CCR RULE GROUNDWATER MONITORING CERTIFICATION

COAL ASH PONDS
ELMER SMITH STATION
DAVIESS COUNTY
OWENSBORO, KENTUCKY

Prepared For:

OWENSBORO MUNICIPAL UTILITIES
OWENSBORO, KENTUCKY

Prepared By:

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
PITTSBURGH, PENNSYLVANIA

CEC Project 164-014

OCTOBER 17, 2017

(AMENDED MARCH 2019)

Civil & Environmental Consultants, Inc.

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1.0 INTRODUCTION

1.1 PURPOSE

The United States Environmental Protection Agency (USEPA) issued 40 CFR §257, Subpart D, *Disposal of Coal Combustion Residuals from Electric Utilities* (CCR Rule) on April 17, 2015. The CCR Rule regulates disposal of CCR in new and active landfills and impoundments.

The CCR Rule states the following criteria for a groundwater monitoring system (GMS) (40 CFR §257.91):

> (a) *Performance standard.* The owner or operator of a CCR unit must install a GMS that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that:
>
> > (1) Accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit. A determination of background quality may include sampling of wells that are not hydraulically upgradient of the CCR management area where:
> >
> > > (i) Hydrogeologic conditions do not allow the owner or operator of the CCR unit to determine what wells are hydraulically upgradient; or
> > >
> > > (ii) Sampling at other wells will provide an indication of background groundwater quality that is as representative or more representative than that provided by the upgradient wells; and
> >
> > (2) Accurately represent the quality of groundwater passing the waste boundary of the CCR unit. The downgradient monitoring system must be installed at the waste boundary that ensures detection of groundwater contamination in the uppermost aquifer. All potential contaminants must be monitored.
>
> (b) The number, spacing, and depths of monitoring systems shall be determined based upon site-specific technical information that must include thorough characterization of:
>
> > (1) Aquifer thickness, groundwater flow rate, groundwater flow direction including seasonal and temporal fluctuations in groundwater flow; and
> >
> > (2) Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer, including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities and effective porosities.

(c) The GMS must include the minimum number of monitoring wells necessary to meet the performance standards specified in paragraph (a) of this section, based on the site-specific information specified in paragraph (b) of this section. The GMS must contain:

(1) A minimum of one upgradient and three downgradient monitoring wells; and

(2) Additional monitoring wells as necessary to accurately represent the quality of background groundwater that has not been affected by leakage from the CCR unit and the quality of groundwater passing the waste boundary of the CCR unit.

The CCR Rule continues to outline well installation, development, sampling, and decommissioning requirements. The CCR Rule requires the owner or operator to obtain a certification from a qualified professional engineer stating that the GMS has been designed and constructed as outlined here. A record of the certification must be placed in the facility's operating record and the publicly accessible internet site and the state must be notified that the information is available.

Owensboro Municipal Utilities (OMU) installed a GMS at their CCR unit to comply with the CCR Rule. OMU retained Civil & Environmental Consultants (CEC) to assist with the design, installation and sampling of the GMS, and the preparation of this report. This report has been amended to provide documentation regarding installation of an additional GMS monitoring well (MW-8) in accordance with the requirements of the CCR Rule.

2.0 SITE OVERVIEW

2.1 BACKGROUND

The Ash Pond area associated with the Elmer Smith Station (ESS) is less than 10 acres in size and consists of three separate unlined ash settling basins (Ponds 1, 2, and 3). A site location map and a site and vicinity aerial map showing the location of the Ash Ponds are provided as Figures 1 and 2, respectively. The basins are not used for the disposal of CCR but for the temporary storage of CCR material prior to being excavated and transported off-site for disposal or beneficial re-use. Pond 1 is used for Unit 1 boiler slag; Pond 2 receives all other ash as well as water plant blowdown (lime softening sludge); and, Pond 3 receives no ash directly and is used for final settling prior to discharge. Other plant discharges, including coal pile runoff, Flue Gas Desulfurization (FGD) blowdown, roof and floor drains, etc. are also conveyed through the ponds. Based on a review of aerial images, contour data from the USGS National Map, Owensboro East Quadrangle, and a site map prepared by others labeled "Structural Fill Finish Grading" dated August 28, 1962[1], the Ash Ponds appear to be incised in the native soils to a depth of approximately 8 feet below ground surface (bgs). This was confirmed through knowledge of site personnel.

Permanent groundwater monitoring wells were not previously installed at the ESS Ash Pond area and no prior groundwater monitoring had been conducted prior to the GMS installation. To comply with the Federal CCR Rule (Section §257.91) published April 17, 2015, permanent groundwater monitoring wells were installed to meet the GMS performance standard.

2.2 HYDROGEOLOGIC SETTING

Subsurface conditions encountered at the site, as evidenced by the soil borings advanced in association with a preliminary Hydrogeologic investigation and the permanent GMS wells, are consistent with Quaternary-aged alluvium, and buried outwash (Tazewell age) typically found within the Ohio River Valley[2]. Variable thicknesses of fine-grained silt and clay lenses are

[1] Drawing No. S-7 "Structural Finish Grading", prepared by Black & Veatch, dated August 28, 1962.

interbedded with deposits of coarser-grained, poorly-graded sand beneath a thin veneer of topsoil, crushed stone fill, or other fill material. The near-surface fine-grained deposits are thicker near the Ohio River, and decrease in thickness away from the river towards the southeast, where sand becomes the predominant soil type. A low permeability clay layer was encountered at depths ranging from 26 to 43 feet bgs, varying in thickness from approximately 1 foot to over 16 feet, with an increasing trend in the thickness of this layer towards the south/southeast. The clay layer is underlain by saturated, coarse-grained deposits that constitute the uppermost aquifer at the site. Aquifer saturated thickness in the vicinity of the site ranges from approximately 60 to 100 feet[2]. Based on the depth to groundwater and the depth of the Ash Ponds, it does not appear that groundwater is in direct communication with the Ash Ponds. Lithology encountered in the borings advanced for the monitoring wells that comprise the GMS is documented in the boring logs included in Appendix A.

2.2.1 Hydrogeologic Characteristics

Groundwater elevation data collected to date have ranged from 346.80 feet above mean sea level (amsl) at MW-7 to 370.29 feet amsl at MW-3. The normal pool elevation of the adjacent Ohio River in the vicinity of ESS is approximately 358 feet AMSL[3]. Potentiometric data are summarized on Table 1 and shown on Figure 3.

Groundwater elevation measurements indicate that the groundwater flow direction is to the southeast at an approximate average hydraulic gradient of 0.006. This flow direction is contrary what is typically observed in this type of hydrogeologic setting, where groundwater flow is towards the surface water body. The southeasterly flow direction is interpreted to be a result of the pumping influence from the 11 nearby water production wells (Figure 2) associated with municipal water production operations at OMU's Cavin Water Treatment Plant, which has a capacity of up to 10 million gallons per day. Between the Cavin Plant and Water Plant A, which is located west of the Cavin Plant and draws from the same well field, OMU's total withdrawal capacity is 28 million

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[2] *Geohydrology and Simulation of Ground-Water Flow for the Ohio River Alluvial Aquifer near Owensboro, Northwestern Kentucky.* U.S. Geological Survey Water-Resources Investigation Report 96-4274. 1997. Figure 7.

[3]Ohio River Navigation Charts from Cairo, Illinois to Foster, Kentucky (June 2010). U.S. Army Corps of Engineers, Louisville District. Chart No. 53.

gallons per day. Absent operation of the production wells, groundwater flow direction is likely to the northwest towards the Ohio River; however, some combination of pumping wells is always in operation and all of the observed groundwater levels measured since the installation of the GMS (Table 1) indicate a southeasterly groundwater flow direction.

Hydraulic conductivity of the uppermost aquifer was not evaluated as part of the GMS installation process; however, based on published scientific reports, the site is located in an area where horizontal hydraulic conductivity values are estimated to range from 126 to 157 feet per day[4].

[4]*Geohydrology and Simulation of Ground-Water Flow for the Ohio River Alluvial Aquifer near Owensboro, Northwestern Kentucky.* U.S. Geological Survey Water-Resources Investigation Report 96-4274. 1997. Figure 11.

3.0 GROUNDWATER MONITORING SYSTEM

3.1 MONITORING WELL SELECTION

The GMS consists of eight monitoring wells. Monitoring wells MW-1 and MW-3 are used to monitor groundwater elevation, and monitoring wells MW-2, MW-4, MW-5, MW-6, MW-7, and MW-8 are utilized to monitor both groundwater elevation and quality. As noted above in Section 2.2.1, the well field pumping influence and proximity of the Ash Ponds to the Ohio River create a unique hydrogeologic setting where there is not an ideal location to establish background groundwater quality conditions (i.e., groundwater that does not have the potential to be affected by leakage from a CCR unit). Two monitoring wells (MW-2 and MW-7) will be used to establish and monitor background groundwater conditions.

While MW-2 is currently hydraulically upgradient, this is an artificial condition created by the operation of the production wells. Prior to the operation of the production wells (ca. 1998) this well was in a downgradient location. Also, should the production wells cease to operate in the future, groundwater flow direction would likely be reversed toward the river and MW-2 would be in a downgradient location. Because of this unique and artificial condition, the MW-7 location was also selected to accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit. MW-7, while located hydraulically downgradient from the ash ponds, is placed in a location so as not to be on a direct flow path from the ponds. MW-7 is also at a sufficient distance from the ponds to be representative of background conditions for the well field aquifer.

Downgradient monitoring wells MW-4, MW-5 and MW-6 will be used to monitor water quality of groundwater passing the waste boundary of the CCR unit. These wells were placed as close as possible to the waste boundary to provide for detection of groundwater contamination in the uppermost aquifer. Additionally, in the event that the well field should cease pumping operations for an extended period of time and the groundwater flow direction reverts back toward the river, monitoring wells MW-1 and MW-3 (currently used only for water level monitoring) can serve as future downgradient wells along with MW-2.

Monitoring well MW-8 was installed in December 2018 after one constituent (molybdenum) was quantified at a statistically significant level (SSL) in downgradient monitoring wells MW-5 and MW-6 in an effort to characterize the nature and extent of the release, as required by §257.95(g)(1).

A summary of the GMS wells is provided in the table below.

CCR RULE GROUNDWATER MONITORING SYSTEM

Location	Relative Location	Well Diameter (in.)	Total Depth (ft-bgs)	Screen Length (ft)
MW 1	Upgradient	4	57	10
MW-2	Upgradient (Background)	4	57	10
MW-3	Upgradient	4	57	10
MW-4	Downgradient	4	59	10
MW-5	Downgradient	4	59	10
MW-6	Downgradient	4	59	10
MW-7	Downgradient (Background)	4	72	10
MW-8	Downgradient	4	63	15

3.2 WELL CONSTRUCTION

The wells are completed in unconsolidated sand and gravel deposits associated with the Ohio River Valley alluvium and outwash complex. Each of the GMS wells was advanced using hollow-stem augers and constructed of 4-inch diameter schedule 40 polyvinyl chloride (PVC) casing with 10 to 15 feet of 0.010-inch slotted well screen and solid riser extended to a height of approximately 2.5 feet above the ground surface (reference Appendix A). Well screens were placed to monitor the uppermost aquifer. Each of the well screens was constructed using U-Pack® double-walled screens instead of traditional single-walled screens to assist with the collection of low turbidity groundwater samples. The U-Pack® screens were filled with sand filter media (silica sand) along the length of the screen prior to lowering it into the borehole to prevent installation of the filter sand through a turbid water column, which can entrain sediment in the filter pack. Global Drilling Suppliers, Inc. #7 filter sand was utilized within the U Pack® screens. As the augers were extracted at each monitoring well location, the annular space between the borehole and the U-Pack® well

screen was backfilled with Global Drilling Suppliers, Inc. #5 filter sand from the base of the screen to approximately 2 feet above the screen. Coated bentonite pellets were then placed in the annulus and hydrated with potable water to construct an approximate 5-foot thick seal above the filter pack. Bentonite grout was then placed via tremie pipe from the top of the seal to ground surface elevation. Each well is completed with a locking steel protective cover, concrete pad, and protective bollards. The Kentucky Attach Well Identification Number (AKGWA) Well Identification label is affixed to the underside of each protective cover lid. After construction, the wells were developed via a combination of surging, bailing and pumping techniques to clean the screens, reduce turbidity, and establish communication with the aquifer.

4.0 GROUNDWATER MONITORING CERTIFICATION

CCR Impoundment Information
Name: Elmer Smith Station Ash Ponds
Operator: Owensboro Municipal Utilities
Address: 4301 E 4th Street Owensboro, Kentucky 42303

Qualified Professional Engineer:
Name: James E. Zentmeyer
Company: Civil & Environmental Consultants

I, James E. Zentmeyer, certify that this Groundwater Monitoring System for the Elmer Smith Station Ash Ponds has been designed and constructed to meet the requirements of the Coal Combustion Residual (CCR) rule 40 CFR §257.91. I am a duly licensed Professional Engineer under the laws of Kentucky.

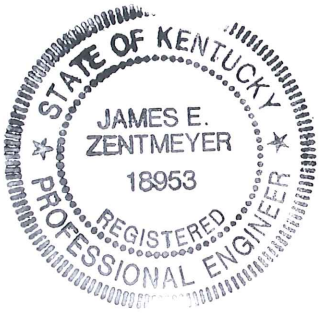
Print Name: James E. Zentmeyer

Signature: _____

Date: 3/29/19

License Number: 18953

My license renewal date is: June 30, 2020



Qualified Professional Geologist:
Name: Matthew G. Nemecek
Company: Civil & Environmental Consultants

I, Matthew G. Nemecek, certify that this Groundwater Monitoring System for the Elmer Smith Station Ash Ponds has been designed and constructed to meet the requirements of the Coal Combustion Residual (CCR) rule 40 CFR §257.91. I am a duly licensed Professional Geologist under the laws of Kentucky.

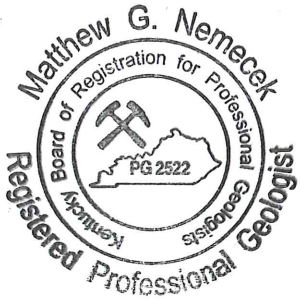
Print Name: Matthew G. Nemecek

Signature: _____

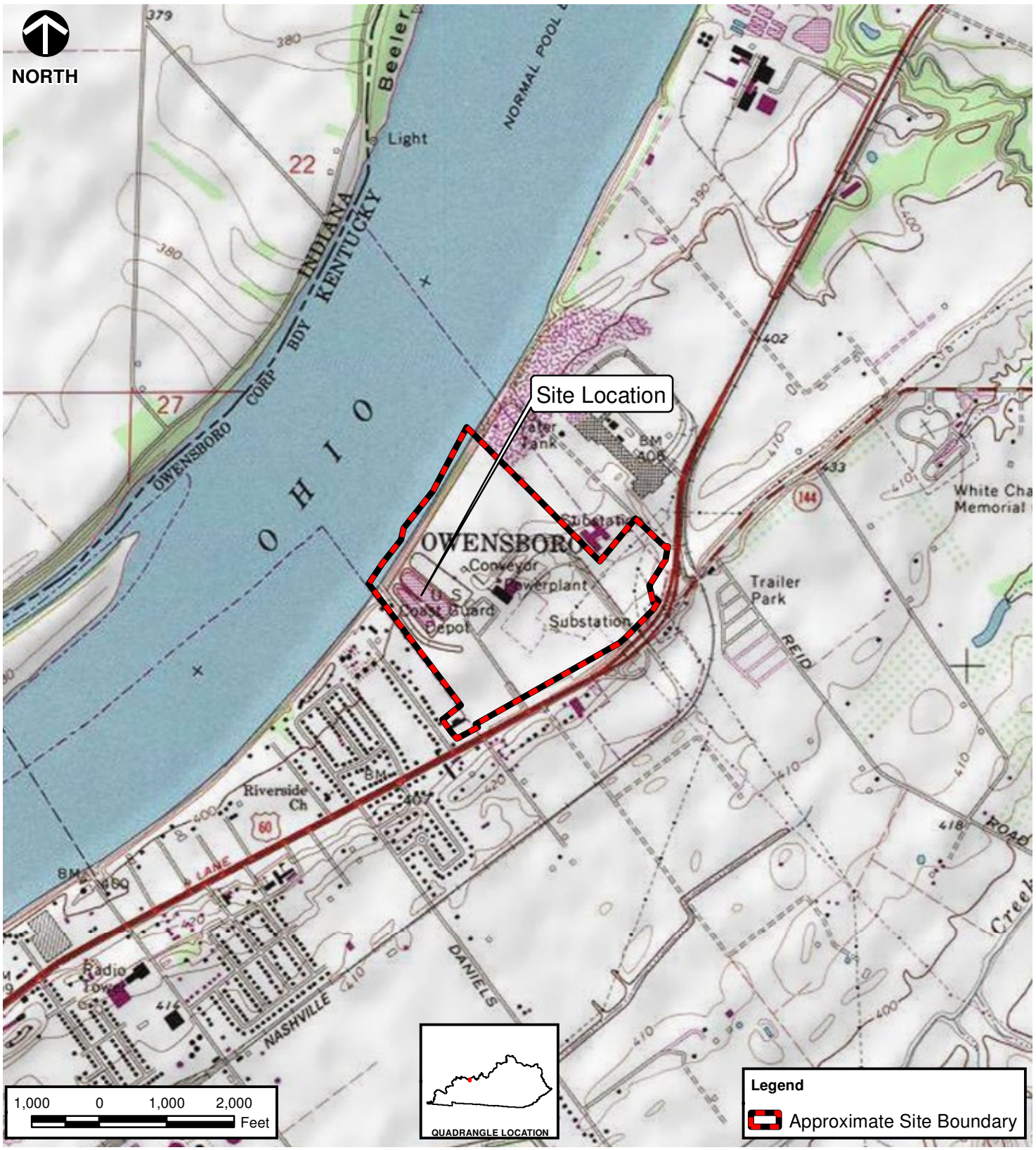
Date: March 29, 2019

License Number: KY-2522

My license renewal date is September: 30, 2019



FIGURES



SOURCE: PORTION OF THE USGS 7.5-MINUTE SERIES TOPOGRAPHIC QUADRANGLE MAP - OWENSBORO EAST, KY - 1983

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OWENSBORO MUNICIPAL UTILITIES
ELMER SMITH STATION ASH PONDS
OWENSBORO, DAVIESS COUNTY, KY

SITE LOCATION MAP

DRAWN BY:	MGN	CHECKED BY:	HTW	APPROVED BY:	HTW*	FIGURE NO:	1
DATE:	JANUARY 18, 2019	DWG SCALE:	1 " = 2,000 '	PROJECT NO:	164-014.0018		

Signature on File *

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NORTH

Ohio River

MW-3
MW-2
MW-1
Pond 1
Pond 2
Pond 3
MW-4
MW-6
MW-5
MW-7
49
63
Cooling Water Discharge Canal (channelized)
48
61
66
65
69
64
68
67
50
MW-8
Coast Guard Lane
Ellis Smeathers Road
State Route 2380
Cavin Water Treatment Plant
E 4th Street (State Route 144)

SOURCE: ESRI WORLD IMAGERY / ARCGIS MAP SERVICE: HTTP://GOTO.ARCGISONLINE.COM/MAPS/WORLD_IMAGERY. LAST ACCESSED: 3/29/2019
IMAGE DATE: 5/19/2016

Legend

- Approximate Site Boundary
- GMS Monitoring Well
- OMU Municipal Production Well

PROJECT LOCATION

200 0 200 400 Feet

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OWENSBORO, DAVIESS COUNTY, KY

SITE AND VICINITY AERIAL MAP
WITH GMS WELLS

DRAWN BY: MGN	CHECKED BY: MGN	APPROVED BY: HTW*	FIGURE NO: 2
DATE: MAR 29, 2019	SCALE: 1 " = 400 '	PROJECT NO: 164-014	

Signature on File *

NORTH

Ohio River

MW-3
368.77
MW-2
368.7
MW-1
368.87

Inferred Groundwater Flow Direction

367'
366'
365'
364'
363'
362'
361'
360'
359'
358'
357'

MW-4
359.15
MW-6
359
MW-5
359.58
MW-7
356
MW-8
356.31

49
48
50
63
61
66
65
69
64
68
67

Cooling Water Discharge Canal (channelized)

Cavin Water Treatment Plant

NOTE: THE WATER LEVELS PRESENTED HEREIN ARE APPLICABLE TO THE LOCATION AND TIME OF MEASUREMENT. WATER LEVELS MAY FLUCTUATE THROUGH TIME. POTENTIOMETRIC CONTOURS GENERATED FROM THIS DATA ARE CONSTRUCTED BY INTERPOLATION BETWEEN POINTS OF KNOWN STATIC WATER LEVEL ELEVATIONS AND USING KNOWLEDGE OF SPECIFIC SITE CONDITIONS. ACTUALSTATIC WATER LEVELS AT LOCATIONS BETWEEN THE MONITORING POINTS MAY DIFFER FROM THOSE DEPICTED.

SOURCE: ESRI WORLD IMAGERY / ARCGIS MAP SERVICE: HTTP://GOTO.ARCGISONLINE.COM/MAPS/WORLD_IMAGERY. LAST ACCESSED: 3/19/2019
IMAGE DATE: 9/7/2016

Legend

- Approximate Site Boundary
- OMU Municipal Production Well
- MW-1 GMS Monitoring Well
- 579.45 Groundwater Elevation (feet above mean sea level)

PROJECT LOCATION

200 0 200 400 Feet

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OWENSBORO, DAVIESS COUNTY, KY

POTENTIOMETRIC SURFACE MAP
DECEMBER 27, 2018

DRAWN BY: MGN	CHECKED BY: MGN	APPROVED BY: HTW*	FIGURE NO: 3
DATE: MAR 19, 2019	SCALE: 1 " = 400 '	PROJECT NO: 164-014	

Signature on File *

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TABLE

TABLE 1
Groundwater Elevation Summary
OMU Elmer Smith Station Ash Ponds
Owensboro, KY
(all measurements are in feet)

Well ID (AKGWA #)	Location Relative to Ash Ponds	Ground Surface Elevation (AMSL)	TOC Elevation (AMSL)	Measurement Date	Depth to Water Measurement (ft BTOC)	Groundwater Elevation (AMSL)
MW-1 (8006-9522)	Upgradient	402.00	404.53	12/8/2016	48.51	356.02
				12/13/2016	48.07	356.46
				2/8/2017	45.69	358.84
				3/8/2017	40.68	363.85
				4/6/2017	43.51	361.02
				5/3/2017	45.91	358.62
				5/15/2017	43.46	361.07
				6/16/2017	49.94	354.59
				6/29/2017	46.72	357.81
				7/13/2017	49.81	354.72
				7/27/2017	49.99	354.54
				8/9/2017	49.15	355.38
				8/23/2017	50.38	354.15
				9/6/2017	50.31	354.22
				9/20/2017	50.04	354.49
				10/10/2017	49.55	354.98
				4/5/2018	34.75	369.78
				6/5/2018	46.61	357.92
				12/12/2018	43.97	360.56
				12/27/2018	35.66	368.87
MW-2 (8006-9523)	Upgradient (Background)	402.75	405.55	12/8/2016	49.21	356.34
				12/13/2016	48.74	356.81
				2/8/2017	46.29	359.26
				3/8/2017	41.24	364.31
				4/6/2017	44.16	361.39
				5/3/2017	45.48	360.07
				5/15/2017	44.02	361.53
				6/16/2017	50.02	355.53
				6/29/2017	47.17	358.38
				7/13/2017	50.16	355.39
				7/27/2017	50.23	355.32
				8/9/2017	50.75	354.80
				8/23/2017	50.97	354.58
				9/6/2017	50.95	354.60
				9/20/2017	50.69	354.86
				10/10/2017	50.20	355.35
				4/5/2018	35.70	369.85
				6/5/2018	47.22	358.33
				12/12/2018	44.51	361.04
				12/27/2018	36.85	368.70
MW-3 (8006-9524)	Upgradient	403.78	406.39	12/8/2016	49.88	356.51
				12/13/2016	49.43	356.96
				2/8/2017	46.95	359.44
				3/8/2017	41.64	364.75
				4/6/2017	44.56	361.83
				5/3/2017	45.90	360.49
				5/15/2017	44.51	361.88
				6/16/2017	50.06	356.33
				6/29/2017	47.29	359.10
				7/13/2017	50.64	355.75
				7/27/2017	50.69	355.70
				8/9/2017	51.35	355.04
				8/23/2017	51.65	354.74
				9/6/2017	51.43	354.96
				9/20/2017	51.25	355.14
				10/10/2017	50.82	355.57
				4/5/2018	36.10	370.29
				6/5/2018	47.84	358.55
				12/12/2018	45.16	361.23
				12/27/2018	37.61	368.78

Notes: AMSL = Above Mean Sea Level
TOC = Top of Casing
Ft BTOC = Feet Below Top of Casing

TABLE 1
Groundwater Elevation Summary
OMU Elmer Smith Station Ash Ponds
Owensboro, KY
(all measurements are in feet)

MW-4 (8006-9525)	Downgradient	406.44	408.02	12/8/2016	54.44	353.58
				12/13/2016	54.06	353.96
				2/8/2017	51.22	356.80
				3/8/2017	52.97	355.05
				4/6/2017	54.99	353.03
				5/3/2017	55.75	352.27
				5/15/2017	53.95	354.07
				6/16/2017	58.65	349.37
				6/29/2017	57.60	350.42
				7/13/2017	58.20	349.82
				7/27/2017	58.73	349.29
				8/9/2017	58.97	349.05
				8/23/2017	59.48	348.54
				9/6/2017	58.73	349.29
				9/20/2017	57.75	350.27
				10/10/2017	57.15	350.87
				4/5/2018	48.85	359.17
				6/5/2018	51.97	356.05
				12/12/2018	50.92	357.10
				12/27/2018	48.87	359.15
MW-5 (8005-9530)	Downgradient	403.56	406.16	6/16/2017	56.37	349.79
				6/29/2017	56.66	349.50
				7/13/2017	56.62	349.54
				7/27/2017	57.03	349.13
				8/9/2017	57.05	349.11
				8/23/2017	57.45	348.71
				9/6/2017	57.11	349.05
				9/20/2017	56.12	350.04
				10/10/2017	55.51	350.65
				4/5/2018	45.14	361.02
				6/5/2018	50.11	356.05
				12/12/2018	49.16	357.00
				12/27/2018	46.58	359.58
MW-6 (8006-9531)	Downgradient	405.23	407.35	6/16/2017	57.96	349.39
				6/29/2017	57.40	349.95
				7/13/2017	57.96	349.39
				7/27/2017	58.16	349.19
				8/9/2017	58.55	348.80
				8/23/2017	58.82	348.53
				9/6/2017	58.65	348.70
				9/20/2017	57.41	349.94
				10/10/2017	56.84	350.51
				4/5/2018	46.53	360.82
				6/5/2018	51.56	355.79
				12/12/2018	50.53	356.82
				12/27/2018	48.35	359.00
MW-7 (8006-9532)	Downgradient (Background)	418.26	421.11	6/16/2017	72.90	348.21
				6/29/2017	73.25	347.86
				7/13/2017	72.87	348.24
				7/27/2017	73.81	347.30
				8/9/2017	74.31	346.80
				8/23/2017	74.31	346.80
				9/6/2017	73.71	347.40
				9/20/2017	73.79	347.32
				10/10/2017	73.70	347.41
				4/5/2018	67.61	353.50
				6/5/2018	69.37	351.74
				12/12/2018	66.12	354.99
				12/27/2018	65.11	356.00
MW-8 (8007-1801)	Downgradient	402.97	405.82	12/27/2018	49.51	356.31

Notes: AMSL = Above Mean Sea Level
TOC = Top of Casing
Ft BTOC = Feet Below Top of Casing

APPENDIX A

BORING LOGS & WELL CONSTRUCTION DIAGRAMS

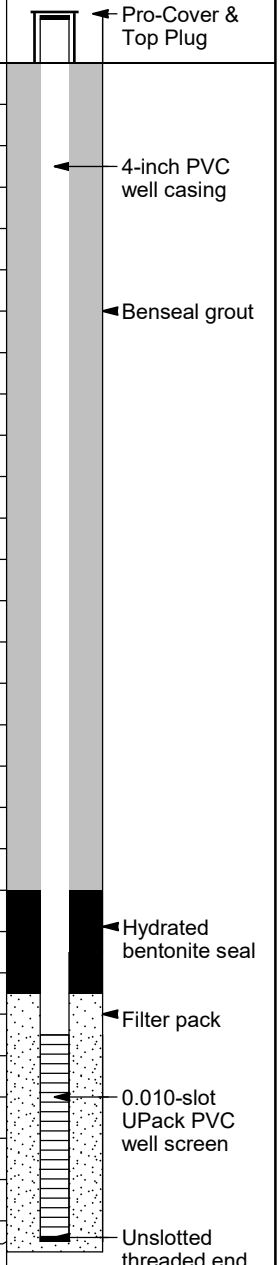
Civil & Environmental Consultants, Inc.
333 Baldwin Road
Pittsburgh, PA 15205

WELL NUMBER MW-1

CLIENT Owensboro Municipal Utilities
PROJECT NAME Elmer Smith Ash Pond
CEC PROJECT NUMBER 164-014
PROJECT LOCATION Owensboro, Kentucky
DATE STARTED 12/5/16 **COMPLETED** 12/5/16
GROUND ELEVATION 402.00 ft **HOLE SIZE** 12 inches
DRILLING CONTRACTOR Richardville Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hydraulic Push/6.25" HSA
AT TIME OF DRILLING 47.0 ft / Elev 355.0 ft
LOGGED BY JEL **CHECKED BY** MGN
AT END OF DRILLING ---
LOCATION N 3815477, E 4541324; AKGWA #8006-9522
72 hours AFTER DRILLING 46.0 ft / Elev 356.0 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	GRAPHIC LOG	MATERIAL DESCRIPTION		PID (ppm)
0						
	DP 1	95		0.3 **TOPSOIL**, moist	401.7	NA
	DP 2	95		Brown sandy **SILT**, medium stiff, moist		NA
	DP 3	100				NA
	DP 4	100		8.5	393.5	NA
10	DP 5	100		10.5 Olive gray silty **SAND**, moist	391.5	NA
	DP 6	100		12.0 Olive gray **SILT**, medium stiff, moist	390.0	NA
	DP 7	90		Light brown to reddish brown silty **CLAY**, some sand, medium stiff to very stiff, moist		NA
	DP 8	90				NA
	DP 9	100				NA
20	DP 10	100				NA
	DP 11	90		21.8	380.3	NA
	DP 12	90		Brown **SAND**, loose, moist		NA
	DP 13	75		26.0	376.0	NA
	DP 14	75		26.5 Brown silty **CLAY**, soft, very moist	375.5	NA
30	DP 15	70		Brown **SAND**, loose, poorly graded, moist, as above		NA
	DP 16	70				NA
	DP 17	80				NA
	DP 18	80				NA
	DP 19	100				NA
40	DP 20	100				NA
	DP 21	70				NA
	DP 22	70				NA
	DP 23	75		...**saturated**, as above, becoming more well-graded		NA
50	DP 24	75				NA
	DP 25	90				NA
	DP 26	90				NA
	DP 27	75				NA
	DP 28	75				NA
	DP 29	150		57.0	345.0	NA
				Bottom of hole at 57.0 feet		

WELL DIAGRAM



GENERAL BH / TP / WELL 164-014 BORING LOGS.GPJ GOOD TEMPLATE.GDT 10/2/17

Civil & Environmental Consultants, Inc.
333 Baldwin Road
Pittsburgh, PA 15205

WELL NUMBER MW-2

CLIENT Owensboro Municipal Utilities
PROJECT NAME Elmer Smith Ash Pond
CEC PROJECT NUMBER 164-014
PROJECT LOCATION Owensboro, Kentucky
DATE STARTED 12/5/16 **COMPLETED** 12/6/16
GROUND ELEVATION 402.746 ft **HOLE SIZE** 12 inches
DRILLING CONTRACTOR Richardville Drilling
GROUND WATER LEVELS:
DRILLING METHOD 6.25" HSA
AT TIME OF DRILLING 47.0 ft / Elev 355.7 ft
LOGGED BY JEL **CHECKED BY** MGN
AT END OF DRILLING ---
LOCATION N 3815642, E 4541451; AKGWA #8006-9523
36 hours AFTER DRILLING 46.4 ft / Elev 356.3 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION		PID (ppm)
0			0.3 **TOPSOIL**, moist	402.4	
			2.0 **GRAVEL** (FILL)	400.7	
			Brown sandy **SILT**, medium stiff, moist		
			6.0	396.7	
			Olive gray silty **SAND**, moist		
			9.0	393.7	
10			Olive gray **SILT**, medium stiff, moist		
			12.0	390.7	
			Light brown to reddish brown silty **CLAY**, some sand, medium stiff to very stiff, moist		
			17.0	385.7	
20			Brown **SAND**, loose, moist		
			26.0	376.7	
			26.5 Brown silty sandy **CLAY**, soft, moist	376.2	
	AU		Light brown **SAND**, poorly graded, loose, moist		NA
30					
40					
			...**saturated**, as above		
50					
			57.0	345.7	

Bottom of hole at 57.0 feet

Lithologic description inferred from MW-1 and MW-3

WELL DIAGRAM

- Pro-Cover & Top Plug
- 4-inch PVC well casing
- Benseal grout
- Hydrated bentonite seal
- Filter pack
- 0.010-slot UPack PVC well screen
- Unslotted threaded end cap

GENERAL BH / TP / WELL 164-014 BORING LOGS.GPJ GOOD TEMPLATE.GDT 10/2/17

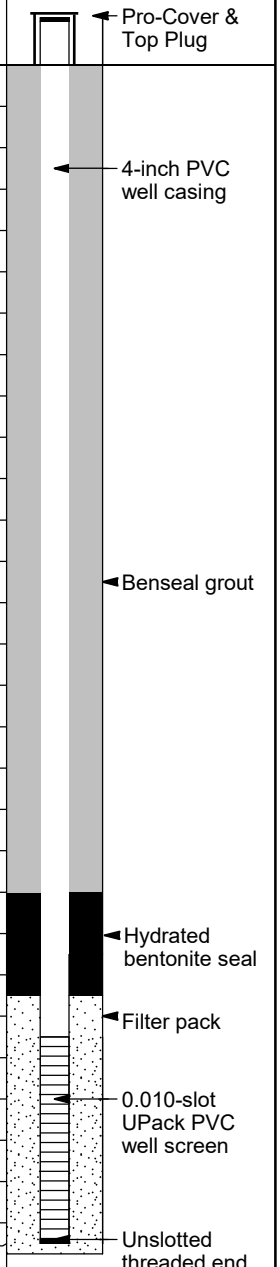
WELL NUMBER MW-3

Civil & Environmental Consultants, Inc.
333 Baldwin Road
Pittsburgh, PA 152050

CLIENT Owensboro Municipal Utilities
PROJECT NAME Elmer Smith Ash Pond
CEC PROJECT NUMBER 164-014
PROJECT LOCATION Owensboro, Kentucky
DATE STARTED 12/5/16 **COMPLETED** 12/5/16
GROUND ELEVATION 403.77 ft **HOLE SIZE** 12 inches
DRILLING CONTRACTOR Richardville Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hydraulic Push/6.25" HSA
AT TIME OF DRILLING 47.0 ft / Elev 356.8 ft
LOGGED BY JEL **CHECKED BY** MGN
AT END OF DRILLING ---
LOCATION N 3815758, E 4541533; , AKGWA #8006-9524
60 hours AFTER DRILLING 47.3 ft / Elev 356.5 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	GRAPHIC LOG	MATERIAL DESCRIPTION		PID (ppm)
0	DP 1	75		0.3 **TOPSOIL**, moist	403.5	NA
				2.0 **GRAVEL** (FILL)	401.8	
	DP 2	75		4.0 Brown **SILT**, some sand, some gravel, medium stiff, moist	399.8	NA
	DP 3	90		Brown to olive gray silty **SAND**, loose, moist		NA
	DP 4	90				NA
				8.8	395.0	
10	DP 5	100		Olive gray to reddish brown clayey **SILT**, medium stiff, moist		NA
	DP 6	100				NA
	DP 7	70		13.8	390.0	NA
				Reddish brown **SAND**, loose, poorly graded, moist		
	DP 8	70				NA
	DP 9	75		18.3	385.5	NA
20				19.0 Reddish brown clayey **SILT**, medium stiff, moist	384.8	NA
	DP 10	75		Brown **SAND**, loose, poorly graded, moist		NA
	DP 11	70				NA
	DP 12	70				NA
				25.5	378.3	NA
	DP 13	70		26.5 Brown sandy **SILT**, soft, moist	377.3	NA
30	DP 14	70		Brown **SAND**, loose, poorly graded, moist, as above		NA
	DP 15	70				NA
	DP 16	70				NA
	DP 17	70				NA
	DP 18	70				NA
40	DP 19	70				NA
	DP 20	70				NA
	DP 21	75				NA
	DP 22	75		...**saturated**, as above, becoming more well-graded		NA
	DP 23	90				NA
50	DP 24	90				NA
	DP 25	67				NA
	DP 26	67				NA
	DP 27	133		57.0	346.8	NA
	DP 28			Bottom of hole at 57.0 feet		
	DP 29					

WELL DIAGRAM



GENERAL BH / TP / WELL 164-014 BORING LOGS.GPJ GOOD TEMPLATE.GDT 10/2/17

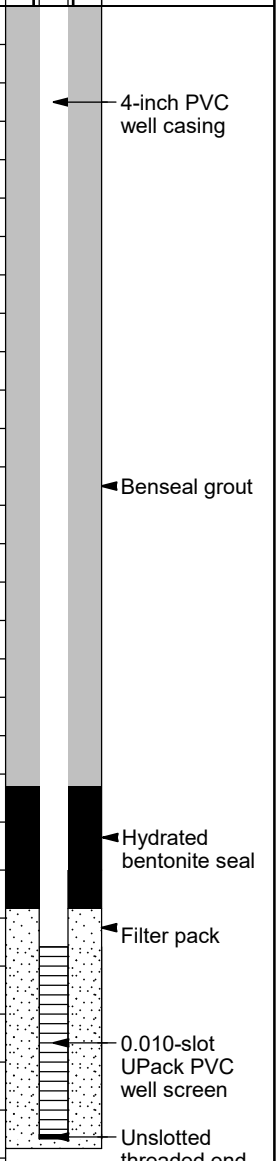
Civil & Environmental Consultants, Inc.
333 Baldwin Road
Pittsburgh, PA 15205

WELL NUMBER MW-4

CLIENT Owensboro Municipal Utilities
PROJECT NAME Elmer Smith Ash Pond
CEC PROJECT NUMBER 164-014
PROJECT LOCATION Owensboro, Kentucky
DATE STARTED 12/5/16 **COMPLETED** 12/7/16
GROUND ELEVATION 406.442 ft **HOLE SIZE** 12 inches
DRILLING CONTRACTOR Richardville Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hydraulic Push/6.25" HSA
AT TIME OF DRILLING 49.0 ft / Elev 357.4 ft
LOGGED BY JEL **CHECKED BY** MGN
AT END OF DRILLING ---
LOCATION N 3815041, E 4542187; AKGWA #8006-9525
48 hours AFTER DRILLING 52.9 ft / Elev 353.6 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	GRAPHIC LOG	MATERIAL DESCRIPTION	PID (ppm)
0	DP 1	75		**GRAVEL** (FILL)	NA
				2.0 404.4	
	DP 2	75		Brown silty **CLAY**, some gravel, some sand, stiff, moist	NA
				4.0 402.4	
	DP 3	90		Brown sandy **SILT** grading to silty SAND, medium stiff, moist	NA
	DP 4	90		8.0 398.4	NA
10	DP 5	100		Light brown **SAND**, some silt, poorly graded, loose, moist	NA
	DP 6	100			NA
	DP 7	70			NA
	DP 8	70			NA
	DP 9	75			NA
20	DP 10	75			NA
	DP 11	70			NA
	DP 12	70			NA
	DP 13	70			NA
30	DP 14	70			NA
	DP 15	70			NA
	DP 16	70			NA
	DP 17	70		38.5 367.9	NA
40	DP 18	84		Brown to olive gray silty **CLAY**, some sand, moist	NA
	DP 19	100		....light brown, poorly graded sand seam	NA
	DP 20	100		...Light gray, medium stiff, moist, as above	NA
	SS 21	100		...reddish brown, sandy, medium stiff, moist, as above	NA
50	SS 22	57		49.0 ▽ 357.4	NA
	SS 23	96		Light brown **SAND**, poorly graded, some clay, wet at 49'	NA
	SS 24	57			NA
	SS 25	100			NA
60	SS 26	100			NA
	SS 27			63.0 343.4	NA
	SS 28			Bottom of hole at 63.0 feet	
	SS 29				

WELL DIAGRAM



GENERAL BH / TP / WELL 164-014 BORING LOGS.GPJ GOOD TEMPLATE.GDT 10/2/17

Civil & Environmental Consultants, Inc.
333 Baldwin Road
Pittsburgh, PA 15205

WELL NUMBER MW-5

CLIENT Owensboro Municipal Utilities
PROJECT NAME Elmer Smith Ash Pond
CEC PROJECT NUMBER 164-014
PROJECT LOCATION Owensboro, Kentucky
DATE STARTED 6/12/17 **COMPLETED** 6/12/17
GROUND ELEVATION 403.560 ft **HOLE SIZE** 12 inches
DRILLING CONTRACTOR Richardville Drilling
GROUND WATER LEVELS:
DRILLING METHOD SS/6.25" HSA
AT TIME OF DRILLING 45.0 ft / Elev 358.6 ft
LOGGED BY BAK **CHECKED BY** MGN
AT END OF DRILLING 52.0 ft / Elev 351.5 ft
LOCATION N 3814865, E 4541764; AKGWA #8006-9530
27 hours AFTER DRILLING 56.0 ft / Elev 347.6 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	MATERIAL DESCRIPTION
0				**GRAVEL** (FILL) 2.0 / 401.6
				Light brown **SAND**, some silt, poorly graded, moist
10	AU	100		
20				
30	SS	100	2-4-5-6 (9)	30.0 / 373.6
	AU	100		Brown and gray Sandy **CLAY**, moist
	SS	75	2-3-3-3 (6)	36.0 / 367.6
40	AU	100		Light brown and gray **SAND**, well graded
	SS	50	2-3-4-4 (7)	...**saturated** at 45'
50	AU			
				59.0 / 344.6
				Bottom of hole at 59.0 feet

WELL DIAGRAM

- Pro-Cover & Top Plug
- 4-inch PVC well casing
- Benseal grout
- Hydrated bentonite seal
- Filter pack
- 0.010-slot UPack PVC well screen
- Unslotted threaded end cap

GENERAL BH / TP / WELL 164-014 BORING LOGS.GPJ GOOD TEMPLATE.GDT 10/2/17

Civil & Environmental Consultants, Inc.
333 Baldwin Road
Pittsburgh, PA 15205

WELL NUMBER MW-6

CLIENT Owensboro Municipal Utilities
PROJECT NAME Elmer Smith Ash Pond
CEC PROJECT NUMBER 164-014
PROJECT LOCATION Owensboro, Kentucky
DATE STARTED 6/13/17 **COMPLETED** 6/13/17
GROUND ELEVATION 405.228 ft **HOLE SIZE** 12 inches
DRILLING CONTRACTOR Richardville Drilling
GROUND WATER LEVELS:
DRILLING METHOD 6.25" HSA
AT TIME OF DRILLING 48.0 ft / Elev 357.2 ft
LOGGED BY BAK **CHECKED BY** MGN
AT END OF DRILLING 56.7 ft / Elev 348.5 ft
LOCATION N 3814947, E 4542003; AKGWA #8006-9531
60 hours AFTER DRILLING 58.0 ft / Elev 347.3 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0					Pro-Cover & Top Plug
				GRAVEL (FILL)	
2.0					403.2
				Brown Silty **CLAY**, moist	4-inch PVC well casing
10					
18.0					387.2
				Light brown **SAND**, some silt, poorly graded, loose, moist	
20					
					Benseal grout
30	AU	100			
38.0					367.2
				Brown and gray Sandy **CLAY**, moist	
40					
42.0					363.2
				Gray **SAND** with Clay, well graded, moist	Hydrated bentonite seal
					Filter pack
				...**saturated** at 48'	
50					
					0.010-slot UPack PVC well screen
59.0					346.2
				Bottom of hole at 59.0 feet	Unslotted threaded end cap

Lithologic description inferred from MW-4 and MW-5

Civil & Environmental Consultants, Inc.
333 Baldwin Road
Pittsburgh, PA 15205

WELL NUMBER MW-7

CLIENT Owensboro Municipal Utilities
PROJECT NAME Elmer Smith Ash Pond
CEC PROJECT NUMBER 164-014
PROJECT LOCATION Owensboro, Kentucky
DATE STARTED 6/15/17 **COMPLETED** 6/15/17
GROUND ELEVATION 418.258 ft **HOLE SIZE** 12 inches
DRILLING CONTRACTOR Richardville Drilling
GROUND WATER LEVELS:
DRILLING METHOD SS/6.25" HSA
AT TIME OF DRILLING 62.5 ft / Elev 355.8 ft
LOGGED BY BAK **CHECKED BY** MGN
AT END OF DRILLING 64.9 ft / Elev 353.4 ft
LOCATION N 3814685, E 4543792; AKGWA #8006-9532
18 hours AFTER DRILLING 71.2 ft / Elev 347.1 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	MATERIAL DESCRIPTION
0				
	AU	100		Brown **SAND**, some silt, poorly graded, loose, moist
33.0				385.3
33.3	SS	60	2-2-3-3 (5)	Brown **CLAY** with silt, moist — 385.0
	AU	100		Brown **SAND**, some silt, poorly graded, loose, moist
43.0				375.3
	SS	100		Firm gray **CLAY**, trace brown silt, moist
	AU	100		
	SS	100	3-4-6-5 (10)	
	AU	100		
	SS	100		...as above, with gray silt and sand
	AU	100		
59.0				359.3
	SS	100		Brown **SAND** with silt, well graded, moist
	AU	100		
	SS	80	5-7-8-10 (15)	...**saturated** at 62.5'
	AU	100		
72.0				346.3
				Bottom of hole at 72.0 feet

WELL DIAGRAM

- Pro-Cover & Top Plug
- 4-inch PVC well casing
- Benseal grout
- Hydrated bentonite seal
- Filter pack
- 0.010-slot UPack PVC well screen
- Unslotted threaded end cap

GENERAL BH / TP / WELL 164-014 BORING LOGS.GPJ GOOD TEMPLATE.GDT 10/2/17

Civil & Environmental Consultants, Inc.
333 Baldwin Road
Pittsburgh, PA 15205

WELL NUMBER MW-8

CLIENT Owensboro Municipal Utilities
PROJECT NAME Elmer Smith Ash Pond
CEC PROJECT NUMBER 164-014
PROJECT LOCATION Owensboro, Kentucky
DATE STARTED 12/19/18 **COMPLETED** 12/19/18
GROUND ELEVATION 402.974 ft **HOLE SIZE** 12 inches
DRILLING CONTRACTOR Richardville Drilling
GROUND WATER LEVELS:
DRILLING METHOD Direct Push/6.25" HSA
AT TIME OF DRILLING 52.0 ft / Elev 351.0 ft
LOGGED BY BAK **CHECKED BY** MGN
AT END OF DRILLING 51.9 ft / Elev 351.0 ft
LOCATION N 3813820, E 4541934
18.5hrs AFTER DRILLING 48.5 ft / Elev 354.5 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	GRAPHIC LOG	MATERIAL DESCRIPTION
0				
	DP 1	58		0.3 **TOPSOIL**, moist 402.7 Brown sandy **CLAY**, some silt, soft, moist
	DP 2	88		6.5 396.5 Brown silty **SAND** trace clay, loose, moist
10	DP 5	83		
	DP 7	88		
	DP 9	83		
20	DP 11	88		...Brown silty **SAND**, as above loose, saturated
	DP 13	83		27.5 375.5 Brown to gray sandy **CLAY**, some silt, soft, moist
30	DP 15	81		
	DP 17	85		33.0 370.0 Gray **SAND**, poorly graded, some clay, moist
	DP 19	83		saturated, as above
40	DP 21	88		43.5 359.5 44.5 Blue-gray silty **CLAY**, some sand, stiff, moist 358.5
	DP 23	94		Light Brown **SAND**, some silt, poorly graded, moist
50	DP 25	85		
	DP 27	98		saturated, as above 56.0 347.0
60				Bottom of hole at 63.0 feet

WELL DIAGRAM

- Pro-Cover & Top Plug
- 4-inch PVC well casing
- Benseal grout
- Hydrated bentonite seal
- Filter pack
- 0.010-slot UPack PVC well screen
- Unslotted threaded end cap