfill Plug (Y (N)
Material: 3/8" med. crushed bentonite chips
Placement Method: poured gravity
Set-up/Hydration Time: _____

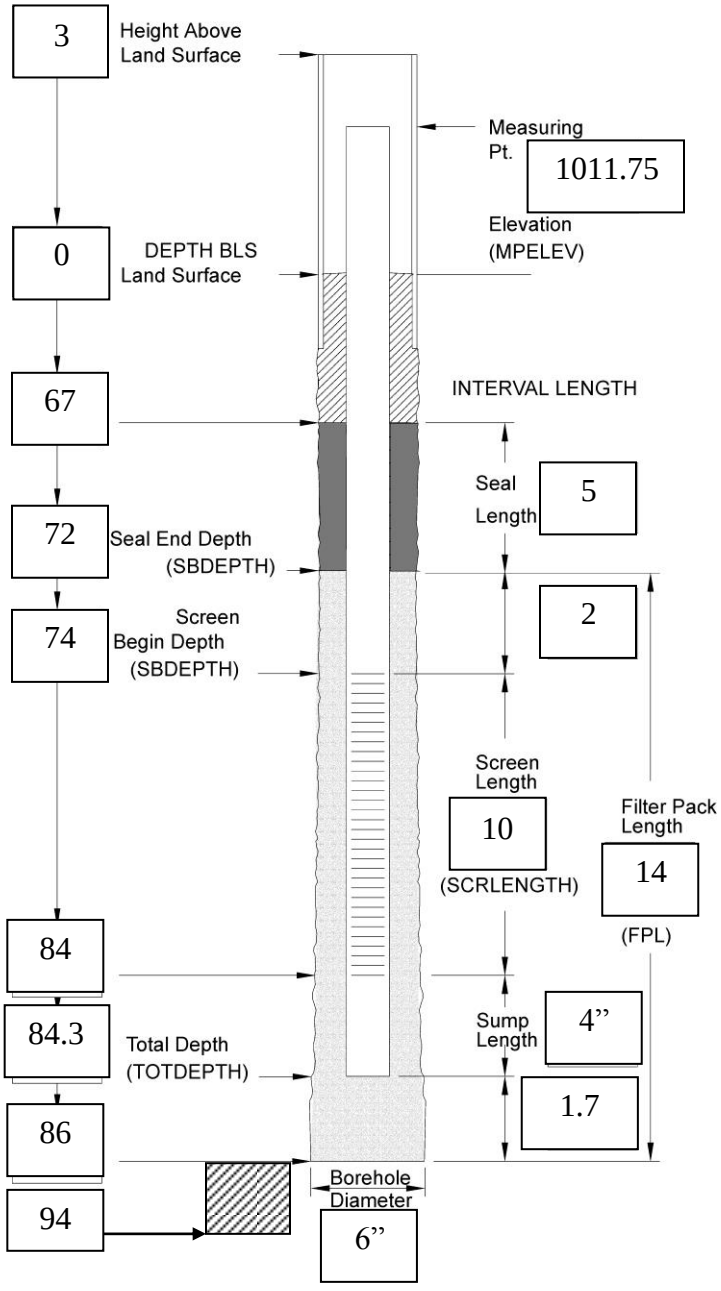
Comments
Total drilled depth = 107'; backfilled to 81' with sand and chips.

Total Water Volume During Construction
Introduced (Gal): 0 Recovered (Gal): -
Reviewed By: J. Neil Couch Date: 4/22/2016

WELL CONSTRUCTION LOG
ABOVE GROUND COMPLETION

Well I.D. (LOCID): S-GS-2
Drilling Company: Layne
Drillers: Danny Allen
Geologist/Engineer: D. Mateas / M. Muenich
Signature: _____

Site: AEP – Cardinal Project Number: CHE8126L
Installation Method: HSA
Casing Installation Date (INSDATE): 4/12/16
Well Type (WTCCODE): Monitoring Well
Well Completion Method (WCMCODE): Above Grade
Geologic Completion Zone (GZCODE): _____



Well Completion
2 Guard Posts (Y / N) Date: _____
Surface Pad Size: 2 ft x 2 ft x 6"
Protective Casing or Cover
Diameter/Type: 4" locking flip-top
Depth BGS: 2 Weep Hole (Y / N)
Grout
Composition/Proportions: 150 lbs Haliburton Bentonite
Quick Grout / 100 gal. H_2O
Placement Method: pressure tremie

Seal Date: 4/12/16
Type: 3/8" coated bentonite pellets
Source: Pel-Plug Western Bentonite
Set-up/Hydration Time: 30 mins
Placement Method: poured gravity
Vol. Fluid Added: N/A - submerged
Filter Pack
Type: #5 filter pack sand
Source: Flat Rock Bagging, Sparta, MI
Amount Used: 10 x 50 lb bags
Placement Method: poured gravity
Well Riser Pipe
Casing Material (CMACODE): Sch. 40 PVC
Casing Inside Diameters (CASDIAM): 2.0 in.
Screen
Material: Pre-packed Sch. 40 PVC
Inside Diameter (SCRDIAM): 2.0 in.
Screen Slot Size: (SOUA): 0.010 10-slot in.
Percent Open Area (PCTOPEN): _____
Sump or Bottom Cap (Y) N)
Type/Length: 4" Sch. 40 PVC
Backfill Plug (Y) N)
Material: 3/8" coated bentonite pellets
Placement Method: poured gravity
Set-up/Hydration Time: 45 mins

Comments
Total boring depth = 94 ft; backfilled with chips to 86'.

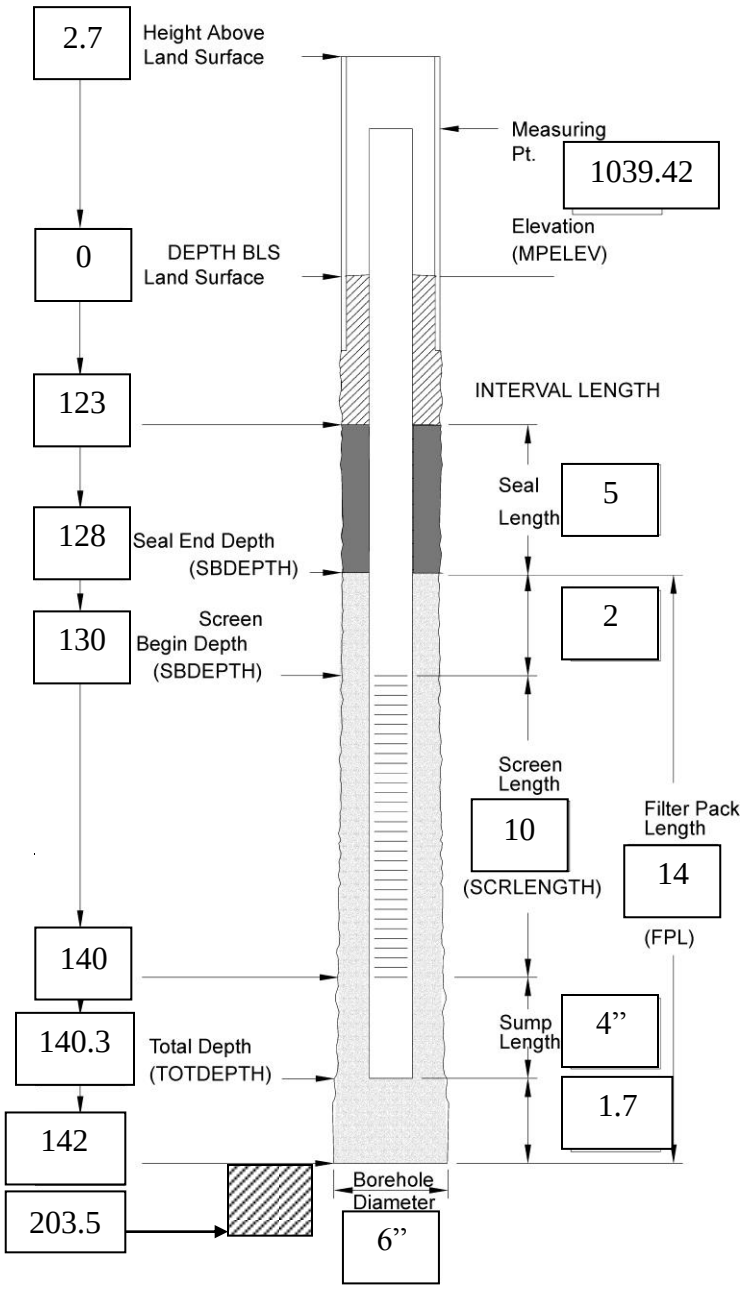
Total Water Volume During Construction
Introduced (Gal): 0 Recovered (Gal): -
Reviewed By: J. Neil Couch Date: 4/22/2016

Geosyntec consultants

WELL CONSTRUCTION LOG
ABOVE GROUND COMPLETION

Well I.D. (LOCID): S-GS-3
Drilling Company: Layne
Drillers: Danny Allen
Geologist/Engineer: J. Bannantine
Signature: _____

Site: AEP – Cardinal Project Number: CHE8126L
Installation Method: HSA/Rotary
Casing Installation Date (INSDATE): 4/5/16
Well Type (WTCCODE): Monitoring Well
Well Completion Method (WCMCODE): Above Grade
Geologic Completion Zone (GZCODE): _____



Well Completion
2 Guard Posts (Y / N) Date: _____
Surface Pad Size: 2 ft x 2 ft x 6"
Protective Casing or Cover
Diameter/Type: 4" locking flip-top
Depth BGS: 2 Weep Hole (Y / N)
Grout
Composition/Proportions: 150 lbs Haliburton Bentonite Quick Grout / 100 gal. H_2O
Placement Method: pressure tremie

Seal Date: 4/5/16
Type: 3/8" coated bentonite pellets
Source: Pel-Plug Western Bentonite
Set-up/Hydration Time: 30 mins
Placement Method: poured gravity
Vol. Fluid Added: N/A - submerged
Filter Pack
Type: #5 med. coarse sand
Source: Flat Rock, Sparta, MI
Amount Used: 8 x 50 lb bags
Placement Method: poured gravity

Well Riser Pipe
Casing Material (CMACODE): Sch. 40 PVC
Casing Inside Diameters (CASDIAM): 2.0 in.
Screen
Material: Pre-packed Sch. 40 PVC
Inside Diameter (SCRDIAM): 2.0 in.
Screen Slot Size: (SOUA): 0.010 10-slot in.
Percent Open Area (PCTOPEN): _____
Sump or Bottom Cap (Y / N)
Type/Length: 4" Sch. 40 PVC
Backfill Plug (Y / N)
Material: 3/8" med. crushed bentonite chips
Placement Method: poured gravity
Set-up/Hydration Time: _____
Total Water Volume During Construction
Introduced (Gal): 0 Recovered (Gal): -
Reviewed By: J. Neil Couch Date: 5/3/2016

Comments
Total drilled depth = 203.5'; backfilled with chips to 142'.

Appendix B

Well Construction and Boring Logs

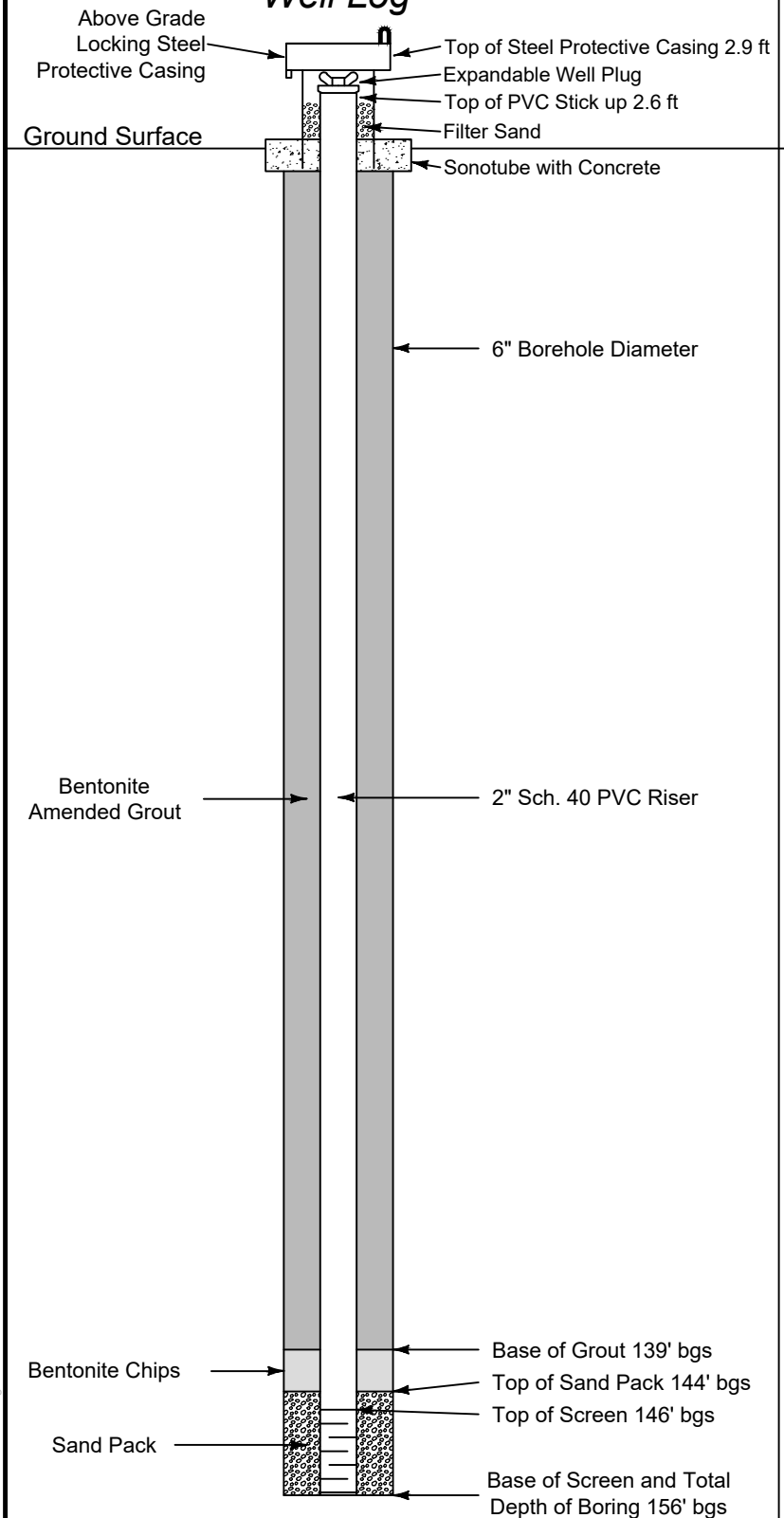
Cox-Colvin & ASSOCIATES, INC. ENVIRONMENTAL SERVICES

Well Construction Log
Well #: M-GS-3R

Project: Cardinal Power Plant
Site Location: Brilliant, Ohio

Coordinates: 830875.88 N	2518836.33 E	(NAD 27)	☒ Surveyed ☐ Estimated
Measuring Point Elevation:	1001.44' amsl	(NGVD 29)	☒ Surveyed ☐ Estimated
Ground Surface Elevation:	998.75' amsl	(NGVD 29)	☒ Surveyed ☐ Estimated

Well Log



Well Construction Details

Well Type: Monitor Well (2" PVC)
Measuring Point Description: Top of Casing
Drilling Company: Cascade Drilling
Driller: Josh Stigler
Drilling Method: Rotary-Sonic 6-inch Core Barrel
Drilling Fluid: Water (from Truck Wash Hydrant)
Fluid Loss During Drilling (gal): 100
Installation Date(s): 05/02 to 05/03/2022
Development Technique: Over Pumping
Development Date: 05/04/2022
Fluid Developed (gal): 44
Static Depth to Water: 67.49 ft
Static Depth to Water Date: 05/04/2022
Prepared by: C. Creal
Soil Boring Cross-Reference: M-GS-3R
Total Depth Below Measuring Point: 158.60 ft
Well Screen: 2" Sch. 40 Screen 0.01" Slot
Comments: Well purged dry multiple times during development. Majority of lost drilling water in void above screened depth.

Unless noted otherwise, all well construction depths are below ground surface (bgs)

DWG NAME: Well Log M-GS-3R DATE PRINTED: 8/30/2022 K:\CCA\PROJECTS\Buckeye_Power\Cardinal\Drawings

Cox-Colvin & Associates, Inc. ENVIRONMENTAL SERVICES

LITHOLOGIC LOG

Boring # : **M-GS-3R**

Boring/Well: **M-GS-3R**
Total Depth: **156 ft**
Drilling Co.: **Cascade**
Driller: **Josh Stigler**
Drilling Method: **Sonic**

Project: **M-GS-3R Installation**
Logged by: **Colton Creal**
Boring Diameter: **6 in**
Sample Interval (ft): **Continuous**
Sampling Device: **Sonic Tooling**

Site: **Cardinal**
Start/Completion: **5/2/22 - 5/3/22**
Location: **Brilliant, Ohio**
Survey Information
Ground Elevation: **998.75 ft amsl**
Northing,Easting (NAD 27): **830875.88, 2518836.33**

Depth (ft)	Recovery (ft)	Lithology	Description and Classification
0	6		OVERBURDEN: Yellowish brown (10YR5/6) sandy lean clay with gravel, medium to high plasticity, moist. Sand and gravel size rock fragments (light brown-brown), orange mottling.
6	4		OVERBURDEN: Medium light gray (N6) to olive gray (5Y4/1) highly weathered siltstone and shale in a lean clay matrix (oxidized – orange mottling), moist, medium plasticity. Highly weathered and very intensely fractured limestone and carbonaceous shale from 9.5'-10', 0.01' seam of decomposed plant organics (black) at 8'.
10	5.1		LIMESTONE: Medium gray (N5), microcrystalline. Moderately weathered, intensely fractured, friable, little pitted weathering, trace pyrite mineralization.
12			SILTSTONE: Medium gray (N5) in a silt matrix. Highly to severely weathered, intensely fractured, fissile.
16			SANDSTONE: Medium dark gray (N4), fine-medium grained, micaceous. Very slightly fractured with few horizontal fractures, cross-bedded.
18			

Depth (ft)	Recovery (ft)	Lithology	Description and Classification
20			
	10		CLAYSTONE: Medium gray (N5). Moderately to highly weathered, very thinly bedded to laminated, clay matrix in weathered fraction.
22			SILTSTONE: Yellowish gray (5Y7/2). Moderately fractured, sub-vertical to sub-horizontal fractures with slightly weathered surfaces, black (N1) fragments filling fractures.
			SANDSTONE: Medium gray (N5), fine-grained. Very slightly fractured with few horizontal fractures, slightly weathered (pitted, trace fine gravel size voids), little to few limestone nodules, cross bedding at base of unit.
24			SILTSTONE: Medium bluish gray (5B5/1) to medium gray (N5) in a silt matrix. Highly weathered, soft, friable, intensely fractured (blocky), little mineral nodules (greenish in color) throughout interval, moderately bedded from 26'-29'.
26			
28			
30	9		CLAYSTONE: Dark greenish gray (5GY4/1) to grayish red purple (5PR4/2). Mottling, slightly weathered, intensely to very intensely fractured, trace slickensides.
32			
34			SILTSTONE: Medium light gray (N6) to medium gray (N5), sandy. Moderately fractured (few vertical fractures), moderately to thinly bedded, few limestone nodules.
36			
38			CLAYSTONE: Medium dark gray (N4). Moderately fractured, thinly bedded to laminated, trace calcareous mineral veins, trace voids (<0.1’ diameter) filled with sandy clay (high plasticity). Intensely fractured from 37’-38’, increase in silt fraction with depth.
40			
	10		
42			

Depth (ft)	Recovery (ft)	Lithology	Description and Classification
44			
46			
48			
50	5.5		LIMESTONE: Medium gray (N5), microcrystalline. Intensely fractured (natural random fractures – irregular), green mottling.
52			
54			
56			
58	5.25		SHALE: Medium gray (N5), calcareous. Thinly bedded to laminated, gradual grading from intensely to moderately fractured, alteration of mineral veins (tan) near base of interval.
60			
62			
64			LIMESTONE: Medium light gray (N6), microcrystalline. Intensely fractured with clayey silt filled voids and fractures.
66			

Depth (ft)	Recovery (ft)	Lithology	Description and Classification
68			CLAYSTONE: Greenish gray (5G4/1) to grayish red (5R4/2) at 70'-72'. Intensely fractured, silty clay filled vertical fractures, becomes slightly fractured with depth.
70	8.3		
72			SILTSTONE: Greenish gray (5GY6/1). Intensely fractured, soft, friable, reddish mottling.
74			LIMESTONE: Light gray (N7), microcrystalline. Slightly weathered, intensely fractured, trace pyrite mineralization veins, becomes very thinly bedded at base of interval.
76			CLAYSTONE: Grayish red purple (5RP4/2) to dark greenish gray (5G4/1), grading to medium gray (N5) with depth. Moderately fractured with sub-horizontal fractures, moderately weathered, soft to moderately soft.
78			
80			
82	9.5		
84			SHALE: Medium gray (N5). Moderately to highly weathered, laminated, little pyrite mineralization.
86			CLAYSTONE: Medium dark gray (N4). Intensely fractured (irregular pattern), few reddish nodules, moderately soft to hard with depth.
88			SILTSTONE: Medium gray (N5), sandy. Slightly fractured, hard, moderately fractured and highly weathered from 89'-89.5' and 94.5'-96', few thin beds (~0.2') of increased clay content (claystone).

Depth (ft)	Recovery (ft)	Lithology	Description and Classification
90	7.5		
92			
94			
96			SANDSTONE: Medium gray (N5) to medium dark gray (N4), fine grained, silty. Slightly to very slightly fractured with few horizontal fractures, cross-bedded, little pyrite mineralization, few bedding planes of moderately sorted medium to coarse grained sand.
98			
100	10		
102			
104			
106			SHALE: Medium dark gray (N4), sandy. Moderately to intensely fractured, thinly bedded to laminated, slightly weathered with few voids.
108			
110	10		LIMESTONE: Light gray (N7). Moderately fractured with voids at the base of interval.
112			SHALE: Grayish red (10R4/2) to medium light gray (N6). Moderately to slightly fractured with medium light gray (N6) silty clay matrix inside the fractures, little to few limestone nodules, little moderate greenish yellow (10Y7/4) fine gravel size angular fragments in fractures.

Depth (ft)	Recovery (ft)	Lithology	Description and Classification
114			
116			
118			
120			
122	10		SILTSTONE: Medium gray (N5). Few highly weathered beds, moderately to intensely fractured with angular sand size rock fragments filling fractures.
124			
126			CLAYSTONE: Dark gray (N3), silty. Slightly to moderately fractured with horizontal fractures along bedding planes, becomes highly fractured from 136’-137’, coal seams from 132'-133'.
128			
130			
132	7.7		
134			
136			

Depth (ft)	Recovery (ft)	Lithology	Description and Classification
138			COAL: Black (N1). Coal seam with coal bearing shale.
			SANDSTONE: Grayish black (N2), fine grained, poorly sorted, micaceous. Thinly bedded to laminated, few mineral nodules, trace coal bearing seams.
140	9.5		SANDSTONE: Dark gray (N3) to medium gray (N5), micaceous, Morgantown Sandstone. Slightly fractured to moderately fractured, primarily horizontal to sub-horizontal fractures with few vertical to sub-vertical fractures from 144'-147', oxidized dark yellowish orange (10YR6/6) to light brown (5YR5/6) from 139.75'-143.75' and dark yellowish brown (10YR4/2) from 148.5'-151', void from 143'-143.25', trace coal seams (~0.01' thick) in top 2' of interval, trace black (N1) mineralization at 146'.
142			
144			
146			
148	9.5		
150			
152			
154			
156			