2022 Annual Groundwater Monitoring Report for Fly Ash Reservoir (FAR) II Cardinal Operating Company – Cardinal Plant 306 County Road 7E Brilliant, Ohio

January 27, 2023

Submitted to:

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

Submitted by:

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Executive Summary

Cox-Colvin & Associates, Inc. (Cox-Colvin) has prepared this 2022 Annual Groundwater Monitoring Report (Report) for the Fly Ash Reservoir II (FAR II), an existing coal combustion residual (CCR) unit at the Cardinal Plant in Brilliant, Ohio. This report has been prepared in accordance with §257.90(e) of the Federal Coal Combustion Residuals Rules ("CCR Rules", 40 CFR Subpart D), which requires owners and/or operators of existing CCR landfills and surface impoundments to prepare a groundwater monitoring and corrective action report no later than January 31, annually. This report summarizes groundwater monitoring activities conducted pursuant to the CCR Rules from January 1, 2022, through December 31, 2022.

During 2022 groundwater monitoring, statistically significant increases (SSIs) above background concentrations were observed for the following constituents and wells:

- Boron: FA-8, M-10, M-11, M-21, M-22, M-23, M-1004, M-GS-3, M-GS-3R
- Calcium: FA-8, M-1003, M-1004, M-GS-1
- Chloride: M-8A, M-13, M-16, M-1003, M-1004, M-GS-3
- Fluoride: FA-8, M-13, M-21, M-22, M-23, M-1309
- pH¹: M-11, M-13, M-16, M-1309
- Sulfate: M-8, M-13, M-1003
- TDS: M-16, M-1003, M-GS-1, M-GS-2

In accordance with §257.95 of the CCR Rules, assessment monitoring at FAR II was initiated in May 2018 after an SSI over groundwater background levels was first detected. FAR II remained in an assessment monitoring program from May 2018 through January 2019. In February 2019, it transitioned to a corrective action program following detection of statistically significant levels (SSLs) of groundwater contamination above groundwater protection standards (GWPSs). In accordance with §257.98(a)(1)(i) of the CCR Rules, assessment monitoring continues to be conducted as part of the corrective actions being performed. FAR II was operating under an assessment monitoring program (§257.95 of the CCR Rules) at the start of the 2022 annual reporting period and remained in the assessment monitoring program throughout the 2022 annual reporting period.

¹ Unlike other monitored constituents that are compared to only a UPL, pH is compared to both a UPL and an LPL when evaluating potential SSIs. In this context, a statistically significant decrease (SSD) of pH values below the LPL is included as a potential "SSI" for consistency with the language and requirements of the CCR Rule.

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Statistical evaluations of two assessment monitoring events were completed during this annual reporting period – the second semiannual event of 2021 (October 2021)² and the first semiannual event of 2022 (April 2022). Consistent with previous evaluations, SSLs above GWPSs were identified for the following constituents and wells:

- Lithium: FA-8, M-11
- Molybdenum: FA-8, M-11

Statistical analysis of the October semi-annual sampling event of 2022 will be completed in 2023 and presented in next year's Annual Groundwater Monitoring Report.

Assessment of corrective measures for the lithium and molybdenum SSLs was initiated on February 7, 2019, and completed on July 9, 2019, with a revised version posted to the public website on November 30, 2020. The public meeting for the assessment of corrective measures was held on September 4, 2019, in Steubenville, Ohio.

A remedy was selected on October 27, 2020. Remedial activities were initiated in 2021 and are ongoing pursuant to §257.98 of the CCR Rules.

² Although samples were collected in October 2021, evaluation of the laboratory results was performed in 2022 and discussion of the evaluation is, therefore, included in this annual report. The October 2021 sampling results were included in the 2021 Annual Groundwater Monitoring Report.

1.0 Introduction

Cox-Colvin & Associates, Inc. (Cox-Colvin) has prepared this 2022 Annual Groundwater Monitoring Report for the Fly Ash Reservoir II (FAR II) at the Cardinal Plant in Brilliant, Ohio (Figure 1-1, Site). This report has been prepared in accordance with §257.90(e) of the Federal Coal Combustion Residuals Rule ("CCR Rules", 40 CFR Subpart D), which requires owners and/or operators of existing CCR landfills and surface impoundments to prepare a groundwater monitoring and corrective action report no later than January 31, annually. This report summarizes groundwater monitoring activities conducted pursuant to the CCR Rules from January 1, 2022, through December 31, 2022.

1.1 Site Summary

The Site is located one mile west and south of Brilliant, Ohio in Jefferson County and is operated by Cardinal Operating Company (Cardinal). Located along the Ohio River, the generating plant consists of three coal-powered units with an 1,800-megawatt (MW) capacity. Units 1 and 2 began operation in 1967 and Unit 3 began operation in 1977. Each generating unit is equipped with an electrostatic precipitator (ESP) for removal of fly ash particulate matter, a selective catalytic reduction (SCR) system for removal of nitrogen oxide, and flue gas desulfurization (FGD) systems for removal of sulfur dioxide (Geosyntec 2017).

1.2 CCR Unit Description

FAR II is an existing wet fly ash disposal reservoir that is located approximately one mile north of the Site and immediately east of the FAR I Residual Solid Waste (RSW) Landfill. The reservoir is contained within Blockhouse Hollow (also referred to as Blockhouse Run in references and drawings) by Fly Ash Dam (FAD) 2 and the decommissioned FAD I. FAR II received sluiced fly ash from the generating units' ESPs and collected stormwater and leachate from the FAR I RSW Landfill. FAR II has a permitted discharge through the National Pollutant Discharge Elimination System (NPDES) Outfall 019 (Geosyntec 2017).

As of July 2021, FAR II no longer receives waste streams and is presently undergoing closure. The CCR Unit and associated monitoring wells are shown in Figure 1-2.

1.3 Regional Physiographic Setting

The Site is underlain by horizontal sequences of lower Permian and upper Pennsylvanian sedimentary rock. The Conemaugh Group, 500 feet (ft) thick in Jefferson County, consists of shale, sandstone, limestone, claystone, and coal. This group includes the Morgantown Sandstone underlain by the Elk Lick Limestone, the Skelly Limestone and Shale, the Ames Limestone, and the Cow Run Sandstone (Geosyntec 2017). Above the current grade of FAR II lies the Monongahela Group, which consists of shale, sandstone,

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limestone, coal, claystone, and siltstone. Overlying the Monongahela Group, at approximately 1,250 feet in elevation, is the Permian-age Dunkard Group (Geosyntec 2017).

Based on monitoring well data in the vicinity of the FAR II, the uppermost aquifer is the Morgantown Sandstone unit. FAR II is partially incised through the Morgantown Sandstone. Hydraulic conductivity values of the Morgantown Sandstone are in the range of 1×10^{-1} to 1×10^{-6} cm/sec and tend to be driven by interconnected fracture flow. The Morgantown Sandstone has a gradient to the east, southeast, and southwest, generally flowing away from FAR II (Geosyntec 2017).

2.0 Groundwater Monitoring System

FAR II's groundwater monitoring network was designed to comply with 40 CFR 257.91. The groundwater monitoring network utilizes monitoring wells initially installed as part of a separate site-wide hydrogeologic investigation and is used to monitor groundwater quality in the uppermost aquifer at the Site. Monitoring well construction and soil boring logs were provided in the Groundwater Monitoring Network Evaluation (Geosyntec 2017).

The FAR II groundwater monitoring network consists of 23 monitoring wells, as shown in Figure 1-2. Five upgradient monitoring wells (CA-0622A, M-12, M-1302, M-6, and M-GS-5) are used to measure background conditions and eighteen downgradient monitoring wells (FA-8, M-10, M-1003, M-1004, M-11, M-13, M-1309, M-14, M-15, M-16, M-21, M-22, M-23, M-8, M-GS-1, M-GS-2, M-GS-3R, and M-GS-4) are used as compliance wells. Additionally, monitoring well M-2000 was installed in 2019 as a delineation well to facilitate characterization of the nature and extent of a previously identified release. Although it has been sampled semi-annually as part of the corrective measures program, it is not part of the groundwater monitoring system used for assessment monitoring.

One CCR monitoring well, M-GS-3R, was installed in Spring 2022 to replace M-GS-3 which was then decommissioned. This change was made in a September 2022 addendum to the groundwater monitoring networks (Cox-Colvin 2022). June 2022 was the last sampling event for M-GS-3 monitoring well, and the first sampling event for M-GS-3R monitoring well was in October 2022.

3.0 Groundwater Monitoring Program

In accordance with §257.95 of the CCR Rules, assessment monitoring at FAR II was initiated in May 2018 after a statistically significant increase (SSI) over groundwater background levels was detected for boron. As discussed in Section **Error! Reference source not found.** concentrations of constituents in groundwater remain above background levels.

FAR II remained in an assessment monitoring program from May 2018 through January 2019. In February 2019, it transitioned to a corrective action program following detection of statistically significant levels (SSLs) of lithium and molybdenum in groundwater above their respective groundwater protection standards (GWPSs). In accordance with §257.98(a)(1)(i) of the CCR Rules, assessment monitoring continues to be conducted as part of the corrective action program. Concentrations of lithium and molybdenum in groundwater remain above their respective GWPSs, and FAR II remained in the corrective action program through 2022.

3.1 Statistical Analysis Plan

Evaluation of analytical data is performed in accordance with the Statistical Analysis Plan (Geosyntec 2020b), which describes a logic process regarding the statistical analysis of groundwater data collected in compliance with the Federal CCR Rules. No revisions were made to the Statistical Analysis Plan during 2022.

3.2 Monitoring Frequency

In accordance with §257.95(d)(1) of the CCR Rules, monitoring wells are sampled semiannually for constituents listed in Appendix III of the CCR Rules. Additionally, annual sampling of all Appendix IV constituents is performed, along with semiannual sampling of those constituents in Appendix IV that were detected during the annual sampling of all Appendix IV constituents.

In September 2021, a demonstration was made that an alternative monitoring frequency may be appropriate (Cox-Colvin 2021). The purpose of the alternative monitoring frequency, which is optional, is to permit semiannual monitoring of all Appendix IV parameters, rather than only those that were previously detected during annual monitoring. The alternative monitoring frequency results in more, rather than less, analysis of groundwater quality. All Appendix IV parameters were analyzed during both 2022 sampling events.

There was no suspension of groundwater monitoring requirements at FAR II under §257.90(g) of the CCR Rules.

4.0 Key Actions Completed

The sections below summarize key actions completed in 2022 with respect to CCR Rules groundwater monitoring and corrective actions at FAR II.

4.1 Groundwater Elevation and Flow

Prior to sampling, a synoptic round of groundwater level measurements was collected from the compliance and background monitoring wells. Potentiometric surface maps based on groundwater elevations measured during the April and October 2022 sampling events are presented in Figures 4-1 and 4-2, respectively. The potentiometric maps show that groundwater near FAR II flows southeast towards the Ohio River. Groundwater flow rate calculations relative to FAR II are summarized in Tables 4-1 and 4-2.

4.2 Groundwater Sampling

Table 4-3 contains a summary of groundwater samples collected for analysis in association with CCR activities at FAR II. The first (Spring) semi-annual monitoring event of 2022 was completed in April 2022 and the second (Fall) semi-annual monitoring event of 2022 was completed in November 2022. A total of 51 samples were collected. Analytical results are summarized in Tables 4-4 and 4-5.

4.3 Data Evaluation

Data evaluations performed in 2022 consisted of the following:

- Comparison of Fall 2021 monitoring data to GWPSs for Appendix IV constituents³
- Comparison of Spring 2022 monitoring data to background levels for Appendix III constituents
- Comparison of Spring 2022 monitoring data to GWPSs for Appendix IV constituents
- Comparison of Fall 2022 monitoring data to background levels for Appendix III constituents

Comparison of Fall 2022 monitoring data to GWPSs for Appendix IV constituents is ongoing and will be included in the 2023 annual report.

³ Although samples were collected in October 2021, evaluation of the laboratory results was performed in 2022 and discussion of the evaluation is, therefore, included in this annual report. The October 2021 sampling results were included in the 2021 Annual Groundwater Monitoring Report.

4.3.1 Background Levels

Appendix III constituent⁴ background levels in FAR II groundwater were most recently updated in November 2021.

During 2022 groundwater monitoring, statistically significant increases (SSIs) above background concentrations were observed for the following constituents and wells:

- Boron: FA-8, M-10, M-11, M-21, M-22, M-23, M-1004, M-GS-3, M-GS-3R
- Calcium: FA-8, M-1003, M-1004, M-GS-1
- Chloride: M-8A, M-13, M-16, M-1003, M-1004, M-GS-3
- Fluoride: FA-8, M-13, M-21, M-22, M-23, M-1309
- pH⁵: M-11, M-13, M-16, M-1309
- Sulfate: M-8, M-13, M-1003
- TDS: M-16, M-1003, M-GS-1, M-GS-2

Background concentrations of Appendix IV constituents in FAR II groundwater were last updated in February 2021. Appendix IV background concentrations are used while determining GWPS values. Because the Appendix IV background levels are based upon upper threshold limits (UTLs), as opposed to UPLs, direct comparison of individual laboratory results to Appendix IV background levels is not appropriate. Instead, statistical evaluation is performed (using confidence bands) to determine whether GWPSs are exceeded, as discussed below.

4.3.2 Groundwater Protection Standards

A GWPS was established for each Appendix IV parameter in accordance with the United States Environmental Protection Agency's Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance (EPA 2009) and the Site's Statistical Analysis Plan (Geosyntec 2020b). The established GWPSs were determined to be the greater value of the background concentration and the maximum contaminant level (MCL) for each Appendix IV parameter. If an MCL was not available, values were obtained from §257.95(h)(2) of the CCR Rules. The current GWPSs are presented in Table 4-6.

⁴ "Appendix III" and "Appendix IV" constituents refer to those constituents listed in the respective appendices of the CCR Rules.

⁵ Unlike other monitored constituents that are compared to only a UPL, pH is compared to both a UPL and an LPL when evaluating potential SSIs. In this context, a statistically significant decrease (SSD) of pH values below the LPL is included as a potential "SSI" for consistency with the language and requirements of the CCR Rule.

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A statistical evaluation of the second 2021 semi-annual event assessment monitoring data was completed in March 2022 and included an evaluation of SSLs for Appendix IV parameters. SSLs were observed for the following constituents and wells:

- Lithium: FA-8, M-11
- Molybdenum: FA-8, M-11

A statistical evaluation of the first 2022 semi-annual event assessment monitoring data was completed in September 2022 and included an evaluation of SSLs for Appendix IV parameters. SSLs were observed for the following constituents and wells.

- Lithium: FA-8, M-11
- Molybdenum: FA-8, M-11

An alternate source was not identified for the SSLs. These SSLs were identified during previous sampling events and are being addressed through the corrective measures process outlined in Section 4.4, below.

Statistical evaluation of the October 2022 assessment monitoring data is ongoing and will be discussed in the 2023 annual groundwater monitoring report.

4.4 Corrective Actions

Following detection of lithium and molybdenum SSLs at FA-8 and M-11, a Notification of Exceedance of Groundwater Protection Standards was published to the public internet site on February 7, 2019, in accordance with 40 CFR 257.105(h) (Buckeye Power 2019). Monitoring well installation and sampling efforts to characterize the nature and extent of the release were described in the Groundwater Characterization Report, Cardinal Site – Fly Ash Reservoir II (Geosyntec 2019b). An Assessment of Corrective Measures (ACM) Report was completed in July 2019 in accordance with 40 CFR 257.96 and published to the public internet site (Geosyntec 2019a). The ACM report listed four potential corrective measures that may be appropriate for addressing the elevated lithium and molybdenum concentrations in Site groundwater. A public meeting was held on September 4, 2019, in Steubenville, Ohio where the selection of potential corrective measures outlined in the ACM Report were reviewed and discussed.

The conclusions of the ACM and public comments resulted in the selection of closure of the FAR II unit with long-term monitoring as the selected remedial approach as detailed in the Remedy Selection Report, Cardinal Site – Fly Ash Reservoir II (Geosyntec 2020a).

On July 13, 2021, Cardinal issued a notice of intent to close the FAR II CCR Unit (Buckeye Power 2021). The notice stated that the unit had ceased receiving waste streams and was initiating closure in place, in accordance with the Closure Plan and the Permit to Install

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issued by the Ohio EPA. The closure activities will include dewatering the FAR II, grading the CCR, and installation of a final cover system. The final cover system is designed to meet the requirements of \$257.102(d)(3) of the CCR Rules.

Closure is currently underway in accordance with §257.100 through §257.102 of the CCR Rules. The groundwater monitoring system will continue to be maintained during the post-closure care period defined in §257.104(c) of the CCR Rules.

5.0 Problems Encountered and Resolutions

Monitoring well CA-0622A was purged dry during the second semi-annual detection monitoring event and a sample could not be collected due to insufficient recovery. Because CA-0622A is an upgradient (background) well, and not a downgradient (compliance) monitoring well, the failure to collect a sample from CA-0622A will not result in a failure to identify an SSI.

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

To better represent groundwater quality in the Morgantown Sandstone, a replacement monitoring well (M-GS-3R) was drilled in the proximity of M-GS-3, but fully screened within the upper portion of the Morgantown Sandstone (i.e., below the coal seam and coal bearing shale). An addendum was made to the groundwater monitoring plan to replace M-GS-3 with M-GS-3R (Section 2.0).

No alternative source demonstrations under either 257.94(e)(2) or 257.95(g)(3)(ii) of the CCR Rules were performed during 2022.

6.0 Projected Key Activities

It is anticipated that the FAR II will remain in the corrective measures program in 2023. The following activities are projected for FAR II:

- The 2022 Annual Groundwater Monitoring Report will be entered into the facility's operating record and posted to the public internet site.
- A statistical evaluation of the October 2022 assessment monitoring event will be completed.
- Two semi-annual groundwater assessment monitoring program events will be conducted.
- A statistical evaluation of the first semiannual assessment monitoring event of 2023 will be completed.
- Implementation of the selected remedy will continue.
- The 2023 Annual Groundwater Monitoring Report will be prepared for submittal in January 2024.

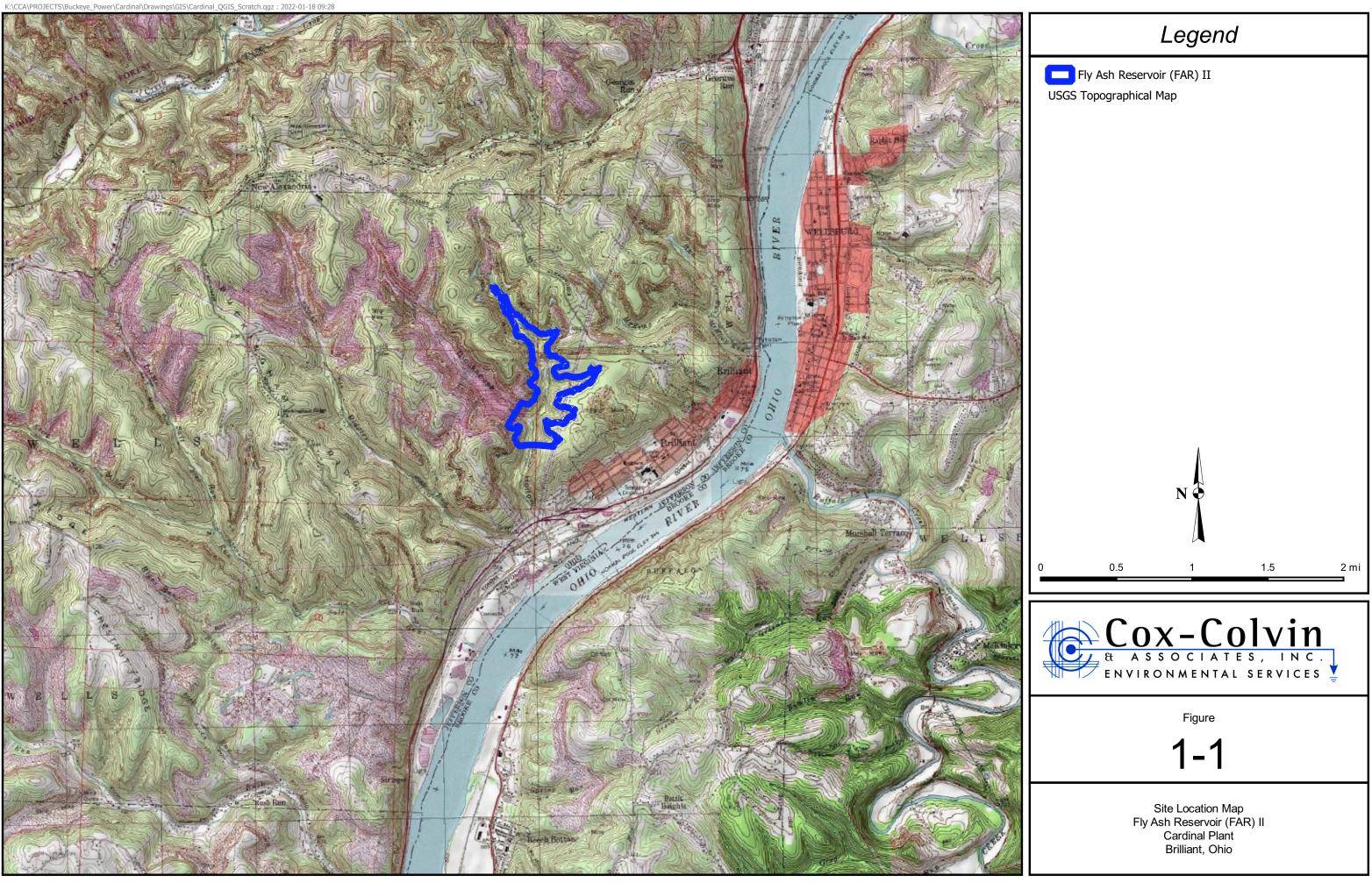
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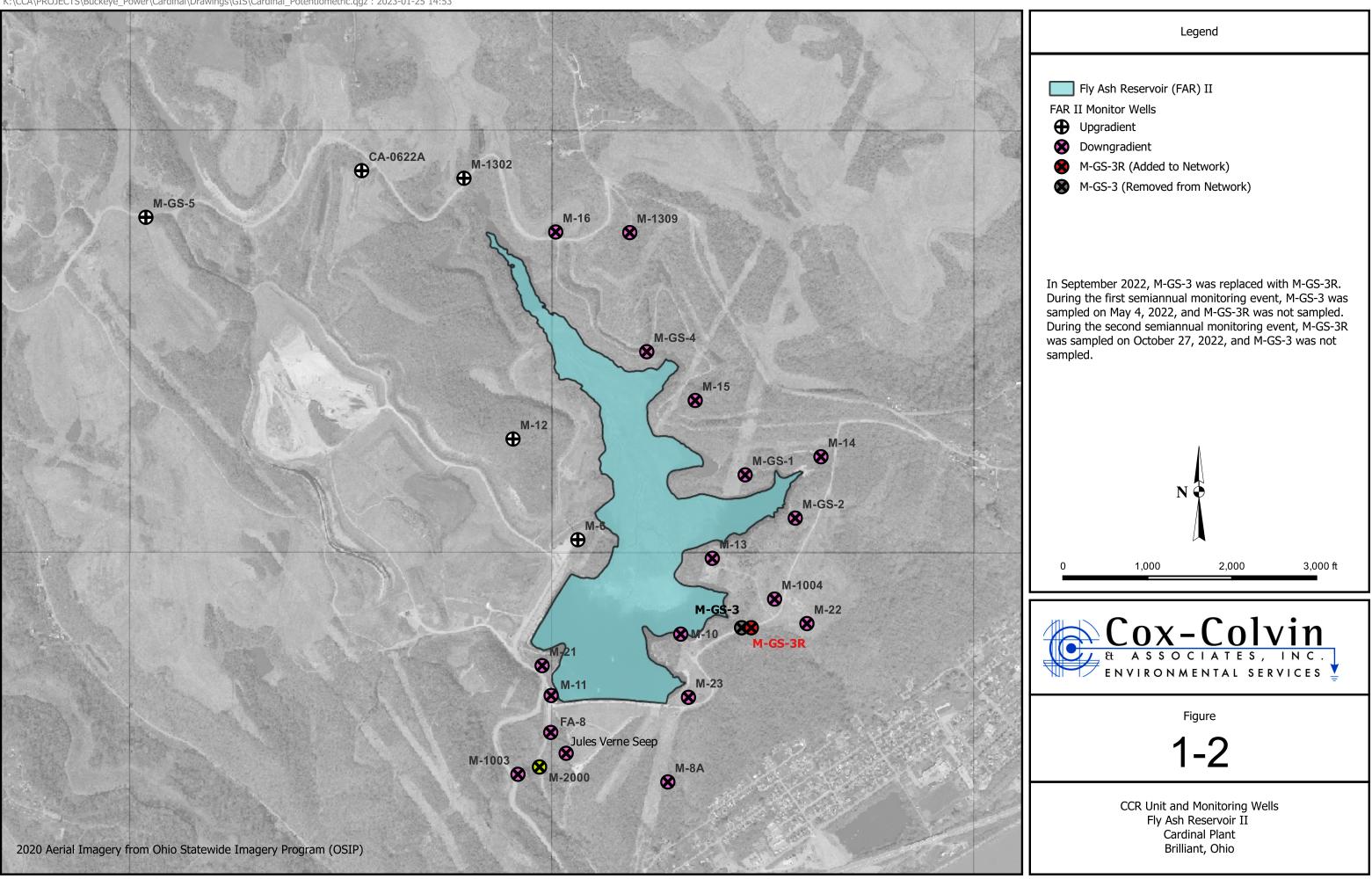
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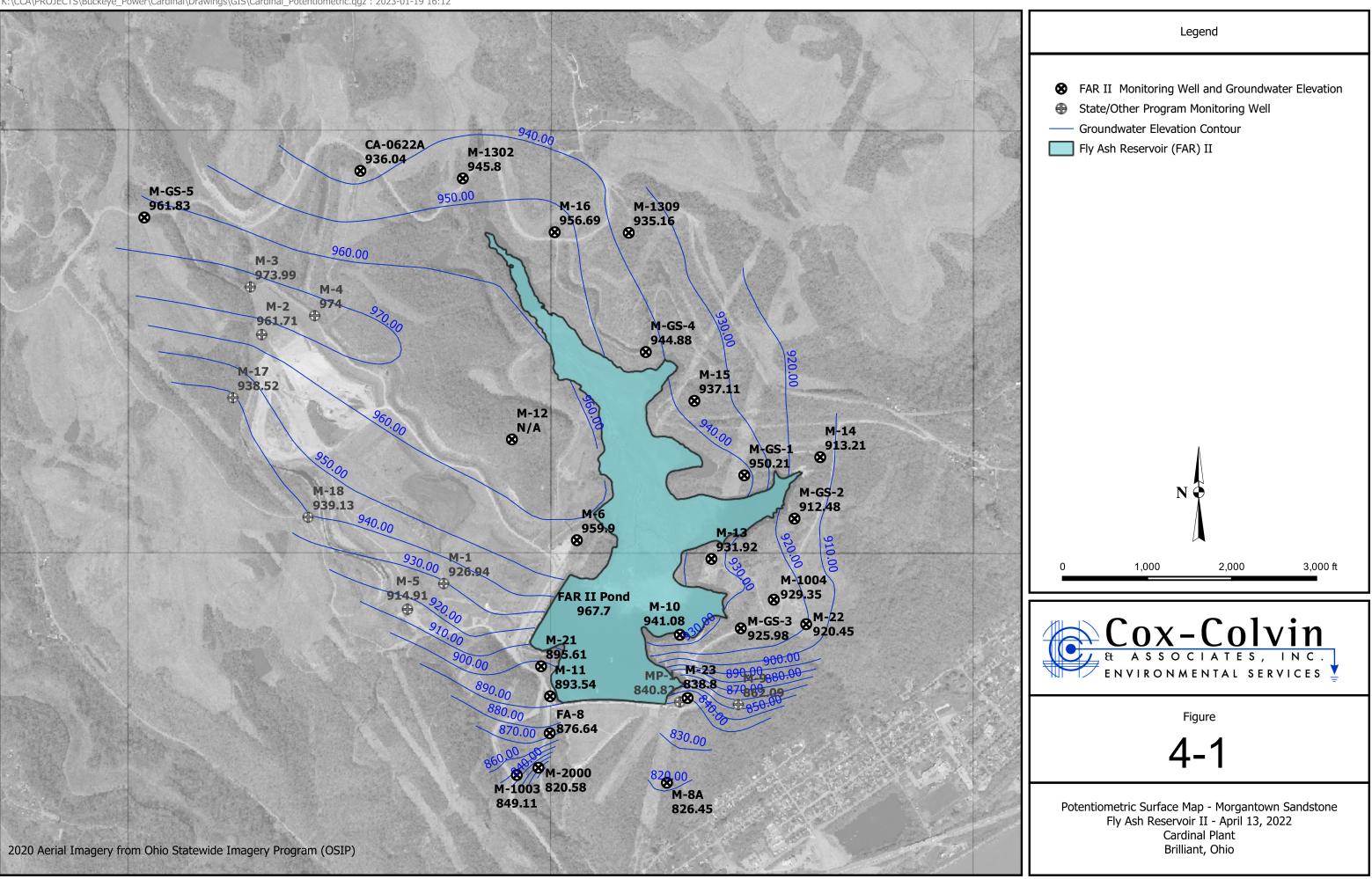
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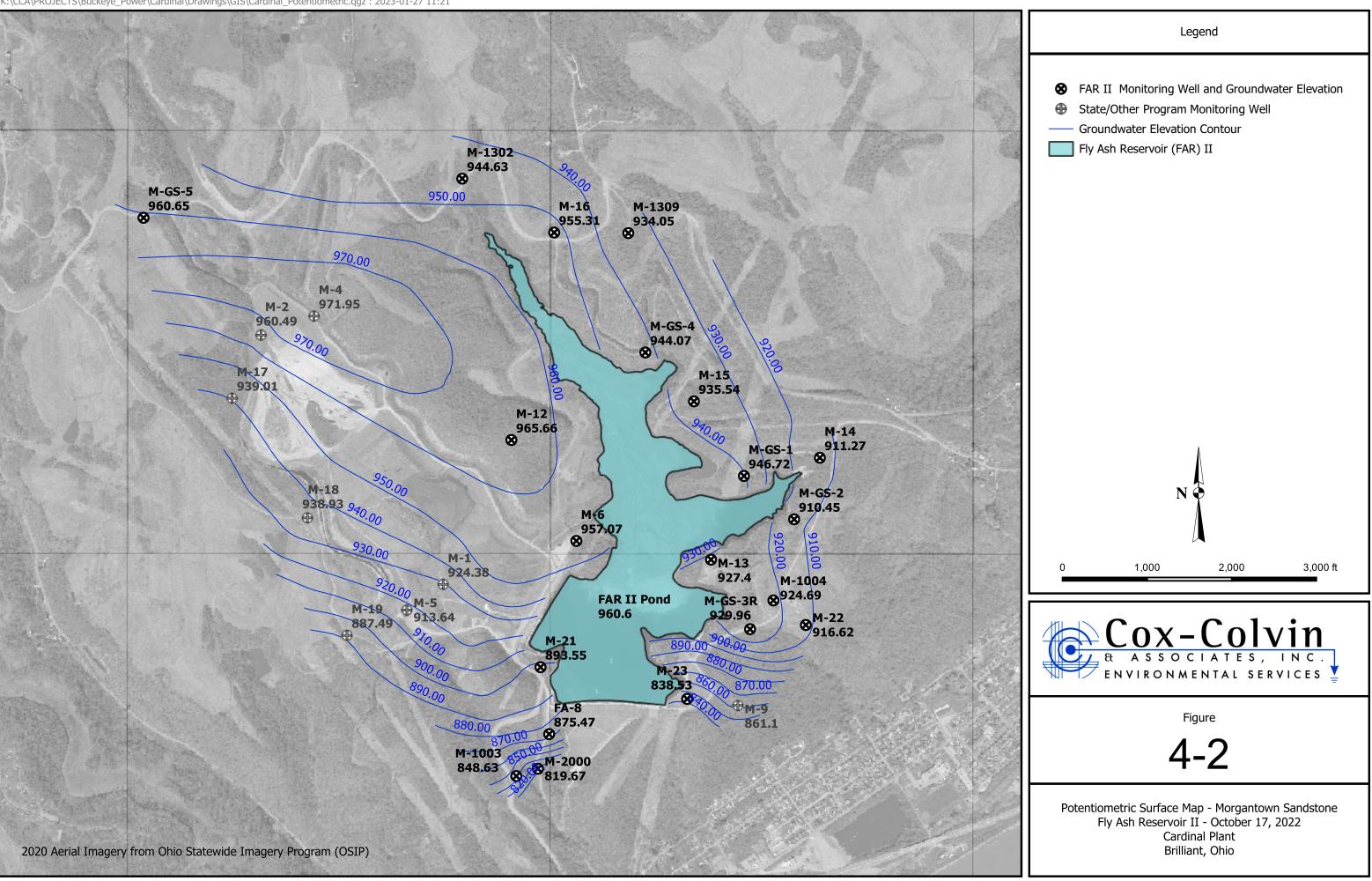
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Tables

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			Hydraulic	Depth to	Potentiometric	Hydraulic Gradient ²	Hydrau	lic Conductivity ⁴ (cm/sec)	Effective	Grou	ndwater Velocity (ft	/day)	Well Diameter ⁵	⁵ Residence Time ⁶ (days)		ys)
Program	Groundwater Zone	Well	Location ¹	Water (ft)	Elevation ³ (ft)	(ft/ft)	Low	Representative	High	Porosity	Low	Representative	High	(in.)	Low	Representative	High
FAR II CCR	Morgantown Sandstone	CA-0622A	Upgradient	226.24	936.04	0.01062	1.E-06	1.E-04	1.E-01	0.32	0.00009	0.00941	9.40696	6	0.053	53	5315
FAR II CCR	Morgantown Sandstone	FA-8	Downgradient	44.39	876.64	0.06644	1.E-06	1.E-04	1.E-01	0.32	0.00059	0.05885	58.85369	6	0.008	8	850
FAR II CCR	Morgantown Sandstone	M-6	Upgradient	50.67	959.9	0.00684	1.E-06	1.E-04	1.E-01	0.32	0.00006	0.00606	6.05810	3	0.041	41	4127
FAR II CCR	Morgantown Sandstone	M-8	Downgradient	66.75	826.45	0.01946	1.E-06	1.E-04	1.E-01	0.32	0.00017	0.01724	17.23962	6	0.029	29	2900
FAR II CCR	Morgantown Sandstone	M-10	Downgradient	92.34	941.08	0.02953	1.E-06	1.E-04	1.E-01	0.32	0.00026	0.02616	26.16037	4.87	0.016	16	1551
FAR II CCR	Morgantown Sandstone	M-11	Downgradient	86.67	893.54	0.01572	1.E-06	1.E-04	1.E-01	0.32	0.00014	0.01393	13.92844	3	0.018	18	1795
FAR II CCR	Morgantown Sandstone	M-12	Upgradient	-	-	0.00441	1.E-06	1.E-04	1.E-01	0.32	0.00004	0.00390	3.90222	6	0.128	128	12813
FAR II CCR	Morgantown Sandstone	M-13	Downgradient	59.22	931.92	0.01650	1.E-06	1.E-04	1.E-01	0.32	0.00015	0.01462	14.61665	6	0.034	34	3421
FAR II CCR	Morgantown Sandstone	M-14	Downgradient	75	913.21	0.01142	1.E-06	1.E-04	1.E-01	0.32	0.00010	0.01012	10.11965	6	0.049	49	4941
FAR II CCR	Morgantown Sandstone	M-15	Downgradient	137.17	937.11	0.01204	1.E-06	1.E-04	1.E-01	0.32	0.00011	0.01066	10.66401	6	0.047	47	4689
FAR II CCR	Morgantown Sandstone	M-16	Downgradient	111.86	956.69	0.01208	1.E-06	1.E-04	1.E-01	0.32	0.00011	0.01070	10.70164	6	0.047	47	4672
FAR II CCR	Morgantown Sandstone	M-21	Downgradient	123	895.61	0.02867	1.E-06	1.E-04	1.E-01	0.32	0.00025	0.02540	25.39633	6	0.020	20	1969
FAR II CCR	Morgantown Sandstone	M-22	Downgradient	87.59	920.45	0.03007	1.E-06	1.E-04	1.E-01	0.32	0.00027	0.02664	26.63736	6	0.019	19	1877
FAR II CCR	Morgantown Sandstone	M-23	Downgradient	147.1	838.8	0.04461	1.E-06	1.E-04	1.E-01	0.32	0.00040	0.03952	39.52079	6	0.013	13	1265
FAR II CCR	Morgantown Sandstone	M-1003	Downgradient	86.77	849.11	0.09375	1.E-06	1.E-04	1.E-01	0.32	0.00083	0.08305	83.05031	6	0.006	6	602
FAR II CCR	Morgantown Sandstone	M-1004	Downgradient	78.94	929.35	0.00859	1.E-06	1.E-04	1.E-01	0.32	0.00008	0.00761	7.61028	6	0.066	66	6570
FAR II CCR	Morgantown Sandstone	M-1302	Upgradient	84.92	945.8	0.01017	1.E-06	1.E-04	1.E-01	0.32	0.00009	0.00901	9.01307	6	0.055	55	5548
FAR II CCR	Morgantown Sandstone	M-1309	Downgradient	236.93	935.16	0.00946	1.E-06	1.E-04	1.E-01	0.32	0.00008	0.00838	8.38051	6	0.060	60	5966
FAR II CCR	Morgantown Sandstone	M-GS-1	Downgradient	41.66	950.21	0.03637	1.E-06	1.E-04	1.E-01	0.32	0.00032	0.03222	32.21847	6	0.016	16	1552
FAR II CCR	Morgantown Sandstone	M-GS-2	Downgradient	78.33	912.48	0.01553	1.E-06	1.E-04	1.E-01	0.32	0.00014	0.01376	13.75715	6	0.036	36	3634
FAR II CCR	Morgantown Sandstone	M-GS-3	Downgradient	74.35	925.98	0.01255	1.E-06	1.E-04	1.E-01	0.32	0.00011	0.01112	11.11955	6	0.045	45	4497
FAR II CCR	Morgantown Sandstone	M-GS-4	Downgradient	83.85	944.88	0.01388	1.E-06	1.E-04	1.E-01	0.32	0.00012	0.01229	12.29284	6	0.041	41	4067
FAR II CCR	Morgantown Sandstone	M-GS-5	Upgradient	77.71	961.83	0.01245	1.E-06	1.E-04	1.E-01	0.32	0.00011	0.01103	11.03281	6	0.045	45	4532

K:\CCA\PROJECTS\Buckeye_Power\Cardinal\FAR II\Annual Groundwater and Corrective Measures Reports\2022\Tables\[Table 4-1 - FAR II April GW Flow.xlsx]Table 4-1

Measurements and calculations represent conditions on April 13, 2022. No depth to water readings were collected at M-12.

¹ Groundwater Monitoring Network Evaluation; Cardinal Site – Fly Ash Reservoir II, Brilliant, Ohio prepared by Geosyntec Consultants in September 2016 (Revised February 2017).

² Hydraulic gradient was calculated from a potentiometric surface using GDAL software tools (https://gdal.org/programs/gdaldem.html).

³ Elevations datum is National Geodetic Vertical Datum of 1929 (NGVD29).

⁴ Low and high conductivity values are from the 2017 Groundwater Monitoring Network Evaluation, with a representative value chosen within this range that is consistent with previous velocity calculations.

⁵ Well diameter represents the diameter of the borehole (sandpack).

⁶ Residence time is an estimation of how long it would take groundwater to travel a distance equivalent to the well diameter at the calculated velocity.

			Hydraulic	Depth to	Potentiometric	Hydraulic Gradient ²	Hydrau	lic Conductivity ⁴ (c	cm/sec)	Effective	Grou	undwater Velocity (f	t/day)	Well Diameter ⁵	Residence Time ⁶ (days)		iys)
Program	Groundwater Zone	Well	Location ¹	Water (ft)	Elevation ³ (ft)	(ft/ft)	Low	Representative	High	Porosity	Low	Representative	High	(in.)	Low	Representative	High
FAR II	Morgantown Sandstone	CA-0622A	Upgradient	-	-	0.00769	1.E-06	1.E-04	1.E-01	0.32	0.00007	0.00681	6.81336	6	0.073	73	7339
FAR II	Morgantown Sandstone	FA-8	Downgradient	45.56	875.47	0.05781	1.E-06	1.E-04	1.E-01	0.32	0.00051	0.05121	51.20523	6	0.010	10	976
FAR II	Morgantown Sandstone	M-6	Upgradient	53.5	957.07	0.00906	1.E-06	1.E-04	1.E-01	0.32	0.00008	0.00803	8.02748	6	0.031	31	3114
FAR II	Morgantown Sandstone	M-8A	Downgradient	-	-	0.01547	1.E-06	1.E-04	1.E-01	0.32	0.00014	0.01370	13.70409	6	0.036	36	3649
FAR II	Morgantown Sandstone	M-10	Downgradient	94.08	939.34	0.04481	1.E-06	1.E-04	1.E-01	0.32	0.00040	0.03970	39.69831	3	0.010	10	1022
FAR II	Morgantown Sandstone	M-11	Downgradient	88.98	891.23	0.01925	1.E-06	1.E-04	1.E-01	0.32	0.00017	0.01705	17.04922	3	0.015	15	1466
FAR II	Morgantown Sandstone	M-12	Upgradient	225	965.66	0.00529	1.E-06	1.E-04	1.E-01	0.32	0.00005	0.00469	4.68543	6	0.107	107	10671
FAR II	Morgantown Sandstone	M-13	Downgradient	63.74	927.4	0.01872	1.E-06	1.E-04	1.E-01	0.32	0.00017	0.01658	16.57939	6	0.030	30	3016
FAR II	Morgantown Sandstone	M-14	Downgradient	76.94	911.27	0.00957	1.E-06	1.E-04	1.E-01	0.32	0.00008	0.00847	8.47484	6	0.059	59	5900
FAR II	Morgantown Sandstone	M-15	Downgradient	138.74	935.54	0.00981	1.E-06	1.E-04	1.E-01	0.32	0.00009	0.00869	8.68838	6	0.058	58	5755
FAR II	Morgantown Sandstone	M-16	Downgradient	113.24	955.31	0.01617	1.E-06	1.E-04	1.E-01	0.32	0.00014	0.01433	14.32675	6	0.035	35	3490
FAR II	Morgantown Sandstone	M-21	Downgradient	125.06	893.55	0.03797	1.E-06	1.E-04	1.E-01	0.32	0.00034	0.03364	33.63701	6	0.015	15	1486
FAR II	Morgantown Sandstone	M-22	Downgradient	91.42	916.62	0.03194	1.E-06	1.E-04	1.E-01	0.32	0.00028	0.02829	28.29155	6	0.018	18	1767
FAR II	Morgantown Sandstone	M-23	Downgradient	147.37	838.53	0.04584	1.E-06	1.E-04	1.E-01	0.32	0.00041	0.04061	40.61059	6	0.012	12	1231
FAR II	Morgantown Sandstone	M-1003	Downgradient	87.25	848.63	0.08345	1.E-06	1.E-04	1.E-01	0.32	0.00074	0.07393	73.92569	6	0.007	7	676
FAR II	Morgantown Sandstone	M-1004	Downgradient	83.6	924.69	0.01489	1.E-06	1.E-04	1.E-01	0.32	0.00013	0.01319	13.18937	4.87	0.038	38	3791
FAR II	Morgantown Sandstone	M-1302	Upgradient	86.09	944.63	0.01049	1.E-06	1.E-04	1.E-01	0.32	0.00009	0.00930	9.29521	6	0.054	54	5379
FAR II	Morgantown Sandstone	M-1309	Downgradient	238.04	934.05	0.01095	1.E-06	1.E-04	1.E-01	0.32	0.00010	0.00970	9.69862	6	0.052	52	5155
FAR II	Morgantown Sandstone	M-GS-1	Downgradient	45.15	946.72	0.03315	1.E-06	1.E-04	1.E-01	0.32	0.00029	0.02937	29.36848	6	0.017	17	1703
FAR II	Morgantown Sandstone	M-GS-2	Downgradient	80.36	910.45	0.02166	1.E-06	1.E-04	1.E-01	0.32	0.00019	0.01919	19.18652	6	0.026	26	2606
FAR II	Morgantown Sandstone	M-GS-3R	Downgradient	71.48	929.96	0.00317	1.E-06	1.E-04	1.E-01	0.32	0.00003	0.00281	2.81019	6	0.178	178	17792
FAR II	Morgantown Sandstone	M-GS-4	Downgradient	84.66	944.07	0.01550	1.E-06	1.E-04	1.E-01	0.32	0.00014	0.01373	13.72759	6	0.036	36	3642
FAR II	Morgantown Sandstone	M-GS-5	Upgradient	78.89	960.65	0.01335	1.E-06	1.E-04	1.E-01	0.32	0.00012	0.01182	11.82433	6	0.042	42	4229

K:\CCA\PROJECTS\Buckeye_Power\Cardinal\FAR II\Annual Groundwater and Corrective Measures Reports\2022\Tables\[Table 4-2 - FAR II October GW Flow.xlsx]Sheet1

Measurements and calculations represent conditions on October 17, 2022.

¹ Groundwater Monitoring Network Evaluation; Cardinal Site – Fly Ash Reservoir II, Brilliant, Ohio prepared by Geosyntec Consultants in September 2016 (Revised February 2017).

² Hydraulic gradient was calculated from a potentiometric surface using GDAL software tools (https://gdal.org/programs/gdaldem.html).

³ Elevations datum is National Geodetic Vertical Datum of 1929 (NGVD29).

⁴ Low and high conductivity values are from the 2017 Groundwater Monitoring Network Evaluation, with a representative value chosen within this range that is consistent with previous velocity calculations.

⁵ Well diameter represents the diameter of the borehole (sandpack).

⁶ Residence time is an estimation of how long it would take groundwater to travel a distance equivalent to the well diameter at the calculated velocity.

Well Name	Type of Well	Sample Date	Constituents Analyzed	Purpose
CA-0622A	Upgradient	4/21/2022	Appendix III and IV	Assessment monitoring program
CA-0622A	Upgradient	11/3/2022	Appendix III and IV	Assessment monitoring program
FA-8	Downgradient	4/19/2022	Appendix III and IV	Assessment monitoring program
FA-8	Downgradient	11/1/2022	Appendix III and IV	Assessment monitoring program
M-6	Upgradient	4/21/2022	Appendix III and IV	Assessment monitoring program
M-6	Upgradient	10/21/2022	Appendix III and IV	Assessment monitoring program
M-8A	Downgradient	4/27/2022	Appendix III and IV	Assessment monitoring program
M-8A	Downgradient	11/1/2022	Appendix III and IV	Assessment monitoring program
M-8A	Downgradient	11/1/2022	Appendix III and IV	Assessment monitoring program (duplicate)
M-10	Downgradient	10/19/2022	Appendix III and IV	Assessment monitoring program
M-10	Downgradient	4/28/2022	Appendix III and IV	Assessment monitoring program
M-11	Downgradient	10/20/2022	Appendix III and IV	Assessment monitoring program
M-11	Downgradient	4/21/2022	Appendix III and IV	Assessment monitoring program
M-12	Upgradient	10/27/2022	Appendix III and IV	Assessment monitoring program
M-12	Upgradient	4/27/2022	Appendix III and IV	Assessment monitoring program
M-13	Downgradient	4/28/2022	Appendix III and IV	Assessment monitoring program
M-13	Downgradient	12/19/2022	Appendix III and IV	Assessment monitoring program
M-14	Downgradient	11/2/2022	Appendix III and IV	Assessment monitoring program
M-14	Downgradient	4/26/2022	Appendix III and IV	Assessment monitoring program
M-15	Downgradient	10/25/2022	Appendix III and IV	Assessment monitoring program
M-15 M-15	Downgradient	4/26/2022	Appendix III and IV	Assessment monitoring program
M-16	Downgradient	10/31/2022	Appendix III and IV	Assessment monitoring program
M-16	Downgradient	4/25/2022	Appendix III and IV	Assessment monitoring program
M-21	Downgradient	10/31/2022	Appendix III and IV	Assessment monitoring program
M-21 M-21	Downgradient	5/3/2022	Appendix III and IV	Assessment monitoring program
M-22	Downgradient	11/3/2022	Appendix III and IV	Assessment monitoring program
M-22 M-22	Downgradient	5/2/2022	Appendix III and IV	Assessment monitoring program
M-23	Downgradient	11/1/2022	Appendix III and IV	Assessment monitoring program
M-23	Downgradient	5/3/2022	Appendix III and IV	Assessment monitoring program
M-1003	Downgradient	11/8/2022	Appendix III and IV	Assessment monitoring program
M-1003	Downgradient	4/22/2022	Appendix III and IV	Assessment monitoring program
M-1003	Downgradient	4/22/2022	Appendix III and IV	Assessment monitoring program (duplicate)
M-1004	Downgradient	10/24/2022	Appendix III and IV	Assessment monitoring program (duplicate)
M-1004	Downgradient	4/28/2022	Appendix III and IV	Assessment monitoring program
M-1302	Upgradient	10/31/2022	Appendix III and IV	Assessment monitoring program
M-1302	Upgradient	4/22/2022	Appendix III and IV	Assessment monitoring program
M-1302 M-1309	Downgradient	11/3/2022	Appendix III and IV	Assessment monitoring program
M-1309	Downgradient	5/3/2022	Appendix III and IV	Assessment monitoring program
M-2000	Downgradient	11/1/2022	Appendix III and IV	Corrective Action Program
M-2000	Downgradient	4/19/2022	Appendix III and IV	Corrective Action Program
	Ţ.		Appendix III and IV	Assessment monitoring program
M-GS-1 M-GS-1	Downgradient	11/2/2022	Appendix III and IV	Assessment monitoring program
	Downgradient	4/26/2022	Appendix III and IV	Assessment monitoring program (duplicate)
M-GS-1	Downgradient	4/26/2022	Appendix III and IV	Assessment monitoring program
M-GS-2	Downgradient	11/2/2022	Appendix III and IV	Assessment monitoring program
M-GS-2	Downgradient	4/26/2022	**	
M-GS-3	Downgradient	5/4/2022	Appendix III and IV	Assessment monitoring program
M-GS-3R	Downgradient	10/27/2022	Appendix III and IV	Assessment monitoring program
M-GS-4	Downgradient	10/20/2022	Appendix III and IV	Assessment monitoring program
M-GS-4	Downgradient	4/25/2022	Appendix III and IV	Assessment monitoring program
M-GS-5	Upgradient	11/2/2022	Appendix III and IV	Assessment monitoring program
M-GS-5	Upgradient	4/19/2022	Appendix III and IV	Assessment monitoring program

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	.												Page 1 of 2
Well Name		CA-0622A	FA-8	M-6	M-8A	M-10	M-11	M-12	M-13	M-14	M-15	M-16	M-21
Type of Well		Background	Compliance	Background	Compliance	Compliance	Compliance	Background	Compliance	Compliance	Compliance	Compliance	Compliance
Sample Name		CA-0622A	FA-8	M-6	M-8	M-10	M -11	M-12	M-13	M-14	M-15	M-16	M-21
Sample Date		4/21/2022	4/19/2022	4/21/2022	4/27/2022	4/28/2022	4/21/2022	4/27/2022	4/28/2022	4/26/2022	4/26/2022	4/25/2022	5/3/2022
Laboratory	Concentration	Pace Analytical											
Lab ID	Units	50314697003	50314461002	50314697002	50315235002	50315235005	50314697001	50315235001	50315235003	50315035002	50315035003	50315035001	50315803001
APPENDIX III CONSTITUENTS	1												
Boron	MG/L	0.338	5.02	0.249	0.0328	0.543	4.43	0.4	0.295	0.209	0.255	0.181	3.85
Calcium	MG/L	61.9	202	15.1	98.3	11.4	213	384	13.2	0.511	1.46	2.4	265
Chloride	MG/L	3120	40.3	39.2	6.4	11.6	37.9	201	1.8	1.5	23.8	10.2	48
Fluoride	MG/L	< 0.05	0.63	1	0.08	0.75	0.56	1.3	1.8	0.81	1.4	0.41	0.12
Sulfate	MG/L	39.9	712	27.1	102	130	701	1670	28.5	0.79	2.9	265	924
Total Dissolved Solids	MG/L	6380	1250	730	439	734	1240	2750	512	388	551	720	1580
рН	SU	8.58	7.49	8.33	7.25	8.55	5.49	6.59	8.29	9.59	9.28	8.01	7.69
APPENDIX IV CONSTITUENTS													
Antimony	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.00055	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Arsenic	MG/L	0.0181	0.0115	0.0068	0.0013	< 0.0005	0.0049	0.0043	0.00077	< 0.0005	0.0017	< 0.0005	0.00082
Barium	MG/L	1.28	0.0228	0.335	0.106	0.0779	0.0199	0.0286	0.154	0.0141	0.0423	0.0329	0.0099
Beryllium	MG/L	< 0.0001	< 0.0001	0.0015	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.00012	< 0.0001	< 0.0001	< 0.0001	0.0005
Cadmium	MG/L	< 0.0001	< 0.0001	0.0011	< 0.0001	< 0.0001	< 0.0001	0.00019	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	MG/L	< 0.001	< 0.001	0.0093	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	MG/L	< 0.0005	0.00084	0.0077	< 0.0005	< 0.0005	0.00078	0.0354	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0024
Fluoride	MG/L	< 0.05	0.63	1	0.08	0.75	0.56	1.3	1.8	0.81	1.4	0.41	0.12
Lead	MG/L	< 0.0005	< 0.0005	0.0303	< 0.0005	0.00076	< 0.0005	< 0.0005	0.00053	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Lithium	MG/L	0.0765	0.188	< 0.02	< 0.01	0.0216	0.175	0.164	0.0115	< 0.01	< 0.01	0.014	0.0997
Mercury	MG/L	0.00000064	< 5E-7	0.0000207	0.00000095	0.00000409	0.00000072	0.00000195	0.0000007	< 5E-7	< 5E-7	< 5E-7	< 5E-7
Molybdenum	MG/L	0.00078	0.261	0.0014	< 0.0005	0.002	0.268	< 0.0005	0.0006	< 0.0005	< 0.0005	< 0.0005	0.0224
Selenium	MG/L	0.00078	0.0025	0.0016	< 0.0005	< 0.0005	0.0041	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Thallium	MG/L	< 0.0005	< 0.0005	0.00076	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Combined Radium	pCi/L	11.8	0	7.03	1.32	0.783	0.479	0.452	1.38	0.284	0.708	1.12	1.57

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NA = Not Analyzed < = Not detected at reporting limit

Bold = Detected

			-			-									Page 2 of 2
Well Name		M-22	M-23	M-1003	M-1003	M-1004	M-1302	M-1309	M-2000	M-GS-1	M-GS-1	M-GS-2	M-GS-3	M-GS-4	M-GS-5
Type of Well		Compliance	Compliance	Compliance	Compliance	Compliance	Background	Compliance	Corrective Action	Compliance	Compliance	Compliance	Compliance	Compliance	Background
Sample Name		M-22	M-23	M-1003	M-1003 Dup	M-1004	M-1302	M-1309	M-2000	M-GS-1	M-GS-1 Dup	M-GS-2	M-GS-3	M-GS-4	M-GS-5
Sample Date		5/2/2022	5/3/2022	4/22/2022	4/22/2022	4/28/2022	4/22/2022	5/3/2022	4/19/2022	4/26/2022	4/26/2022	4/26/2022	5/4/2022	4/25/2022	4/19/2022
Laboratory	Concentration	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical							
Lab ID	Units	50315432001	50315803003	50314709002	50314709003	50315235004	50314709001	50315803002	50314461001	50315027002	50315027004	50315027003	50315800001	50315027001	50314455001
APPENDIX III CONSTITUENTS															
Boron	MG/L	3.86	0.712	0.143	0.143	2.88	0.292	0.289	5.31	0.301	0.304	0.259	1.44	0.207	0.321
Calcium	MG/L	171	109	83.6	85.2	111	3.07	3.16	202	16.4	12.6	5.03	78.2	2.87	3.34
Chloride	MG/L	50.2	12.9	8.1	8	34.9	29.1	40.9	48.6	34.8	32.9	26.2	33.3	10.5	95.9
Fluoride	MG/L	0.52	0.7	0.16	0.16	1.3	1.9	1.4	0.43	0.65	0.66	0.4	0.31	0.53	5.1
Sulfate	MG/L	400	1730	146	153	298	37.3	71.4	750	71.5	72.3	102	1280	17	421
Total Dissolved Solids	MG/L	940	3180	527	529	892	675	682	1330	647	637	624	2200	479	1240
рН	SU	6.73	7.69	7.36	NA	7.51	9.26	9.15	7.48	7.68	NA	7.8	7.05	8.92	9.06
APPENDIX IV CONSTITUENTS			r		1	r	1	•	1		1	1	1	1	
Antimony	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.00081	< 0.0005	< 0.0005
Arsenic	MG/L	< 0.0005	0.00083	< 0.0005	< 0.0005	0.0013	< 0.0005	0.0017	0.0013	< 0.0005	< 0.0005	0.0049	0.0947	0.0023	0.0072
Barium	MG/L	0.0218	0.0077	0.0769	0.075	0.037	0.113	0.0299	0.0237	0.0672	0.0673	0.023	0.0153	0.016	0.128
Beryllium	MG/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Cadmium	MG/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	MG/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.00098	< 0.0005	< 0.0005	< 0.0005	0.0023	< 0.0005	< 0.0005
Fluoride	MG/L	0.52	0.7	0.16	0.16	1.3	1.9	1.4	0.43	0.65	0.66	0.4	0.31	0.53	5.1
Lead	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0018	< 0.0005	< 0.0005
Lithium	MG/L	0.0527	0.0719	< 0.02	< 0.02	0.0255	< 0.02	0.0172	0.188	0.0197	0.0189	0.0166	0.068	< 0.01	< 0.02
Mercury	MG/L	< 5E-7	0.00000123	< 5E-7	< 5E-7	0.00000116	0.000000673	0.00000372	< 5E-7	< 5E-7	< 5E-7	< 5E-7	0.00000631	< 5E-7	< 5E-7
Molybdenum	MG/L	0.0514	< 0.0005	< 0.0005	< 0.0005	0.0112	< 0.0005	0.0011	0.205	< 0.0005	< 0.0005	0.0033	0.0026	0.002	0.0016
Selenium	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Thallium	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Combined Radium	pCi/L	1.77	2.21	3.43	2.32	0.616	0.194	0.534	1.24	1.48	0.48	0.426	1.98	0.772	1.73

K:(CCA)PROJECTS\Buckeye_Power\Cardinal\FAR II\Annual Groundwater and Corrective Measures Reports\2022\Tables\[Table 4-4 - Sampling Results Spring.xlsx]Table 1

NA = Not Analyzed < = Not detected at reporting limit

Bold = Detected

Table 4-5. Sampling Results: October-December 2022, Fly Ash Reservoir (FAR) II, Cardinal Plant, Brilliant, Ohio

										Page 1 of 3
Well Name		CA-0622A*	FA-8	M-6	M-8A	M-8A	M-10	M-11	M-12	M-13
Type of Well		Background	Compliance	Background	Compliance	Compliance	Compliance	Compliance	Compliance	Compliance
Sample Name		CA-0622A	FA-8	M-6	M-8	M-8 Dup	M-10	M-11	M-12	M-13
Sample Date		11/3/2022	11/1/2022	10/21/2022	11/1/2022	11/1/2022	10/19/2022	10/20/2022	10/27/2022	12/19/2022
Laboratory	Concentration	NA	Pace Analytical							
Lab ID	Units	NA	50330090008	50329053003	50330090006	50330090009	50329053001	50329053002	50329676001	50333987001
APPENDIX III CONSTITUENTS										
Boron	MG/L	NA	4.88	0.27	0.0304	0.029	0.515	5.06	0.311	0.231
Calcium	MG/L	NA	245	13.7	104	106	11.1	182	374	4.81
Chloride	MG/L	NA	34.9	46	7.2	7.2	12.8	33.2	223	3.5
Fluoride	MG/L	NA	0.61	1.1	0.11	0.11	0.77	0.59	1.4	1.4
Sulfate	MG/L	NA	717	24.2	101	101	127	700	1770	17.2
Total Dissolved Solids	MG/L	NA	1290	776	430	437	628	1250	2650	479
рН	SU	NA	7.35	8.25	7.28	NA	8.29	7.25	6.44	9.09
APPENDIX IV CONSTITUENTS										
Antimony	MG/L	NA	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Arsenic	MG/L	NA	0.0107	0.006	0.0011	0.0012	< 0.0005	0.006	0.0041	< 0.0005
Barium	MG/L	NA	0.0236	0.467	0.11	0.107	0.0752	0.0223	0.0242	0.0814
Beryllium	MG/L	NA	< 0.0001	0.0016	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001
Cadmium	MG/L	NA	< 0.0001	0.00022	< 0.0001	< 0.0001	0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	MG/L	NA	< 0.001	0.0113	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cobalt	MG/L	NA	0.0012	0.007	< 0.0005	< 0.0005	< 0.0005	0.001	0.0404	< 0.0005
Fluoride	MG/L	NA	0.61	1.1	0.11	0.11	0.77	0.59	1.4	1.4
Lead	MG/L	NA	< 0.0005	0.0298	0.00089	0.00056	0.0035	0.00064	< 0.0005	0.00065
Lithium	MG/L	NA	0.193	0.0273	< 0.01	< 0.01	0.0227	0.148	0.155	< 0.01
Mercury	MG/L	NA	< 5E-7	0.000014	0.0000076	0.0000086	0.00000375	< 5E-7	0.00000163	0.00000092
Molybdenum	MG/L	NA	0.253	0.0017	< 0.0005	< 0.0005	0.0018	0.256	< 0.0005	< 0.0005
Potassium	UG/L	NA	12400	3610	1880	2000	2130	9060	5770	1000
Selenium	MG/L	NA	< 0.0005	0.0018	< 0.0005	< 0.0005	< 0.0005	0.0011	< 0.0005	< 0.0005
Thallium	MG/L	NA	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Combined Radium	pCi/L	NA	0.717	9.36	1.24	1.64	0.709	0.768	0.704	1.52

K:\CCA\PROJECTS\Buckeye_Power\Cardinal\FAR II\Annual Groundwater and Corrective Measures Reports\2022\Tables[[Table 4-5 - Sampling Results Fall.xlsx]Table 4-5

* A sample was not collected because there was insufficient groundwater in monitor well CA-0622A during the sampling event.

< = Not detected at reporting limit

Bold = Detected

NA = Not Analyzed

Table 4-5. Sampling Results: October-December 2022, Fly Ash Reservoir (FAR) II, Cardinal Plant, Brilliant, Ohio

									Page 2 of 3
Well Name		M-14	M-15	M-16	M-21	M-22	M-23	M-1003	M-1004
Type of Well		Compliance							
Sample Name		M-14	M-15	M-16	M-21	M-22	M-23	M-1003	M-1004
Sample Date		11/2/2022	10/25/2022	10/31/2022	10/31/2022	11/3/2022	11/1/2022	11/8/2022	10/24/2022
Laboratory	Concentration	Pace Analytical							
Lab ID	Units	50330282001	50329464002	50330090003	50330090004	50330282002	50330090005	50330960001	50329464001
APPENDIX III CONSTITUENTS									
Boron	MG/L	0.211	0.271	0.182	3.71	3.68	0.696	0.137	2.66
Calcium	MG/L	0.631	1.51	2.5	251	169	108	81.5	107
Chloride	MG/L	1.8	23.9	11.3	43.3	46.1	14.2	9	40
Fluoride	MG/L	0.77	1.3	0.37	0.11	0.46	0.54	0.21	1.2
Sulfate	MG/L	1.1	5.6	266	841	364	1610	153	319
Total Dissolved Solids	MG/L	379	562	808	1510	916	3220	499	872
pH	SU	9.16	9.23	8.23	7.28	7	7.06	7.23	7.31
APPENDIX IV CONSTITUENTS									
Antimony	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Arsenic	MG/L	< 0.0005	0.0016	< 0.0005	0.0017	< 0.0005	0.00084	< 0.0005	0.0012
Barium	MG/L	0.0148	0.0396	0.0341	0.0101	0.0249	0.0074	0.0708	0.0329
Beryllium	MG/L	< 0.0001	< 0.0001	< 0.0001	0.00068	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Cadmium	MG/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	MG/L	< 0.001	< 0.001	< 0.001	< 0.001	0.0061	< 0.001	< 0.001	< 0.001
Cobalt	MG/L	< 0.0005	< 0.0005	< 0.0005	0.0022	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Fluoride	MG/L	0.77	1.3	0.37	0.11	0.46	0.54	0.21	1.2
Lead	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Lithium	MG/L	< 0.01	0.0131	0.0122	0.0858	0.051	0.0606	0.0102	0.0265
Mercury	MG/L	< 5E-7	< 5.1E-7	0.00000109	0.00000222	0.00000059	< 5E-7	< 5E-7	< 5.1E-7
Molybdenum	MG/L	< 0.0005	< 0.0005	< 0.0005	0.022	0.0533	< 0.0005	< 0.0005	0.0105
Potassium	UG/L	522	833	1140	6020	2460	5870	3500	2090
Selenium	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Thallium	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Combined Radium	pCi/L	0.52	1.17	0.9	1.57	0.432	2.85	1.49	1.66

K:|CCA\PROJECTS\Buckeye_Power\Cardinal\FAR II\Annual Groundwater and Corrective Measures Reports\2022\Tables|[Table 4-5 - Sampling Results Fall.xlsx]Table 4-5

NA = Not Analyzed < = Not detected at reporting limit Bold = Detected Table 4-5. Sampling Results: October-December 2022, Fly Ash Reservoir (FAR) II, Cardinal Plant, Brilliant, Ohio

									Page 3 of 3
Well Name		M-1302	M-1309	M-2000	M-GS-1	M-GS-2	M-GS-3R	M-GS-4	M-GS-5
Type of Well		Background	Compliance	Corrective Action	Compliance	Compliance	Compliance	Compliance	Compliance
Sample Name		M-1302	M-1309	M-2000	M-GS-1	M-GS-2	M-GS-3R	M-GS-4	M-GS-5
Sample Date		10/31/2022	11/3/2022	11/1/2022	11/2/2022	11/2/2022	10/27/2022	10/20/2022	11/2/2022
Laboratory	Concentration	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical
Lab ID	Units	50330090002	50330282003	50330090007	50330285001	50330285002	50329646001	50329067003	50330285003
APPENDIX III CONSTITUENT	'S								
Boron	MG/L	0.297	0.267	5.07	0.285	0.228	3.06	0.182	0.299
Calcium	MG/L	3.07	3.8	224	10.7	7	168	2.61	3.72
Chloride	MG/L	31.1	40.9	46.9	27.4	21.2	53.2	11.2	83.4
Fluoride	MG/L	2	0.95	0.45	0.67	0.47	0.12	0.58	4.7
Sulfate	MG/L	40.3	88.4	727	53.5	146	531	24.3	479
Total Dissolved Solids	MG/L	700	678	1320	611	661	1030	475	1380
рН	SU	8.5	8.7	7.29	7.73	7.88	6.88	8.62	8.55
APPENDIX IV CONSTITUENT	S								
Antimony	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Arsenic	MG/L	< 0.0005	0.0012	0.0014	< 0.0005	0.0057	0.0066	0.002	0.0063
Barium	MG/L	0.113	0.0337	0.0246	0.0739	0.0269	0.0261	0.0176	0.112
Beryllium	MG/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Cadmium	MG/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Chromium	MG/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.0011	< 0.001	< 0.001
Cobalt	MG/L	< 0.0005	< 0.0005	0.001	< 0.0005	< 0.0005	0.0024	< 0.0005	< 0.0005
Fluoride	MG/L	2	0.95	0.45	0.67	0.47	0.12	0.58	4.7
Lead	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.00072	< 0.0005	< 0.0005
Lithium	MG/L	0.0128	0.0126	0.2	0.018	0.013	0.0361	0.0107	0.0192
Mercury	MG/L	< 5.1E-7	0.00000314	< 5E-7	< 5E-7	< 5E-7	0.00000107	< 5E-7	< 5E-7
Molybdenum	MG/L	< 0.0005	0.0013	0.2	< 0.0005	0.0071	0.0368	0.0015	0.0018
Potassium	UG/L	1410	1200	10800	1630	1300	3960	1030	2160
Selenium	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Thallium	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Combined Radium	pCi/L	0.585	0.448	1.08	0.336	0.156	0.791	0.322	0.4

K:\CCA\PROJECTS\Buckeye_Power\Cardinal\FAR II\Semi-Annual Groundwater Statistical Memos\2022\Fall\Tables\Table 1 - Sampling Results.xlsx

NA = Not Analyzed < = Not detected at reporting limit Bold = Detected

	Concentration		CCR Rules	Backgorund	FAR II
	Units	MCL	§ 257.95(h)(2)	Limit	GWPS
APPENDIX IV CONSTITUENTS					
Antimony	MG/L	0.006	-	0.0029	0.006
Arsenic	MG/L	0.01	-	0.037	0.037
Barium	MG/L	2	-	1.24	2
Beryllium	MG/L	0.004	-	0.002	0.004
Cadmium	MG/L	0.005	-	0.0002	0.005
Chromium	MG/L	0.1	-	0.015	0.1
Cobalt	MG/L	-	0.006	0.032	0.032
Fluoride	MG/L	4	-	6.6	6.6
Lead	MG/L	-	0.015	0.055	0.055
Lithium	MG/L	-	0.04	0.149	0.149
Mercury	MG/L	0.002	-	0.000017	0.002
Molybdenum	MG/L	-	0.1	0.068	0.1
Radium, Combined	pCi/L	5	-	15.2	15.2
Selenium	MG/L	0.05	-	0.016	0.05
Thallium	MG/L	0.002	_	0.001	0.002

Table 4-6. Groundwater Protection Standards (GWPS), Fly Ash Reservoir (FAR) II, Cardinal Plant, Brilliant, Ohio

K:\CCA\PROJECTS\Buckeye_Power\Cardinal\FAR II\Annual Groundwater and Corrective Measures Reports\2022\Tables\[Table 4-6 - Far II GWPS Values.xlsx]Table 4-6

MCL = Maximum Contaminant Level

GWPS is the higher value of either the background limit or the MCL. If an MCL is not available, values from the CCR Rules are used.

Background values are based upon statistical upper threshold limit (UTL) calculations.

UTLs are intended for comparison to confidence bands, not individual observations.