2017 GROUNDWATER MONITORING & CORRECTIVE ACTION REPORT

COAL ASH PONDS
ELMER SMITH STATION
DAVIESS COUNTY
OWENSBORO, KENTUCKY

Prepared For:
OWENSBORO MUNICIPAL UTILITIES
OWENSBORO, KENTUCKY

Prepared By:
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CEC Project 164-014

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1.0 INTRODUCTION

The United States Environmental Protection Agency (USEPA) issued 40 C.F.R. § 257, Subpart D, *Disposal of Coal Combustion Residuals from Electric Utilities* (CCR Rule) on April 17, 2015. The CCR Rule regulates disposal of coal combustion residuals (CCR) in new and active landfills and impoundments. Civil & Environmental Consultants, Inc. (CEC) has been engaged by Owensboro Municipal Utilities (OMU) to provide the 2017 Groundwater Monitoring and Corrective Action Report for the Coals Ash Ponds (aka the Site) at the Elmer Smith Station (ESS) as required by the CCR Rule. This document summarizes the monitoring activity through 2017, including sampling events and changes to the Groundwater Monitoring System (GMS) network. It is intended that this document will be placed in the facility operating record as required by 40 C.F.R. §257.105(h)(1), and posted on the publicly accessible website as required by 40 C.F.R. §257.107(h)(1).

2.0 SITE OVERVIEW

2.1 BACKGROUND

The Ash Pond area associated with the 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 other ash and 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.

CEC assisted OMU with the design and installation of a permanent GMS to comply with the GMS performance standard contained within the Federal CCR Rule (Section 257.91), as documented in the GMS Certification Report dated October 17, 2017. Prior to the installation of the GMS, groundwater monitoring had not been conducted at the site.

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 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

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

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 comprise 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. Refer to the GMS Certification Report for a geologic cross-section and boring logs for the site.

2.2.1 Hydrogeologic Characteristics

Groundwater occurs within the coarse-grained deposits that constitute the uppermost aquifer at the site. Depth to water measurements ranged from 74.31 feet below top of casing (BTOC) at MW-7 to 40.68 feet BTOC at MW-1 over the monitoring period. Static groundwater elevations on-site ranged from 346.80 feet above mean sea level (AMSL) at MW-7 to 364.75 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 0.004. This flow direction is contrary to the hydrogeologic setting where groundwater flow is typically towards the Ohio River. 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 treatment capacity is 28 million gallons per day. Absent operation of the production wells, groundwater flow direction is likely to the

[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.

northwest towards the Ohio River; however, some combination of pumping wells is always in operation and 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 seven 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, and MW-7 are utilized to monitor both groundwater elevation and quality. Refer to the GMS Certification Report for lithologic descriptions and well construction diagrams. As noted above in Section 2.2.1, the well field pumping influence and proximity of the 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. 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

4.0 2017 GROUNDWATER MONITORING SUMMARY

4.1 BASELINE SAMPLING EVENTS

Baseline groundwater sampling was performed between February 8, 2017 and September 6, 2017 (refer to table below). Samples were collected from GMS wells MW-2, MW-4, MW-5, MW-6 and MW-7 during each of the eight baseline sampling events, with the exception of the June 16, 2017 sampling event where insufficient groundwater was available for the collection of a representative sample from MW-7. These baseline samples were analyzed for both Appendix III and Appendix IV parameters. Samples were collected per the facility Sampling and Analysis Plan (SAP) and submitted to ALS Environmental Laboratory (ALS), an American Association for Laboratory Accreditation (A2LA) accredited laboratory. A summary of the laboratory analytical data for the baseline sampling events is provided in Table 2.

4.2 DETECTION MONITORING EVENT

The initial Detection Monitoring sampling event was performed on October 10, 2017, with samples being collected from GMS wells MW-2, MW-4, MW-5, MW-6 and MW-7 and analyzed for Appendix III parameters. Samples were collected in accordance with the facility SAP and submitted to ALS. The laboratory results were finalized on October 27, 2017. Laboratory analytical results for the initial Detection Monitoring sampling event are summarized in Table 3.

A summary of 2017 sampling events is listed below. No transition between CCR Rule groundwater monitoring programs occurred in 2017.

Location	Baseline Monitoring Events – Appendix III and IV								Detection Monitoring Event – Appendix III
Event No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Background Wells									
MW-2	02/08/17	3/8/17	4/6/17	5/3/17	6/16/17	7/13/17	8/9/17	9/6/17	10/10/17
MW-7	NS	6/29/17	7/13/17	7/27/17	8/9/17	8/23/17	9/6/17	9/20/17	10/10/17
Downgradient Wells									
MW-4	02/08/17	3/8/17	4/6/17	5/3/17	6/16/17	7/13/17	8/9/17	9/6/17	10/10/17
MW-5	6/16/17	6/29/17	7/13/17	7/27/17	8/9/17	8/23/17	9/6/17	9/20/17	10/10/17
MW-6	6/16/17	6/29/17	7/13/17	7/27/17	8/9/17	8/23/17	9/6/17	9/20/17	10/10/17

Notes:

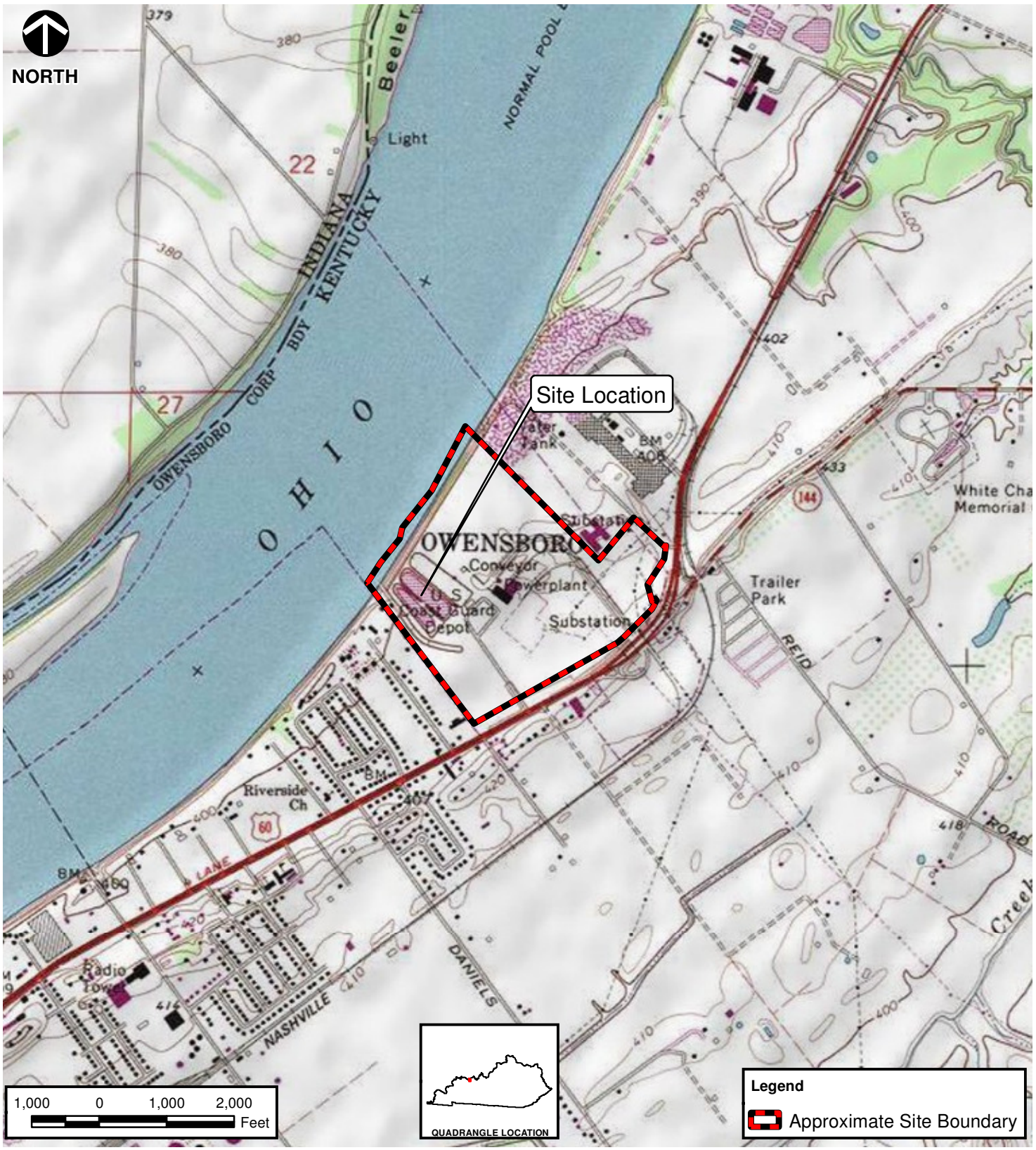
= Background Well
= Downgradient Well

NS = Not sampled due to insufficient water

4.3 RECORD KEEPING REQUIREMENTS

In accordance with §257.105(h) this document has been placed in OMU's Operating Record. A copy will also be placed on the publicly accessible website and a notification will be submitted to the Kentucky Department for Environmental Protection to comply with §257.107(h) and §257.106(h) of the CCR Rule.

FIGURES



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

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OWENSBORO MUNICIPAL UTILITIES
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OWENSBORO, DAVIESS COUNTY, KY

SITE LOCATION MAP

DRAWN BY:	MGN	CHECKED BY:	HTW	APPROVED BY:	JEZ*	FIGURE NO:	1
DATE:	OCTOBER 17, 2017	DWG SCALE:	1 " = 2,000 '	PROJECT NO:	164-014		

Signature on File *

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NORTH

Ohio River

Pond 1

Pond 2

Pond 3

MW-1

MW-2

MW-3

MW-4

MW-5

MW-6

MW-7

49

48

50

61

63

64

65

66

67

68

69

Cooling Water Discharge Canal (channelized)

Cavin Water Treatment Plant

Ellis Smeathers Road

State Route 2380

Coast Guard Lane

E 4th Street (State Route 144)

SOURCE: ESRI WORLD IMAGERY / ARCGIS MAP SERVICE: HTTP://GOTO.ARCGISONLINE.COM/MAPS/WORLD_IMAGERY. LAST ACCESSED: 10/17/2017
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:	HTW	APPROVED BY:	JEZ*	FIGURE NO:	2
DATE:	OCT 17, 2017	SCALE:	1 " = 400 '	PROJECT NO:	164-014		

Signature on File *

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NORTH

Ohio River

MW-3
355.565

MW-2
355.346

MW-1
354.982

Pond 1

Pond 2

Pond 3

Inferred Groundwater Flow Direction

354
353
352
351
350
349
348
355

MW-4
350.87

MW-6
350.514

MW-5
350.647

MW-7
347.41

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: 1/15/2018
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
OCTOBER 10, 2017

DRAWN BY:	BAK	CHECKED BY:	MGN	APPROVED BY:	HTW*	FIGURE NO: 3
DATE:	JAN 15, 2018	SCALE:	1 " = 400 '	PROJECT NO:	164-014	

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TABLES

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
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
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
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
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
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
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

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

TABLE 2

Groundwater Analytical Summary - CCR Rule Baseline Sampling
OMU Elmer Smith Station
Owensboro, KY

Sample ID		MW-2								MW-4							
Collection Date		02/08/17	3/8/17	4/6/17	5/3/17	6/16/17	7/13/17	8/9/17	9/6/17	02/08/17	3/8/17	4/6/17	5/3/17	6/16/17	7/13/17	8/9/17	9/6/17
Total Metals	**Units**																
Antimony	mg/L	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Arsenic	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Barium	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Beryllium	mg/L	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040
Boron	mg/L	0.11	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.6	1.4	2.3	2.5	4.7	4.3	7.6	8.2
Cadmium	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Calcium	mg/L	110	76	69	71	72	77	82	57	67	82	86	96	94	140	140	160
Chromium	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.079	<0.020	<0.020	0.095	0.058	0.47	<0.020
Cobalt	mg/L	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	0.011	<0.0040
Lead	mg/L	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Lithium	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Mercury	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Molybdenum	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Selenium	mg/L	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0.04	0.04	0.03	<0.030
Thallium	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Anions																	
Chloride	mg/L	24	23	24	23	22	21	24	20	13	16	19	27	27	39	43	38
Fluoride	mg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Sulfate	mg/L	54	40	31	23	29	31	31	20	44	86	140	210	220	360	470	430
Radium																	
Radium-226	pCi/L	<0.13	0.23	0.24	0.21	<0.16	0.28	<0.17	<0.18	0.25	<0.17	<0.25	0.21	0.24	<0.23	0.24	0.26
Radium-228	pCi/L	<0.98	<0.65	<1.03	<0.96	<0.92	<0.91	<0.97	<0.97	<0.92	<0.96	<0.99	<0.93	<0.81	<0.9	<0.85	<0.96
pH																	
pH	Std. Units	7.1	7.3	7.3	7.4	7.4	7.3	7.5	7.4	7.2	7.4	7.5	7.6	7.6	7.2	7.6	7.2
Total Dissolved Solids																	
Total dissolved solids	mg/L	480	350	420	350	330	430	400	290	350	410	590	620	670	1,100	1,100	1,100

TABLE 2
Groundwater Analytical Summary - CCR Rule Baseline Sampling
OMU Elmer Smith Station
Owensboro, KY

Sample ID		MW-5								MW-6								MW-7							
Collection Date		6/16/17	6/29/17	7/13/17	7/27/17	8/9/17	8/23/17	9/6/17	9/20/17	6/16/17	6/29/17	7/13/17	7/27/17	8/9/17	8/23/17	9/6/17	9/20/17	6/16/17	6/29/17	7/13/17	7/27/17	8/9/17	8/23/17	9/6/17	9/20/17
Total Metals	**Units**																								
Antimony	mg/L	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	NS	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Arsenic	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.012	<0.010	<0.010	NS	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Barium	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	NS	0.12	0.11	0.18	0.11	0.12	<0.10	0.10
Beryllium	mg/L	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	NS	<0.00040	<0.00040	0.00091	<0.00040	<0.00040	<0.00040	<0.00040
Boron	mg/L	8.0	8.4	9.6	9.1	9.2	9.0	9.6	9.7	8.9	10	11	12	13	13	14	15	NS	0.33	<0.10	0.11	<0.10	<0.10	<0.10	0.10
Cadmium	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	NS	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Calcium	mg/L	100	110	110	110	100	110	110	110	170	210	210	210	190	200	230	240	NS	98	97	110	93	110	110	110
Chromium	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.059	<0.020	0.026	0.092	NS	2.1	0.15	4.1	0.89	1.2	0.11	0.021
Cobalt	mg/L	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	NS	0.060	0.015	0.098	0.023	0.028	<0.0040	<0.0040
Lead	mg/L	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	NS	<0.015	<0.015	0.015	<0.015	<0.015	<0.015	<0.015
Lithium	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Mercury	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	NS	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Molybdenum	mg/L	0.76	1.3	0.95	0.99	0.98	0.92	1.0	0.94	2.2	2.8	2.5	2.4	2.5	2.6	2.6	2.8	NS	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Selenium	mg/L	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0.044	0.058	0.064	0.057	0.066	0.056	0.066	0.070	NS	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Thallium	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	NS	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Anions																									
Chloride	mg/L	60	63	59	68	62	55	48	54	60	59	51	56	48	36	40	41	NS	42	46	49	50	49	44	48
Fluoride	mg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.5	<2.0	<2.0	<2.0	<2.0	<2.0	2.1	<2.0	2.4	NS	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Sulfate	mg/L	240	250	270	270	290	260	250	230	450	530	610	660	1,100	530	670	640	NS	75	73	77	91	140	97	86
Radium																									
Radium-226	pCi/L	<0.22	<1.6	<0.18	0.22	<0.23	<0.19	0.23	0.25	0.23	9.5	0.59	0.15	0.5	0.34	0.25	0.43	NS	8.5	0.36	NS	NS	NS	4.2	0.23
Radium-228	pCi/L	<0.8	<0.82	<0.89	<0.85	<0.91	<0.98	<0.99	<0.94	<0.8	<0.85	<1.14	<0.95	1.08	<0.92	<0.95	<0.91	NS	<0.82	<0.98	NS	NS	NS	<1.05	<0.91
pH																									
pH	Std. Units	7.5	7.5	7.5	7.5	7.9	7.5	7.5	7.5	7.4	7.2	7.2	7.5	7.4	7.2	7.2	7.1	NS	7.1	7.0	7.6	8	7.4	7.3	7.1
Total Dissolved Solids																									
Total dissolved solids	mg/L	810	1,100	1,200	1,000	1,000	930	930	880	1,200	1,400	1,600	1,500	1,400	1,100	1,400	1,500	NS	700	770	690	600	640	650	650

NS = Well not sampled due to insufficient water at the time of sampling

TABLE 2

Groundwater Analytical Summary - CCR Rule Baseline Sampling

OMU Elmer Smith Station

Owensboro, KY

Sample ID		Duplicate[1]								Equipment Blank							
Collection Date		02/08/17	3/8/17	4/6/17	5/3/17	6/16/17	7/13/17	8/9/17	9/6/17	02/08/17	3/8/17	4/6/17	5/3/17	6/16/17	7/13/17	8/9/17	9/6/17
Total Metals	**Units**																
Antimony	mg/L	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Arsenic	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Barium	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Beryllium	mg/L	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040
Boron	mg/L	0.11	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	8.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Calcium	mg/L	110	77	70	69	76	75	83	160	<0.20	0.23	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Chromium	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Cobalt	mg/L	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Lead	mg/L	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Lithium	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Mercury	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Molybdenum	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Selenium	mg/L	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Thallium	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Anions																	
Chloride	mg/L	25	22	24	24	23	22	23	39	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Fluoride	mg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Sulfate	mg/L	54	41	31	22	27	29	32	440	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Radium																	
Radium-226	pCi/L	<0.17	<0.16	<0.26	0.25	0.28	<0.24	0.2	<0.24	<0.149	<0.18	<0.2	<0.131	<0.175	<0.21	<0.21	<0.146
Radium-228	pCi/L	<0.94	<0.65	<1.01	<0.99	<0.95	<0.89	<0.96	<0.97	<1.06	<0.66	<0.94	<0.96	<0.81	<1.03	<0.92	<0.98
pH																	
pH	Std. Units	7.4	7.3	7.4	7.6	7.5	7.3	7.4	7.3	6.9	6.3	7.8	5.7	6.2	7.2	6.7	7.0
Total Dissolved Solids																	
Total dissolved solids	mg/L	490	350	410	280	350	440	330	1,100	<20	<20	<20	<20	<20	<20	<20	22

[1]Duplicate sample collected at MW-2; except for 9/6/17 sampling event where the duplicate was collected from MW-4

TABLE 3

Groundwater Analytical Summary - CCR Rule Detection Monitoring
OMU Elmer Smith Station
Owensboro, KY

Sample ID		MW-2	MW-4	MW-5	MW-6	MW-7	Duplicate[1]	Equipment Blank
Collection Date		10/10/17	10/10/17	10/10/17	10/10/17	10/10/17	10/10/17	10/10/17
Total Metals	**Units**							
Boron	mg/L	<0.10	10	10	15	0.10	0.11	<0.10
Calcium	mg/L	57	190	98	220	110	57	<0.20
Anions								
Chloride	mg/L	19	45	50	35	46	19	<2.0
Fluoride	mg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Sulfate	mg/L	15	510	240	720	84	15	<5.0
pH								
pH	pH Units	7.5	7.2	7.7	7.4	7.3	7.7	9.8
Total Dissolved Solids								
Total dissolved solids	mg/L	260	1,100	800	1,200	590	260	<20

[1]Duplicate sample collected at MW-2