TABLE OF CONTENTS

FIGURES

TABLES

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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 prepare the 2020 Groundwater Monitoring and Corrective Action Report for the Coal Ash Ponds (aka the Site) at the Elmer Smith Station (ESS) as required by the CCR Rule. This document summarizes the monitoring activity conducted during 2020, including sampling events and statistical analyses. 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 Site 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. OMU historically operated two coal-fired power generating units at the Site. Power Generation Unit 1 was idled in June 2019, and Power Generation Unit 2 was idled in May 2020. The basins were 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 was used for Unit 1 boiler slag; Pond 2 received other ash and water plant blowdown (lime softening sludge), and, Pond 3 received no ash directly and was used for final settling prior to discharge. Other plant discharges, including coal pile runoff, Flue Gas Desulfurization (FGD) blowdown, roof and floor drains, etc. were also conveyed through the ponds. Based on a review of aerial images, topographic contour data from the USGS National Map, Owensboro East Quadrangle, a Site map prepared by others labeled "Structural Fill Finish Grading" dated August 28, 1962[1], and visual observations made by OMU personnel during pond dredging activities, the Ash Ponds appear to be incised in the native soils to a depth of approximately 8 feet below ground surface (bgs).

CEC assisted OMU with the design and installation of a permanent Groundwater Monitoring System (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 (CEC, 2017 (1)) and Amended GMS Certification Report dated March 2019 (CEC 2019(1)). 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

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

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 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 layer thickness 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 (CEC, 2017[1]) 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 collected from the GMS monitoring well network during the 2020 sampling events ranged from 60.50 feet below top of casing (BTOC) at MW-7 to 38.06 feet BTOC at MW-1. Static groundwater elevations on-site during 2020 ranged from 358.27 feet above mean sea level (AMSL) at MW-8 to 367.07 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 Figures 3a and 3b.

Groundwater elevation measurements obtained during the May 13, 2020 groundwater monitoring event indicated that the groundwater flow direction was to the southeast at an approximate average hydraulic gradient of 0.002, which is consistent with previous findings. This flow direction is

[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.

contrary to what is typically observed in this type of hydrogeologic setting, where groundwater flow is towards the adjacent surface water body and 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.

Groundwater elevation measurements obtained during the December 2, 2020 groundwater monitoring event indicated that the groundwater flow direction was to the southwest at an approximate average hydraulic gradient of 0.001. While the gradient appears to be consistent with prior findings, the flow direction is not and is interpreted to be a result of OMU terminating the operation of the production wells in the vicinity of the Ash Ponds in October 2020. OMU is now utilizing three new production wells located about 1 mile southwest and downstream of ESS to generate groundwater for treatment and distribution to its drinking water customers. Groundwater flow patterns are interpreted to currently be in a state of flux as they transition from the pumping-induced state created by the operation of the production wells proximate to ESS to a state that is consistent with present-day conditions, which includes a combination of influence from the new production wells pumping to the southwest and the groundwater-surface water interactions of the adjacent Ohio River.

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 approximately 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

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 groundwater quality. Refer to the GMS Certification Report (CEC, 2017[1]) for lithologic descriptions and well construction diagrams. As noted above in Section 2.2.1, the groundwater pumping at the municipally-operated well field and proximity of the Ash Ponds to the Ohio River created a unique hydrogeologic setting where there was 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). Therefore, two monitoring wells (MW-2 and MW-7) were used to establish and monitor background groundwater conditions.

While MW-2 has historically been hydraulically upgradient, this was interpreted to be an artificial condition created by the operation of the production wells. Based on groundwater elevations obtained during the December 2, 2020 monitoring event, it appears that MW-2 may transition to being a downgradient monitoring well in the future. Because of the unique and artificial condition created by the now idled production wells, a secondary location (MW-7) was selected to accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit. MW-7 was placed in a location so as not to be on a direct flow path from the Ash Ponds regardless of the potential pumping influence and is also at a sufficient distance from the ponds to be representative of background conditions.

The remainder of the GMS wells were strategically located taking into account the possibility that production well operations may eventually terminate and cause a shift in the groundwater flow direction. With groundwater flow direction being consistently observed to the southeast since 2016, MW-4, MW-5, and MW-6 have been used to monitor water quality of groundwater passing the boundary of the CCR unit. These wells were placed as close as possible to the CCR unit boundary to provide for detection of groundwater contamination in the uppermost aquifer. GMS wells MW-1, MW-2, and MW-3, which have been used as background/upgradient wells (MW-2) and to monitor groundwater elevation (MW-1 and MW-3) are also positioned for use as

downgradient monitoring wells should production well pumping operations cease for an extended period of time and the groundwater flow direction reverts back toward the river. OMU plans to continue to monitor the groundwater elevations over the next year and will evaluate re-classification of the GMS wells (i.e., upgradient versus downgradient) and/or the need for additional GMS wells as part of the 2021 Annual Groundwater Monitoring and Corrective Action Report.

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 (see Section 6.0) 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	**Location Relative to CCR Unit**	**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

4.0 CCR RULE SAMPLING PROGRAM PROGRESSION

4.1 BASELINE DATA AND BACKGROUND VALUES

The baseline sampling at ESS was performed between February 2017 and September 2017. The Appendix III background concentration values were determined using an upper prediction limit (UPL) method in accordance with the statistical methodology described in the *Detection Monitoring Statistical Methods Certification* for the Site, dated October 17, 2017 (CEC, 2017(2)). Background UPL values were calculated for each parameter based on the initial eight baseline sampling events conducted at the two background wells to establish background UPL values. The final background UPL values are summarized in the table below:

CCR RULE APPENDIX III BACKGROUND VALUES		
Parameter	**Units**	**UPL Value**
Boron, Total	mg/L	0.33
Calcium, Total	mg/L	139.5
Chloride	mg/L	50
Fluoride	mg/L	NC
pH, laboratory	s.u.	8.01
Sulfate	mg/L	154.3
Total Dissolved Solids	mg/L	950.8

NC = not calculated because constituent was not quantified at concentrations exceeding laboratory detection limit.

4.2 SSI DETERMINATION

Statistically Significant Increases (SSIs) for Appendix III parameters were determined within the Detection Monitoring program based upon comparison of the results from the October 2017 Detection Monitoring event to the UPL of the mean concentration detected in the background wells from the eight rounds of baseline monitoring. Based upon the results, one or more SSIs were identified at MW-4, MW-5, and MW-6.

Each downgradient monitoring well location had at least one identified SSI. SSIs for boron, calcium, sulfate, and total dissolved solids (TDS) were the most common among the downgradient wells. Below is a tabular summary of the SSIs observed:

SUMMARY OF OBSERVED SSIs AT OMU ESS							
Monitoring Point	Appendix III Parameters						
	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids (TDS)
MW-4	X	X				X	X
MW-5	X					X	
MW-6	X	X				X	X

X – SSI Determined

4.3 TRANSITION TO ASSESSMENT MONITORING

As a result of the SSI determinations, the Assessment Monitoring Program was initiated in April 2018 for ESS consisting of sampling and analysis for Appendix IV constituents. A notification of the transition into the Assessment Monitoring Program was placed in the facility's Operating Record in accordance with §257.105(h) on January 19, 2018 (CEC, 2018).

4.4 GROUNDWATER PROTECTION STANDARDS

The CCR Rule requires that two Assessment Monitoring events be performed and analytical results obtained before establishing Groundwater Protection Standards (GWPSs) for Appendix IV constituents in accordance with Section §257.95(h) of the CCR Rule. The GWPSs are then compared to the downgradient Appendix IV concentrations to identify if downgradient concentrations exceed the GWPS at Statistically Significant Levels (SSLs) prompting an Assessment of Corrective Measures.

A GWPS may be determined as follows:

- For constituents having a maximum contaminant level (MCL) that has been established under U.S. EPA 40 C.F.R. §141.62 and §141.66 of this title, the GWPS is equal to the MCL;
- For cobalt, lead, lithium, and molybdenum, which do not have MCLs established, the GWPS is set equal to the concentrations outlined in §257.95(h)(2); and,

- For constituents having background groundwater concentrations exceeding the MCL identified under the first bullet above, or the standards identified under option 2, the GWPS is equal to the UPL of the background concentration in accordance with §257.95(h)(3).

In accordance with the third bulleted item above, the background concentration for each parameter was determined from the UPL using the initial eight baseline sampling events from the two background wells. This value was then compared to the MCL or the established Health-Based Value to determine the final GWPS.

GWPS values were established for the Site, consistent with §257.95(d)(2). The table below summarizes background concentrations, MCL values, and health-based values for detected constituents at the Site.

GWPS DETERMINATION FOR OMU ESS					
Appendix IV Constituent	**Units**	**UPL**	**MCL**	**Health-based Value**	**Final GWPS**
Total Metals					
Antimony, Total	mg/L	ND/NC	0.006	--	0.006
Arsenic, Total	mg/L	ND/NC	0.010	--	0.010
Barium, Total	mg/L	0.18	2	--	2
Beryllium, Total	mg/L	0.00091	0.004	--	0.004
Cadmium, Total	mg/L	ND/NC	0.005	--	0.005
Chromium, Total	mg/L	4.1	0.1	--	4.1
Cobalt, Total	mg/L	0.098	--	0.006	0.098
Lead, Total	mg/L	0.015	0.015	0.015	0.015
Lithium, Total	mg/L	ND/NC	--	0.040	0.040
Mercury, Total	mg/L	ND/NC	0.002	--	0.002
Molybdenum, Total	mg/L	ND/NC	--	0.100	0.100
Selenium, Total	mg/L	ND/NC	0.05	--	0.05
Thallium, Total	mg/L	ND/NC	0.002	--	0.002
Non-Metals					
Fluoride	mg/L	1.0	4	--	4
Combined Radium-226/228	pCi/L	9.32	5	--	9.32

Notes:

- ND/NC = constituent was not detected at concentrations exceeding laboratory reporting limits in the background monitoring wells, and therefore the UPL was not calculated.
- -- = No Value Established

4.5 STATISTICALLY SIGNIFICANT LEVEL DETERMINATION

The final SSL determination was based on whether or not an exceedance of GWPSs occurred for an Appendix IV constituent at a downgradient GMS location in both the initial (April 2018) and resample (June 2018) sampling events. Based on the analytical results, one constituent (molybdenum) was detected at a SSL at two locations (MW-5 and MW-6). A summary of the constituents quantified at a SSL are summarized below:

Downgradient GMS Location	Appendix IV Parameters														
	Antimony, Total	Arsenic, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Chromium, Total	Cobalt, Total	Lead, Total	Lithium, Total	Mercury, Total	Molybdenum, Total	Selenium, Total	Thallium, Total	Fluoride	Combined Radium 226/228
MW-4															
MW-5											X				
MW-6											X				

X – SSL Determined

In accordance with §257.105(h), a notification was placed into the facility's Operating Record on October 31, 2018 indicating that an SSL had been observed for molybdenum. The Site will remain in Assessment Monitoring unless concentrations of constituents in Appendix IV are quantified at levels equal to or less than the GWPS.

The December 2018 SSL evaluation confirmed the SSL determinations from the April and June 2018 Assessment Monitoring events. As a result of the confirmation of the SSL for molybdenum, the facility was required to perform an Assessment of Corrective Measures (CEC, 2019) in addition to continuing with the Assessment Monitoring Program.

The source of the observed SSLs in the downgradient GMS wells was determined to be attributable to the Ash Ponds. A Release Characterization was initiated in December 2018, consisting of the

installation of one monitoring well (MW-8) in the southwest corner of the ESS property to delineate the extent of the molybdenum impact in groundwater downgradient from the Ash Ponds (Figure 2). Molybdenum has not been quantified at concentrations exceeding laboratory reporting limits in groundwater samples collected from MW-8.

5.0 2020 GROUNDWATER SAMPLING SUMMARY

In accordance with §257.95(b), an annual Assessment Monitoring event was performed on May 13, 2020. Groundwater samples were collected from the six GMS sampling locations and submitted to ALS Environmental Laboratory (ALS) in Cincinnati, Ohio for analysis of Appendix III and Appendix IV parameters. The semi-annual Assessment Monitoring event was performed on December 2, 2020, in accordance with §257.95(d)(1), which included sampling of the six GMS locations and laboratory analysis for Appendix III parameters and the Appendix IV parameters that were quantified at concentrations exceeding their respective laboratory reporting limits during the May 2020 sampling event. An analytical summary for the Assessment Monitoring sampling events is provided in Table 2.

A summary of the 2020 sampling events is provided below. The Site remained in the Assessment Monitoring Program throughout 2020.

2020 CCR RULE GROUNDWATER SAMPLING EVENTS		
Location	**May 2020 Event**	**December 2020 Event**
Downgradient Wells		
MW-4	5/13/2020	12/2/2020
MW-5	5/13/2020	12/2/2020
MW-6	5/13/2020	12/2/2020
MW-8	5/13/2020	12/2/2020
Background Wells		
MW-2	5/13/2020	12/2/2020
MW-7	5/13/2020	12/2/2020

6.0 STATISTICALLY SIGNIFICANT LEVEL DETERMINATION

6.1 NOVEMBER 2019 ANALYTICAL RESULTS

The 2019 Groundwater Monitoring and Corrective Action Report was issued prior to performing the SSL evaluation of the results from the November 2019 sampling event. The conclusions of that evaluation are discussed here.

One constituent (molybdenum) was detected at a SSL in two of the downgradient GMS locations (MW-5 [0.85 mg/L] and MW-6 [2.0 mg/L]), which is consistent with the findings of the prior sampling events. No other Appendix IV constituents were detected at SSLs.

6.2 MAY 2020 ANALYTICAL RESULTS

The analytical results from the May 2020 sampling event were consistent with prior events and reported detections of molybdenum at a SSL at MW-5 and MW-6. The molybdenum concentrations reported were slightly less than, but of similar order of magnitude (0.52 mg/L and 1.8 mg/L, respectively) to, those detected in the December 2019 sampling event. No other Appendix IV constituents were detected at SSLs.

6.3 DECEMBER 2020 ANALYTICAL RESULTS

Statistical analysis of the laboratory data obtained from the December 2020 will be performed within 90 days of receiving the laboratory results to evaluate whether or not constituents are present at SSLs, consistent with §257.95(g).

7.0 REMEDY SELECTION

As noted in Section 4.5, due to the presence of molybdenum in groundwater at SSLs, OMU was required to conduct an Assessment of Corrective Measures pursuant to 40 CFR §257.96. CEC prepared the Assessment of Corrective Measures report, dated May 29, 2019 (CEC, 2019[3]), evaluating various corrective measures options, including: monitored natural attenuation, waste excavation and disposal, in-situ remediation, capping, operation of a pump and treat groundwater remediation system, and installation of a groundwater cut-off wall with respect to the requirements of §257.97(b)(1) through (5) and §257.97 (c)(1) through (4) and two primary corrective measures objectives:

1. Reduce leaching of CCR chemicals of concern (COCs) from the coal ash impoundments via infiltration of surface water and inundation of groundwater, which appears to be the primary source of the observed groundwater impacts; and,
2. Monitor performance of the selected corrective measure through continued sampling of the GMS wells to demonstrate compliance with the GWPS.

A copy of the Assessment of Corrective Measures report is accessible on the publicly-accessible website.

Due to the COVID-19 pandemic and the restrictions on public mass gatherings in Kentucky, a public meeting to discuss the remedy selection was unable to be held in 2020. Therefore, OMU has prepared semi-annual progress reports pursuant to §257.105(h)(12) to document the progress in selecting the remedy. Copies of these reports are accessible on the publicly-available website. The final remedy will be selected following the public meeting and comment period in accordance with §257.96(e). However, after consideration of the available options, the preferred corrective measures approach is excavation and off-site disposition of the CCR within the Ash Ponds. Monitored natural attenuation will also be conducted to evaluate the performance of the applied corrective measure. OMU has outlined the preliminary approach for implementing this remedy in their Initial and Post Closure Plan for the facility, dated October 17, 2016 (revised October 19, 2017). This option provides protection of human health and the environment and a high level of confidence that further releases of COCs from the Ash Ponds will not occur. The

monitored natural attenuation will serve to monitor the performance of the excavation remedy, while the pump and treat option will serve in a backup capacity in the event that the excavation does not perform as expected.

8.0 PLANNED ACTIVITIES FOR 2021

This section discusses the groundwater monitoring and reporting activities anticipated for ESS in 2021. All dates are tentative and subject to change based on findings.

January 2021:

- Enter the *2020 Annual Groundwater Monitoring and Corrective Action Report* into the facility's Operating Record.

February 2021:

- Evaluate analytical data from the December 2020 Assessment Monitoring sampling event against GWPS.

March 2021:

- Post the *2020 Annual Groundwater Monitoring and Corrective Action Report* to the public internet site and notify KDEP.

May 2021:

- The first semi-annual groundwater monitoring event in 2021 will be conducted. Assessment Monitoring samples (i.e., Appendix III and IV) will be collected during the event.
- Assuming mass gathering restrictions are lifted, hold public meeting to discuss the results of the ACM and the remedy that is anticipated to be selected.
- Prepare semi-annual progress report on remedy selection if public meeting and final remedy selection have not occurred.

June 2021:

- Post to the public internet site and notify KDEP of the final Remedy Selection report.
- Place documentation of the public meeting in the Operating Record.

August 2021:

- Appendix IV sample results collected in May 2021 will be evaluated for a SSL over background.

November 2021:

- The second semi-annual groundwater monitoring event in 2021 will be conducted. Assessment Monitoring samples (i.e., Appendix III and IV) will be collected during the event. Note SSLs for the November 2021 Assessment Monitoring event will be determined by January 2022.

December 2021:

- Preparation of the *2021 Annual Groundwater Monitoring and Corrective Action Report* will begin.

9.0 RECORDKEEPING 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 KDEP to comply with §257.107(h) and §257.106(h) of the CCR Rule.

10.0 REFERENCES

CEC, 2017(1). CCR Rule Groundwater Monitoring Certification Coal Ash Ponds, Elmer Smith Station, Owensboro, Kentucky, Prepared For: Owensboro Municipal Utilities, Owensboro, Kentucky, Prepared by Civil & Environmental Consultants, Inc., Pittsburgh, Pennsylvania, CEC Project 164-014, October 2017.

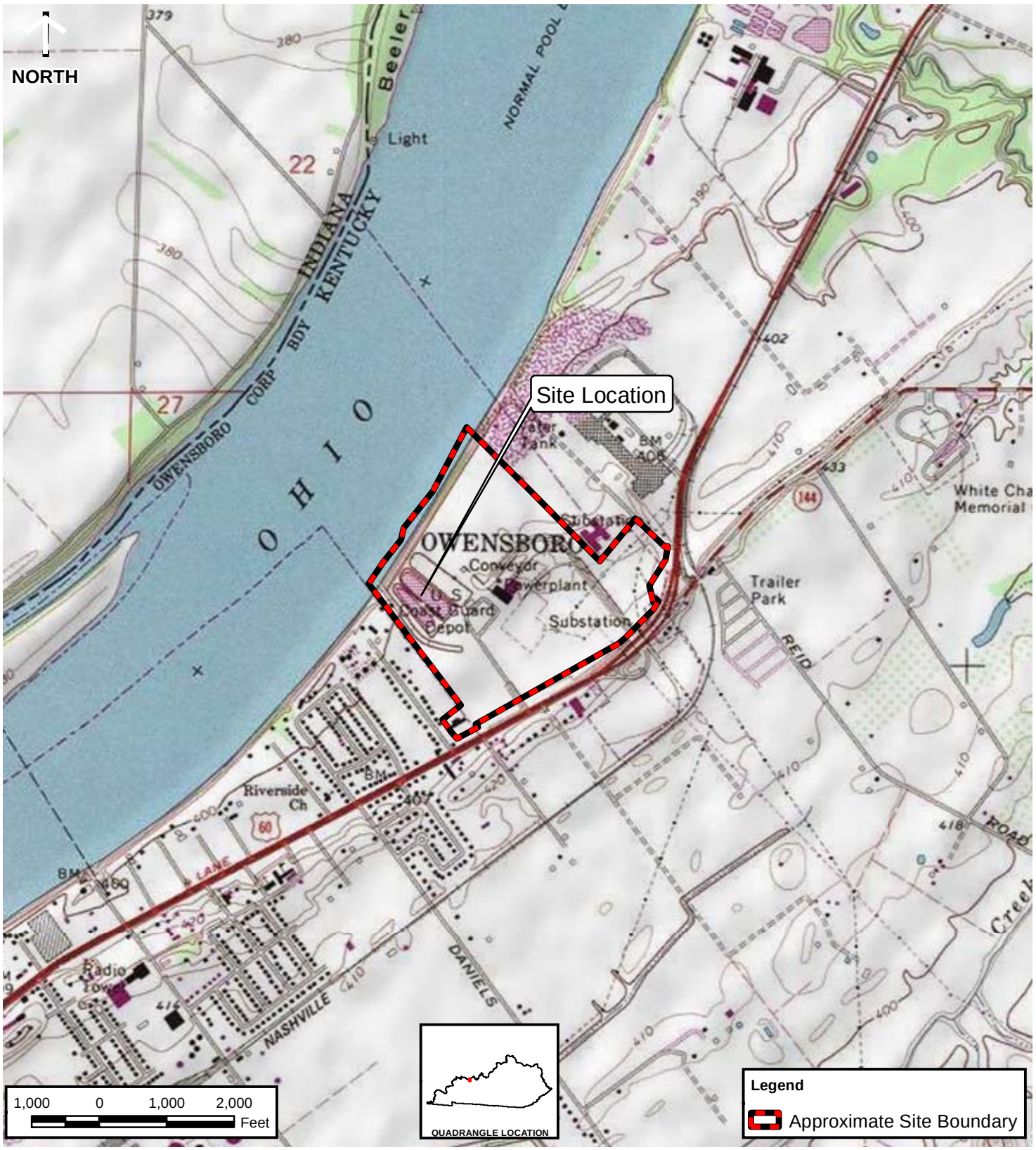
CEC, 2017(2). Detection Monitoring Statistical Methods Certification, Coal Ash Ponds, Elmer Smith Station, Owensboro, Kentucky, Prepared For: Owensboro Municipal Utilities, Owensboro, Kentucky, Prepared by Civil & Environmental Consultants, Inc., Pittsburgh, Pennsylvania, CEC Project 164-014, October 2017.

CEC, 2019(1). 2018 Groundwater Monitoring and Corrective Action Report, Coal Ash Ponds, Elmer Smith Station, Owensboro, Kentucky, Prepared For: Owensboro Municipal Utilities, Owensboro, Kentucky, Prepared by Civil & Environmental Consultants, Inc., Pittsburgh, Pennsylvania, CEC Project 164-014, January 2019.

CEC, 2019(2). Amended Detection Monitoring Statistical Methods Certification, Coal Ash Ponds, Elmer Smith Station, Owensboro, Kentucky, Prepared For: Owensboro Municipal Utilities, Owensboro, Kentucky, Prepared by Civil & Environmental Consultants, Inc., Pittsburgh, Pennsylvania, CEC Project 164-014, March 2019.

CEC, 2019(3). Assessment of Corrective Measures, Coal Ash Ponds, Elmer Smith Station, Owensboro, Kentucky, Prepared For: Owensboro Municipal Utilities, Owensboro, Kentucky, Prepared by Civil & Environmental Consultants, Inc., Pittsburgh, Pennsylvania, CEC Project 164-106, May 2019.

FIGURES



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

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www.cecinc.com

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 07, 2021	DWG SCALE:	1 " = 2,000 '	PROJECT NO:	164-014.0028		

Signature on File *

\\SVR-CINC\Projects\2016\164-014\-GIS\Maps\Task 0028 - GWMCA Report 2020\FIG1 164014 EN28 SLM.mxd - 1/7/2021 - 10:52:32 AM (mnemecek)

NORTH

Ohio River

MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MW-7
MW-8

Pond 1
Pond 2
Pond 3

Cooling Water Discharge Canal (channelized)

Cavin Water Treatment Plant

Ellis Smeathers Road

State Route 2380

Coast Guard Lane

E 4th Street (State Route 144)

49
48
63
61
50
66
65
69
64
68
67

SOURCE: CITY OF OWENSBORO GIS SERVER; IMAGE DATE: 2019

Legend

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

PROJECT LOCATION

200 0 200 400 Feet

Civil & Environmental Consultants, Inc.
333 Baldwin Road - Pittsburgh, PA 15205
412-429-2324 - 800-365-2324
www.cecinc.com

OWENSBORO MUNICIPAL UTILITIES
ELMER SMITH STATION ASH PONDS
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:	JAN 26, 2021	SCALE:	1 " = 400 '	PROJECT NO:	164-014		

Signature on File *

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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
				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
				5/23/2019	42.30	362.23
				11/7/2019	45.43	359.10
				5/13/2020	38.06	366.47
				12/2/2020	45.65	358.88
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
				5/23/2019	42.94	362.61
				11/7/2019	46.13	359.42
				5/13/2020	38.56	366.99
				12/2/2020	46.24	359.31

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)

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-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
				5/23/2019	43.51	362.88
				11/7/2019	46.59	359.80
				5/13/2020	39.32	367.07
				12/2/2020	46.98	359.41
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
				5/23/2019	45.72	362.30
				11/7/2019	49.83	358.19
				5/13/2020	42.30	365.72
				12/2/2020	48.46	359.56

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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-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
				5/23/2019	44.07	362.09
				11/7/2019	47.47	358.69
				5/13/2020	40.50	365.66
				12/2/2020	47.21	358.95
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
				5/23/2019	45.30	362.05
				11/7/2019	48.77	358.58
				5/13/2020	41.76	365.59
				12/2/2020	48.07	359.28
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
				5/23/2019	61.60	359.51
				11/7/2019	62.83	358.28
				5/13/2020	57.55	363.56
				12/2/2020	60.50	360.61
MW-8 (8007-1801)	Downgradient	402.97	405.82	12/27/2018	49.51	356.31
				5/23/2019	46.10	359.72
				11/7/2019	49.00	356.82
				5/13/2020	42.01	363.81
				12/2/2020	47.55	358.27

Notes: AMSL = Above Mean Sea Level
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TABLE 2
Groundwater Analytical Summary - CCR Rule Assessment Monitoring
OMU Elmer Smith Station
Owensboro, KY

		Background/Upgradient							Downgradient								
Sample ID		MW-2							MW-4								**Groundwater**
Collection Date		4/5/18	6/5/18	12/12/18	12/12/18	5/23/19	11/7/19	5/13/20	4/5/18	6/5/18	6/5/18	12/12/18	5/23/19	11/7/19	5/13/20	5/13/20	**Protection Standard**
Total Metals	**Units**																
Antimony	mg/L	<0.0060	NA	NA	NA	<0.0060	NA	<0.0050	<0.0060	NA	NA	NA	<0.0060	NA	<0.0050	<0.0050	0.006
Arsenic	mg/L	<0.010	NA	NA	NA	<0.010	NA	<0.0050	<0.010	NA	NA	NA	<0.010	NA	<0.0050	<0.0050	0.010
Barium	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	**0.062**	**0.019**	<0.10	<0.10	<0.10	<0.10	<0.10	**0.045**	**0.024**	**0.024**	2
Beryllium	mg/L	<0.00040	NA	NA	NA	<0.00040	NA	<0.0020	<0.00040	NA	NA	NA	<0.00040	NA	<0.0020	<0.0020	0.004
Boron	mg/L	NA	<0.10	**0.11**	0.14	<0.10	**17**	**0.36**	NA	**11**	**10**	**5.6**	**9.8**	**13**	**4.6**	**4.6**	0.330
Cadmium	mg/L	<0.0050	NA	NA	NA	<0.0050	NA	<0.0020	<0.0050	NA	NA	NA	<0.0050	NA	<0.0020	<0.0020	0.005
Calcium	mg/L	NA	**53**	**100**	**100**	**70**	**250**	**71**	NA	**180**	**180**	**100**	**200**	**200**	**110**	**110**	139.35
Chromium	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.0050	<0.0050	<0.020	<0.020	<0.020	<0.020	<0.020	<0.0050	<0.0050	<0.0050	4.10
Cobalt	mg/L	<0.0040	NA	NA	NA	<0.0040	<0.0050	<0.0050	<0.0040	NA	NA	NA	<0.0040	<0.0050	<0.0050	<0.0050	0.098
Lead	mg/L	<0.015	NA	NA	NA	<0.015	NA	<0.0050	<0.015	NA	NA	NA	<0.015	NA	<0.0050	<0.0050	0.015
Lithium	mg/L	<0.10	NA	NA	NA	<0.010	<0.0050	<0.010	<0.10	NA	NA	NA	<0.010	<0.0050	<0.010	<0.010	0.040
Mercury	mg/L	<0.00020	NA	NA	NA	<0.00020	NA	<0.00020	<0.00020	NA	NA	NA	<0.00020	NA	<0.00020	<0.00020	0.002
Molybdenum	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	**0.011**	**0.0077**	<0.10	<0.10	<0.10	<0.10	<0.10	**0.0085**	**0.0093**	**0.0094**	0.10
Selenium	mg/L	<0.030	NA	NA	NA	<0.030	**0.017**	<0.0050	<0.030	NA	NA	NA	<0.030	<0.0050	<0.0050	<0.0050	0.050
Thallium	mg/L	<0.0050	NA	NA	NA	<0.0020	NA	<0.0050	<0.0050	NA	NA	NA	<0.0020	NA	<0.0050	<0.0050	0.002
Anions																	
Chloride	mg/L	NA	**18**	**18**	**18**	**16**	**45**	**15**	NA	**37**	**37**	**27**	**200**	**44**	**35**	**35**	50.0
Fluoride	mg/L	<2.0	**0.30**	<2.0	<2.0	<2.0	<0.20	<0.20	<2.0	<0.50	<0.50	<2.0	<2.0	<0.20	<0.20	<0.20	4
Sulfate	mg/L	NA	**36**	**19**	**19**	**56**	**570**	**43**	NA	**370**	**370**	**140**	**730**	**500**	**200**	**200**	154.26
Radium																	
Radium-226	pCi/L	<0.25 (+/-0.13)	<0.193 (+/-0.098)	<0.28 (+/-0.17)	<0.25 (+/-0.15)	<0.34 (+/-0.18)	NA	**0.31 (+/-0.23)**	**0.49 (+/-0.23)**	**0.32 (+/-0.18)**	**0.32 (+/-0.17)**	<0.23 (+/-0.15)	<0.39 (+/-0.28)	NA	<0.27 (+/-0.15)	<0.3 (+/-0.24)	9.32
Radium-228	pCi/L	<0.94 (+/-0.4)	NA	<0.84 (+/-0.42)	<0.81 (+/-0.41)	<0.79 (+/-0.36)	NA	<0.71 (+/-0.35)	<0.98 (+/-0.48)	NA	NA	<0.82 (+/-0.39)	<0.81 (+/- 0.4)	NA	<0.75 (+/-0.36)	<0.73 (+/-0.32)	
pH																	
pH	s.u.	NA	**7.7**	**7.6**	**6.1**	**7.8**	**6.9**	**7.6**	NA	**7.5**	**7.4**	**7.8**	**7.2**	**6.8**	**7.3**	**7.4**	8.01
Total Dissolved Solids																	
Total Dissolved Solids	mg/L	NA	**260**	**420**	**420**	**330**	**1,400**	**300**	NA	**1,100**	**1,100**	**570**	**1,300**	**1,300**	**690**	**680**	950.8

= Appendix III constituent (fluoride is included on both Appendix III & IV lists)
= Appendix IV constituent (fluoride is included on both Appendix III & IV lists)
Bold indicates result detected above laboratory reporting limit
12/12/2018 = Blind duplicate sample
NA = Not analyzed for this constituent

TABLE 2
Groundwater Analytical Summary - CCR Rule Assessment Monitoring
OMU Elmer Smith Station
Owensboro, KY

		Downgradient						Downgradient									
Sample ID		MW-5						MW-6									**Groundwater**
Collection Date		4/5/18	6/5/18	12/12/18	5/23/19	11/7/19	5/13/20	4/5/18	4/5/18	6/5/18	12/12/18	5/23/19	5/23/19	11/7/19	11/7/19	5/13/20	**Protection Standard**
Total Metals	**Units**																
Antimony	mg/L	<0.0060	NA	NA	<0.0060	NA	<0.0050	<0.0060	<0.0060	NA	NA	<0.0060	<0.0060	NA	NA	<0.0050	0.006
Arsenic	mg/L	<0.010	NA	NA	<0.010	NA	<0.0050	<0.010	<0.010	NA	NA	<0.010	<0.010	NA	NA	<0.0050	0.010
Barium	mg/L	**0.11**	**0.12**	<0.10	<0.10	**0.074**	**0.095**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.05**	**0.05**	**0.032**	2
Beryllium	mg/L	<0.00040	NA	NA	<0.00040	NA	<0.0020	<0.00040	<0.00040	NA	NA	<0.00040	<0.00040	NA	NA	<0.0020	0.004
Boron	mg/L	NA	**12**	**10**	**12**	**13**	**11**	NA	NA	**10**	**11**	**9.1**	**9.2**	**13**	**13**	**10**	0.330
Cadmium	mg/L	<0.0050	NA	NA	<0.0050	NA	<0.0020	<0.0050	<0.0050	NA	NA	<0.0050	<0.0050	NA	NA	<0.0020	0.005
Calcium	mg/L	NA	**150**	**120**	**130**	**130**	**220**	NA	NA	**180**	**170**	**130**	**130**	**150**	**150**	**110**	139.35
Chromium	mg/L	<0.020	<0.020	<0.020	<0.020	<0.0050	<0.0050	**0.021**	**0.020**	<0.020	<0.020	<0.020	<0.020	<0.0050	<0.0050	<0.0050	4.10
Cobalt	mg/L	<0.0040	NA	NA	<0.0040	<0.0050	<0.0050	<0.0040	<0.0040	NA	NA	**0.0063**	**0.006**	<0.0050	<0.0050	<0.0050	0.098
Lead	mg/L	<0.015	NA	NA	<0.015	NA	<0.0050	<0.015	<0.015	NA	NA	<0.015	<0.015	NA	NA	<0.0050	0.015
Lithium	mg/L	<0.10	NA	NA	**0.019**	**0.02**	**0.019**	<0.10	<0.10	NA	NA	<0.010	<0.010	<0.0050	<0.0050	<0.010	0.040
Mercury	mg/L	<0.00020	NA	NA	<0.00020	NA	<0.00020	<0.00020	<0.00020	NA	NA	<0.00020	<0.00020	NA	NA	<0.00020	0.002
Molybdenum	mg/L	**0.34**	**0.41**	**0.36**	**0.5**	**0.85**	**0.52**	**1.7**	**1.7**	**1.8**	**2.1**	**1.8**	**1.8**	**2**	**2**	**1.8**	0.10
Selenium	mg/L	<0.030	NA	NA	<0.030	**0.019**	**0.031**	<0.030	<0.030	NA	NA	**0.035**	**0.037**	**0.047**	**0.046**	**0.040**	0.050
Thallium	mg/L	<0.0050	NA	NA	<0.0020	NA	<0.0050	<0.0050	<0.0050	NA	NA	<0.0020	<0.0020	NA	NA	<0.0050	0.002
Anions																	
Chloride	mg/L	NA	**62**	**49**	**70**	**38**	**110**	NA	NA	**37**	**37**	**30**	**29**	**31**	**31**	**25**	50.0
Fluoride	mg/L	**2.3**	**1.9**	<2.0	**2.2**	**2.2**	**2.2**	<2.0	<2.0	<0.50	<2.0	<2.0	<2.0	**0.93**	**0.91**	**1.1**	4
Sulfate	mg/L	NA	**390**	**260**	**330**	**340**	**600**	NA	NA	**370**	**550**	**450**	**450**	**480**	**460**	**370**	154.26
Radium																	
Radium-226	pCi/L	<0.13 (+/-0.11)	**0.2 (+/-0.13)**	<0.61 (+/-0.35)	<0.36 (+/-0.23)	NA	<0.41 (+/-0.22)	<0.19 (+/-0.13)	**0.25 (+/-0.16)**	**0.32 (+/-0.17)**	<0.27 (+/-0.2)	<0.34 (+/-0.19)	<0.47 (+/-0.27)	NA	NA	<0.3 (+/-0.14)	9.32
Radium-228	pCi/L	<1.01 (+/-0.45)	NA	<0.76 (+/-0.36)	<0.78 (+/-0.38)	NA	<0.75 (+/-0.39)	<0.98 (+/-0.45)	<0.98 (+/-0.43)	NA	<0.72 (+/-0.34)	<0.78 (+/-0.38)	<0.78 (+/-0.41)	NA	NA	<0.71 (+/-0.36)	
pH																	
pH	s.u.	NA	**7.5**	**8.0**	**7.6**	**7.9**	**7.4**	NA	NA	**7.4**	**7.8**	**7.4**	**7.5**	**7.4**	**7.0**	**7.4**	8.01
Total Dissolved Solids																	
Total Dissolved Solids	mg/L	NA	**1,200**	**840**	**1,100**	**940**	**1,600**	NA	NA	**1,100**	**1,100**	**870**	**1,000**	**960**	**960**	**750**	950.8

= Appendix III constituent (fluoride is included on both Appendix III & IV lists)
= Appendix IV constituent (fluoride is included on both Appendix III & IV lists)
Bold indicates result detected above laboratory reporting limit
1.8 = Appendix IV constituent quantified at Statistically Significant Level (exceeding Groundwater Protection Standard)
NA = Not analyzed for this constituent
12/12/2018 = Blind duplicate sample