2022 Annual Groundwater Monitoring Report for FAR I Residual Solid Waste Landfill Cardinal Operating Company – Cardinal Plant 306 County Road 7E Brilliant, Ohio

January 27, 2023

Submitted to:

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Cox-Colvin & ASSOCIATES, INC. ENVIRONMENTAL SERVICES

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Executive Summary

Cox-Colvin & Associates, Inc. (Cox-Colvin) has prepared this 2022 Annual Groundwater Monitoring Report for the FAR I Residual Solid Waste (RSW) Landfill 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.

At the start of the 2022 annual reporting period, the RSW Landfill was operating under the detection monitoring program (40 CFR 257.94). The RSW Landfill remained in the detection monitoring program throughout the 2022 annual reporting period.

Two semi-annual assessment monitoring events were completed during this annual reporting period – the first in April 2022 and the second in October 2022. During this annual reporting period, no statistically significant increases (SSIs) above background were identified. As such, no testing for statistically significant levels (SSLs) above groundwater protection standards (GWPSs) was necessary or performed.

1.0 Introduction

Cox-Colvin & Associates, Inc. (Cox-Colvin) has prepared this 2022 Annual Groundwater Monitoring Report for the FAR I Residual Solid Waste (RSW) Landfill 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 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.

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 2016).

1.2 CCR Unit Description

The RSW Landfill unit is a dry landfill disposal facility located approximately one mile north of the Site in a portion of Blockhouse Hollow (also referred to as Blockhouse Run in references and drawings) that was formerly surface mined for the Pittsburgh No. 8 coal. The FAR I RSW Landfill is an existing, active CCR landfill which receives gypsum waste, fly ash, and bottom ash from the Bottom Ash Pond (BAP) and minor amounts of residual solid wastes. Two of the six cells of the RSW Landfill were in operation at the time the CCR Rules became effective. Construction of future cells would be considered lateral expansions. The RSW Landfill previously used FAR II as a leachate and stormwater collection pond (Geosyntec 2016), but these are now managed in settling tanks following initiation of FAR II closure activities in 2021.

The FAR I RSW Landfill 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. Above the current grade of the RSW Landfill lies the Monongahela Group, which consists of shale, sandstone, limestone, coal, claystone, and siltstone. Overlying the Monongahela Group, at approximately 1,250 feet in elevation, is the Permian-age Dunkard Group (Geosyntec 2016).

The uppermost aquifer at the FAR I RSW Landfill is comprised of unconsolidated mine waste and shallow sandstone and limestone deposits overlying a discontinuous shale aquitard above the Morgantown Sandstone. Groundwater in the uppermost aquifer generally flows south-southeast towards the Ohio River with hydraulic conductivity ranging from 1×10^{-1} to 1×10^{-4} centimeters per second (cm/s). The hydraulic conductivity of the confining shale layer ranges from 1×10^{-7} to 1×10^{-9} cm/s (Geosyntec 2016).

2.0 Groundwater Monitoring System

The FAR I RSW Landfill's groundwater monitoring network was designed to comply with §257.91 of the CCR Rules. 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 2016).

The FAR I RSW Landfill groundwater monitoring network consists of 16 monitoring wells, shown in Figure 1-2. Nine (9) upgradient monitoring wells (CA-0623A, OAE 2005 10C, S-2, S-GS-3, S-4, S-5, S-6, S-17, and S-19A) are used to establish background conditions and seven (7) downgradient monitoring wells (S-GS-1, S-GS-2, S-1, S-7, S-10, S-18, and S-20) are used as compliance wells.[1]

No CCR monitoring wells were installed or decommissioned during 2022.

[1] In January 2018, network monitoring wells S-2 and S-19A were switched from downgradient monitoring wells to upgradient monitoring wells based on a better understanding of groundwater flow.

3.0 Groundwater Monitoring Program

In accordance with §257.94 of the CCR Rules, the FAR I RSW Landfill remained in the detection monitoring program through December 2022.

3.1 Statistical Analysis Plan

Evaluation of analytical data is performed in accordance with the Statistical Analysis Plan (Geosyntec 2020), 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 §257.94 of the CCR Rules, monitoring wells are sampled semi-annually for constituents listed in Appendix III of the CCR Rules.

There was no suspension of groundwater monitoring requirements at the FAR I RSW Landfill 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 the FAR I RSW Landfill.

4.1 Groundwater Elevation and Flow

Prior to sampling, a synoptic round of groundwater level measurements was collected from the background and downgradient monitoring wells. Potentiometric surface maps based on groundwater elevations measured on April 13, 2022, and October 17, 2022, are presented in Figures 4-1 and 4-2, respectively. The potentiometric maps show that groundwater near the RSW Landfill flows southeast towards the Ohio River. Groundwater flow rate calculations relative to the RSW Landfill 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 the FAR I RSW Landfill. The first (Spring) semi-annual monitoring event of 2022 was completed in April, with resampling in June 2022. The second (Fall) semi-annual monitoring event of 2022 was completed in October - November 2022, with resampling conducted in December 2022. A total of 37 samples were collected. Analytical results are summarized in Tables 4-4 through 4-7.

4.3 Data Evaluation

Data evaluations performed in 2022 consisted of the following:

- Comparison of Spring 2022 monitoring data, including resampling data, to background levels for Appendix III constituents
- Comparison of Fall 2022 monitoring data, including resampling data, to background levels for Appendix III constituents

As discussed below, no statistically significant increases (SSIs) above background were identified. As such, no testing for statistically significant levels (SSLs) above groundwater protection standards (GWPSs) was necessary or performed.

4.3.1 Background Levels

Background levels in the FAR I RSW Landfill groundwater were established for Appendix III constituents[2] in December 2019. In November 2021, these background levels were updated using additional data collected since 2019. Background levels are provided in Table 4-8.

There were no confirmed SSIs above background concentrations during 2022 groundwater monitoring.

4.3.2 Groundwater Protection Standards

Because there were no SSIs above background levels, the FAR I RSW Landfill remains in detection monitoring. In the absence of an SSI, there is no reason to anticipate SSLs of Appendix IV constituents above GWPSs. In accordance with CCR Rules, laboratory analysis of Appendix IV constituents was, therefore, neither necessary nor performed.

4.4 Corrective Actions

In the absence of an identified release from the FAR I RSW Landfill, no corrective actions or remedies were either necessary or performed during 2022.

[2] "Appendix III" and "Appendix IV" constituents refer to those constituents listed in the respective appendices of the CCR Rules. In compliance with §257.94(b) of the CCR Rules, groundwater samples collected in 2016 and 2017 were analyzed for both Appendix III and IV constituents in order to establish an initial background dataset. Since that time, there has been no need to use the background data set to establish background levels of Appendix IV constituents.

5.0 Problems Encountered and Resolutions

Problems with low water levels at monitoring wells during detection monitoring in 2022 were encountered at the RSW Landfill. Monitoring well S-17 was purged dry during sampling in both semi-annual detection monitoring events and CA-0623A was purged dry during the second semi-annual sampling event; therefore, samples were not collected due to insufficient recovery. Because S-17 and CA-0623A are upgradient (background) wells, and not downgradient (compliance) monitoring wells, not collecting these samples will not result in a failure to identify an SSI.

During the April 2022 sampling event, analysis of total dissolved solids (TDS) was performed outside of laboratory holding time for background monitoring well S-6. To ensure a representative background data set, resampling and analysis was performed in June 2022.

During the April 2022 sampling event, TDS at S-1, fluoride at S-18, and pH at S-GS-2 were detected at concentrations above their background levels. In accordance with the Statistical Analysis Plan (Geosyntec 2020), resampling was performed in June 2022. The concentrations of these constituents during June 2022 resampling were below their respective background levels. As such, no SSI was identified.

During the October 2022 sampling event, pH was detected in groundwater at monitoring well S-7 at a concentration above its background level. In accordance with the Statistical Analysis Plan (Geosyntec 2020), resampling was performed in December 2022. The pH level during December 2022 resampling was below its background level. As such, no SSI was identified.

Conflicting historical top of casing elevations were observed for Monitoring Well S-4. The top of casing was re-surveyed in January 2023 and was surveyed to be 1017.33'. The 2022 potentiometric maps have been updated to reflect the new top of casing.

No monitoring wells were abandoned or added to the network during 2022.

Because there was not an SSI above background levels, no alternative source demonstrations under §257.94(e)(2) were considered or performed during 2022.

6.0 Projected Key Activities

It is anticipated that the FAR I RSW Landfill will remain in detection monitoring in 2023. The following activities are projected for the FAR I RSW Landfill:

- The 2022 Annual Groundwater Monitoring Report will be entered into the facility's operating record and posted to the public internet site.
- Two semi-annual groundwater detection monitoring program sampling events will be conducted, and the resulting data will be evaluated for SSIs over background levels. The FAR I RSW Landfill's monitoring status will be confirmed following the SSI evaluation.
- The 2023 Annual Groundwater Monitoring Report will be prepared for submittal in January 2024.

7.0 References

Geosyntec. 2016. *Groundwater Monitoring Network Evaluation; Cardinal Site - Former Fly Ash Reservoir I - Residual Solid Waste Landfill; Brilliant, Ohio.* Oak Brook, IL: Geosyntec Consultants.

Geosyntec. 2020. *Statistical Analysis Plan; Cardinal Power Plant; Brilliant, Ohio (Revision 1).* Columbus, Ohio: Geosyntec Consultants.

Figures

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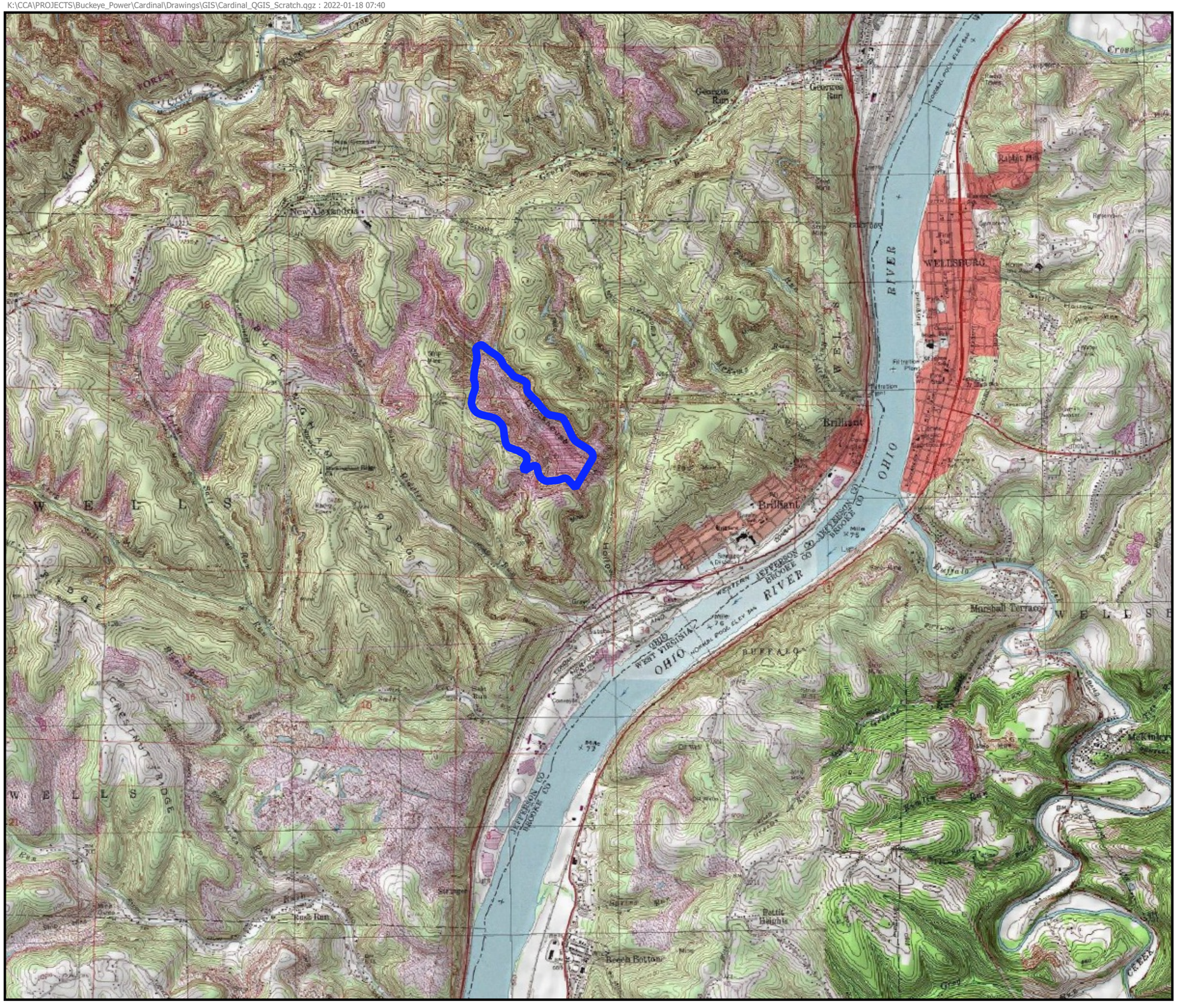

Legend

FAR I RSW Landfill

USGS Topographical Map

N

0 0.5 1 1.5 2 mi

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Figure

1-1

Site Location Map
FAR I RSW Landfill
Cardinal Plant
Brilliant, Ohio

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Legend

FAR I RSW Landfill

Monitoring Wells

- Background
- Downgradient

N

0 1,000 2,000 3,000 ft

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Figure

1-2

CCR Unit and Monitoring Wells
FAR I RSW Landfill
Cardinal Plant
Brilliant, Ohio

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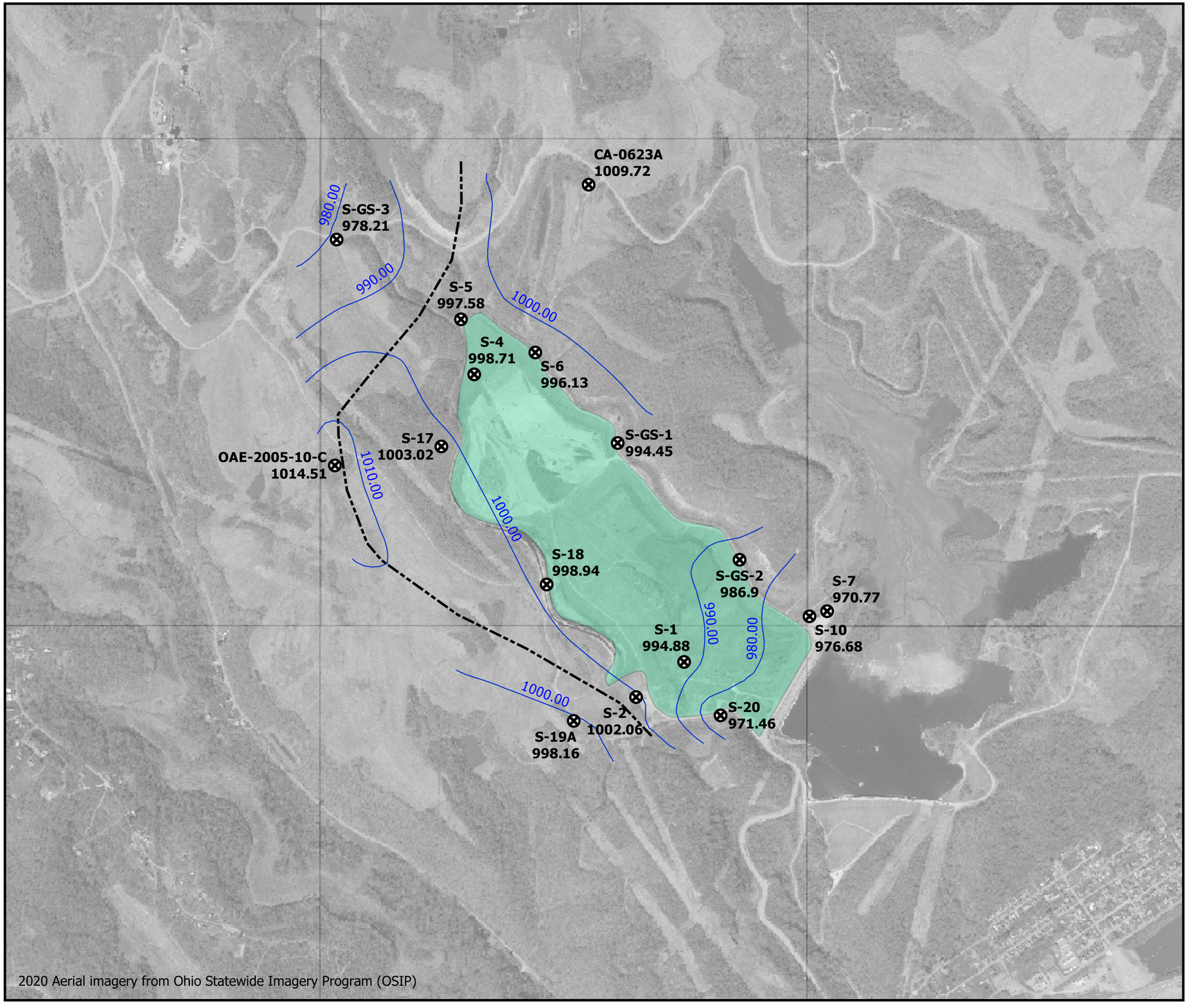

Legend

- FAR I Monitoring Well and Groundwater Elevation
- Groundwater Elevation Contour
- FAR I RSW Landfill
- Approximate Location of Groundwater Divide

N

0 1,000 2,000 3,000 ft

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Figure

4-1

Potentiometric Surface Map - Shallow Aquifer
FAR I RSW Landfill - April 13, 2022
Cardinal Plant
Brilliant, Ohio

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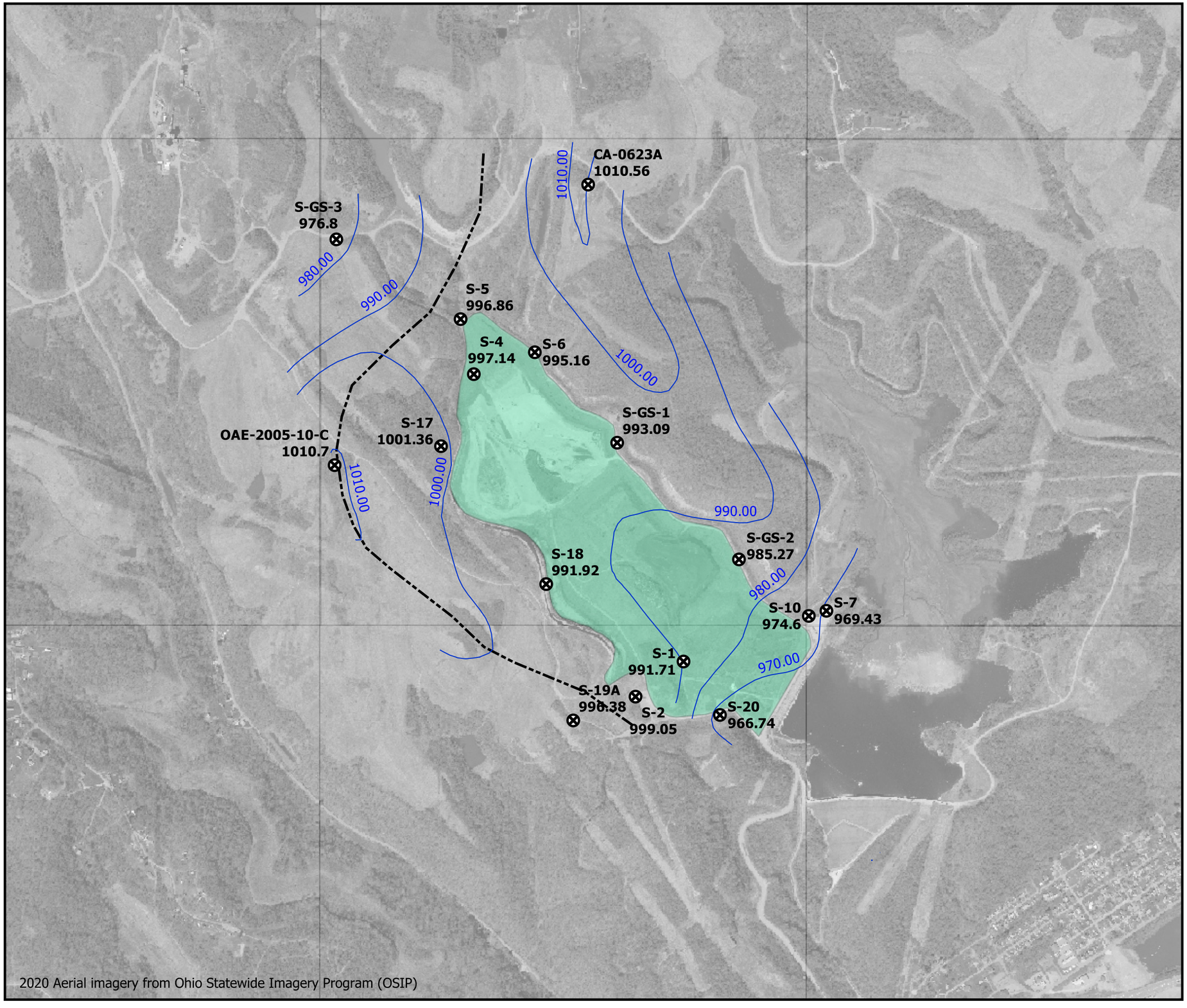

Legend

- FAR I Monitoring Well and Groundwater Elevation
- Groundwater Elevation Contour
- FAR I RSW Landfill
- Approximate Location of Groundwater Divide

N

0 1,000 2,000 3,000 ft

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Figure

4-2

Potentiometric Surface Map - Shallow Aquifer
FAR I RSW Landfill - October 17, 2022
Cardinal Plant
Brilliant, Ohio

Tables

Table 4-1. Groundwater Flow Calculations April 2022, FAR I RSW Landfill, Cardinal Plant, Brilliant, Ohio

Program	Groundwater Zone	Well	Hyrdaulic Location[1]	Depth to Water (ft)	Potentiometric Elevation (ft)[2]	Gradient[3] (ft/ft)	Hydraulic Conductivity[4] (cm/sec)			Effective Porosity	Groundwater Velocity (ft/day)			Well Diameter[5] (in.)	Residence Time[6] (days)		
							Low	Representative	High		Low	**Representative**	High		Low	**Representative**	High
FAR I	Fly Ash Shallow	CA-0623A	Upgradient	153	1009.72	0.01297	0.0001	0.05	0.1	0.32	0.0115	**5.75**	11.49	6	0.04	**0.09**	44
FAR I	Fly Ash Shallow	OAE-2005-10-C	Upgradient	226.34	1014.51	0.00170	0.0001	0.05	0.1	0.32	0.0015	**0.75**	1.51	6	0.33	**0.66**	332
FAR I	Fly Ash Shallow	S-1	Downgradient	7.53	994.88	0.01390	0.0001	0.05	0.1	0.32	0.0123	**6.16**	12.31	3	0.02	**0.04**	20
FAR I	Fly Ash Shallow	S-2	Upgradient	37.39	1002.06	0.00848	0.0001	0.05	0.1	0.32	0.0075	**3.76**	7.51	3	0.03	**0.07**	33
FAR I	Fly Ash Shallow	S-4	Upgradient	18.62	998.71	0.00515	0.0001	0.05	0.1	0.32	0.0046	**2.28**	4.56	3	0.05	**0.11**	55
FAR I	Fly Ash Shallow	S-5	Upgradient	4.62	997.58	0.00360	0.0001	0.05	0.1	0.32	0.0032	**1.59**	3.19	3	0.08	**0.16**	78
FAR I	Fly Ash Shallow	S-6	Upgradient	10.53	996.13	0.00500	0.0001	0.05	0.1	0.32	0.0044	**2.21**	4.43	3	0.06	**0.11**	56
FAR I	Fly Ash Shallow	S-7	Downgradient	39.84	970.77	0.00608	0.0001	0.05	0.1	0.32	0.0054	**2.69**	5.38	3	0.05	**0.09**	46
FAR I	Fly Ash Shallow	S-10	Downgradient	28.51	976.68	0.01481	0.0001	0.05	0.1	0.32	0.0131	**6.56**	13.12	6	0.04	**0.08**	38
FAR I	Fly Ash Shallow	S-17	Upgradient	194.98	1003.02	0.00890	0.0001	0.05	0.1	0.32	0.0079	**3.94**	7.88	6	0.06	**0.13**	63
FAR I	Fly Ash Shallow	S-18	Downgradient	156.43	998.94	0.00370	0.0001	0.05	0.1	0.32	0.0033	**1.64**	3.28	6	0.15	**0.30**	152
FAR I	Fly Ash Shallow	S-19A	Upgradient	100.44	998.16	0.01038	0.0001	0.05	0.1	0.32	0.0092	**4.60**	9.19	6	0.05	**0.11**	54
FAR I	Fly Ash Shallow	S-20	Downgradient	34.42	971.46	0.00865	0.0001	0.05	0.1	0.32	0.0077	**3.83**	7.66	6	0.07	**0.13**	65
FAR I	Fly Ash Shallow	S-GS-1	Downgradient	20.12	994.45	0.00297	0.0001	0.05	0.1	0.32	0.0026	**1.32**	2.64	6	0.19	**0.38**	190
FAR I	Fly Ash Shallow	S-GS-2	Downgradient	24.85	986.9	0.01174	0.0001	0.05	0.1	0.32	0.0104	**5.20**	10.40	6	0.05	**0.10**	48
FAR I	Fly Ash Shallow	S-GS-3	Upgradient	61.21	978.21	0.00606	0.0001	0.05	0.1	0.32	0.0054	**2.68**	5.37	6	0.09	**0.19**	93

Measurements and calculations represent conditions on April 13, 2022.

[1] *Groundwater Monitoring Network Evaluation; Cardinal Site – Forner Fly Ash Reservoir I - Residual Solid Waste Landfill, Brilliant, Ohio* prepared by Geosyntec Consultants in July 2016.

[2] Elevations datum is National Geodetic Vertical Datum of 1929 (NGVD29).

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

[4] Low and high conductivity values are from the 2016 Groundwater Monitoring Network Evaluation, with a representative value chosen at the midpoint of this range.

[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.

Table 4-2. Groundwater Flow Calculations October 2022, FAR I RSW Landfill, Cardinal Plant, Brilliant, Ohio

Program	Groundwater Zone	Well	Hyrdaulic Location[1]	Depth to Water (ft)	Potentiometric Elevation (ft)[2]	Gradient[3] (ft/ft)	Hydraulic Conductivity[4] (cm/sec)			Effective Porosity	Groundwater Velocity (ft/day)			Well Diameter[5] (in.)	Residence Time[6] (days)		
							Low	Representative	High		Low	**Representative**	High		Low	**Representative**	High
FAR I	Fly Ash Shallow	CA-0623A	Upgradient	152.16	1010.56	0.01137	0.0001	0.05	0.1	0.32	0.0101	**5.03**	10.07	6	0.05	**0.10**	50
FAR I	Fly Ash Shallow	OAE-2005-10-C	Upgradient	230.15	1010.7	0.00272	0.0001	0.05	0.1	0.32	0.0024	**1.20**	2.41	6	0.21	**0.42**	208
FAR I	Fly Ash Shallow	S-1	Downgradient	10.7	991.71	0.01494	0.0001	0.05	0.1	0.32	0.0132	**6.62**	13.24	3	0.02	**0.04**	19
FAR I	Fly Ash Shallow	S-2	Upgradient	40.4	999.05	0.01034	0.0001	0.05	0.1	0.32	0.0092	**4.58**	9.16	3	0.03	**0.05**	27
FAR I	Fly Ash Shallow	S-4	Upgradient	20.19	992.75	0.00262	0.0001	0.05	0.1	0.32	0.0023	**1.16**	2.32	3	0.11	**0.22**	108
FAR I	Fly Ash Shallow	S-5	Upgradient	5.34	996.86	0.00213	0.0001	0.05	0.1	0.32	0.0019	**0.94**	1.89	3	0.13	**0.27**	133
FAR I	Fly Ash Shallow	S-6	Upgradient	34.55	972.11	0.00508	0.0001	0.05	0.1	0.32	0.0045	**2.25**	4.50	3	0.06	**0.11**	56
FAR I	Fly Ash Shallow	S-7	Downgradient	41.18	969.43	0.00973	0.0001	0.05	0.1	0.32	0.0086	**4.31**	8.62	3	0.03	**0.06**	29
FAR I	Fly Ash Shallow	S-10	Downgradient	30.59	974.6	0.01582	0.0001	0.05	0.1	0.32	0.0140	**7.01**	14.01	6	0.04	**0.07**	36
FAR I	Fly Ash Shallow	S-17	Upgradient	196.64	1001.36	0.00556	0.0001	0.05	0.1	0.32	0.0049	**2.46**	4.92	6	0.10	**0.20**	102
FAR I	Fly Ash Shallow	S-18	Downgradient	163.45	991.92	0.00450	0.0001	0.05	0.1	0.32	0.0040	**1.99**	3.99	6	0.13	**0.25**	125
FAR I	Fly Ash Shallow	S-19A	Upgradient	102.22	996.38	0.00790	0.0001	0.05	0.1	0.32	0.0070	**3.50**	7.00	6	0.07	**0.14**	71
FAR I	Fly Ash Shallow	S-20	Downgradient	39.14	966.74	0.00505	0.0001	0.05	0.1	0.32	0.0045	**2.24**	4.48	6	0.11	**0.22**	112
FAR I	Fly Ash Shallow	S-GS-1	Downgradient	21.48	993.09	0.00425	0.0001	0.05	0.1	0.32	0.0038	**1.88**	3.77	6	0.13	**0.27**	133
FAR I	Fly Ash Shallow	S-GS-2	Downgradient	26.48	985.27	0.00781	0.0001	0.05	0.1	0.32	0.0069	**3.46**	6.92	6	0.07	**0.14**	72
FAR I	Fly Ash Shallow	S-GS-3	Upgradient	62.62	976.8	0.00548	0.0001	0.05	0.1	0.32	0.0049	**2.43**	4.85	6	0.10	**0.21**	103

Measurements and calculations represent conditions on October 17, 2022, except for S-17 which was measured on October 18, 2022.

[1] *Groundwater Monitoring Network Evaluation; Cardinal Site – Forner Fly Ash Reservoir I - Residual Solid Waste Landfill, Brilliant, Ohio* prepared by Geosyntec Consultants in July 2016.

[2] Elevations datum is National Geodetic Vertical Datum of 1929 (NGVD29).

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

[4] Low and high conductivity values are from the 2016 Groundwater Monitoring Network Evaluation, with a representative value chosen at the midpoint of this range.

[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.

Table 4-3 Summary of CCR Groundwater Samples, FAR I RSW Landfill, Cardinal Plant, Brilliant, Ohio

Well Name	Type of Well	Sample Date	Constituents Analyzed	Purpose
CA-0623A	Upgradient	4/21/2022	Appendix III	Detection monitoring program
OAE-2005-10-C	Upgradient	11/2/2022	Appendix III	Detection monitoring program
OAE-2005-10-C	Upgradient	4/27/2022	Appendix III	Detection monitoring program
S-1	Upgradient	10/20/2022	Appendix III	Detection monitoring program
S-1	Upgradient	4/26/2022	Appendix III	Detection monitoring program
S-1	Downgradient	6/29/2022	Appendix III	Detection monitoring program
S-2	Downgradient	10/20/2022	Appendix III	Detection monitoring program
S-2	Downgradient	4/25/2022	Appendix III	Detection monitoring program
S-4	Downgradient	10/24/2022	Appendix III	Detection monitoring program
S-4	Downgradient	4/19/2022	Appendix III	Detection monitoring program
S-5	Downgradient	10/21/2022	Appendix III	Detection monitoring program
S-5	Downgradient	4/19/2022	Appendix III	Detection monitoring program
S-6	Downgradient	10/21/2022	Appendix III	Detection monitoring program
S-6	Upgradient	4/19/2022	Appendix III	Detection monitoring program
S-6	Upgradient	6/29/2022	Appendix III	Detection monitoring program
S-7	Upgradient	10/25/2022	Appendix III	Detection monitoring program
S-7	Upgradient	4/21/2022	Appendix III	Detection monitoring program
S-7	Upgradient	12/20/2022	Appendix III	Detection monitoring program
S-10	Downgradient	10/26/2022	Appendix III	Detection monitoring program
S-10	Downgradient	4/20/2022	Appendix III	Detection monitoring program
S-10	Downgradient	4/20/2022	Appendix III	Detection monitoring program (Duplicate)
S-18	Downgradient	11/2/2022	Appendix III	Detection monitoring program
S-18	Downgradient	4/27/2022	Appendix III	Detection monitoring program
S-18	Downgradient	6/29/2022	Appendix III	Detection monitoring program
S-19A	Downgradient	10/18/2022	Appendix III	Detection monitoring program
S-19A	Downgradient	4/27/2022	Appendix III	Detection monitoring program
S-20	Downgradient	11/1/2022	Appendix III	Detection monitoring program
S-20	Downgradient	4/22/2022	Appendix III	Detection monitoring program
S-GS-1	Upgradient	10/26/2022	Appendix III	Detection monitoring program (Duplicate)
S-GS-1	Upgradient	10/26/2022	Appendix III	Detection monitoring program
S-GS-1	Downgradient	4/19/2022	Appendix III	Detection monitoring program (Duplicate)
S-GS-1	Downgradient	4/19/2022	Appendix III	Detection monitoring program
S-GS-2	Downgradient	10/26/2022	Appendix III	Detection monitoring program
S-GS-2	Downgradient	4/19/2022	Appendix III	Detection monitoring program
S-GS-2	Upgradient	6/29/2022	Appendix III	Detection monitoring program
S-GS-3	Upgradient	10/26/2022	Appendix III	Detection monitoring program
S-GS-3	Upgradient	4/18/2022	Appendix III	Detection monitoring program

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Table 4-4. Downgradient Well Monitoring Results - First Semi-Annual Event, Cardinal Plant, FAR I RSW Landfill, Brilliant, Ohio

Sample Name		S-1	S-1	S-7	S-10	S-10 Dup	S-18	S-18	S-20	S-GS-1	S-GS-1 Dup	S-GS-2	S-GS-2
Sample Date		4/26/2022	6/29/2022	4/21/2022	4/20/2022	4/20/2022	4/27/2022	6/29/2022	4/22/2022	4/19/2022	4/19/2022	4/19/2022	6/29/2022
Laboratory	Concentration	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical
Lab ID	Units	50315032001	50320085006	50314705001	50314458003	50314458004	50315239002	50320085007	50314705003	50314456001	50314456002	50314456003	S-GS-2 062922
APPENDIX III CONSTITUENTS													
Boron	MG/L	**0.686**	NA	**2.05**	**1.21**	**1.21**	**0.521**	NA	**0.32**	**0.885**	**0.895**	**0.503**	NA
Calcium	MG/L	**317**	NA	**258**	**269**	**272**	**148**	NA	**251**	**92.2**	**91.7**	**5.08**	NA
Chloride	MG/L	**4.3**	NA	**27.5**	**26**	**26**	**1.2**	NA	**2.2**	**22.8**	**23.7**	**97.2**	NA
Fluoride	MG/L	**0.21**	NA	**0.065**	**0.19**	**0.2**	**0.46**	**0.33**	**0.26**	**0.66**	**0.67**	**3**	NA
Sulfate	MG/L	**953**	NA	**1110**	**828**	**855**	**554**	NA	**897**	**856**	**870**	**13.5**	NA
Total Dissolved Solids	MG/L	**2340**	**1850**	**1940**	**1480**	**1500**	**1050**	NA	**1630**	**1680**	**1650**	**1450**	NA
pH	SU	**7**	**7.58**	**7.15**	**6.81**	NA	**7.19**	**7.07**	**6.83**	**7.94**	NA	**8.8**	**8.07**

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NA - Not Analyzed

Bold - Detection

Table 4-5. Background Well Monitoring Results - First Semi-Annual Event, Cardinal Plant, FAR I RSW Landfill, Brilliant, Ohio

Sample Name		CA-0623A	OAE-2005-10-C	S-2	S-4	S-5	S-6	S-6	S-17*	S-19A	S-GS-3
Sample Date		4/21/2022	4/27/2022	4/25/2022	4/19/2022	4/19/2022	4/19/2022	6/29/2022	4/27/2022	4/27/2022	4/18/2022
Laboratory	Concentration	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	NA	Pace Analytical	Pace Analytical
Lab ID	Units	50314702001	50315239001	50315032002	50314458001	50314458002	50314705002	50320003001	NA	50315239003	50314456004
APPENDIX III CONSTITUENTS											
Boron	MG/L	**0.452**	**0.483**	**1.05**	**0.27**	**0.0333**	**0.911**	NA	NA	**0.413**	**0.331**
Calcium	MG/L	**1.06**	**4.45**	**310**	**490**	**284**	**82.3**	NA	NA	**419**	**5.1**
Chloride	MG/L	**12.6**	**10.7**	**7.2**	**2.3**	**7.1**	**17.7**	NA	NA	**2**	**469**
Fluoride	MG/L	**1.9**	**1.4**	**0.51**	**0.26**	**0.083**	**0.28**	NA	NA	**0.46**	**2**
Sulfate	MG/L	**25.2**	**234**	**1540**	**1540**	**695**	**583**	NA	NA	**1900**	**77.1**
Total Dissolved Solids	MG/L	**636**	**1240**	**2340**	**2180**	**1270**	**~~1330~~****	**1270**	NA	**2820**	**1900**
pH	SU	**9.15**	**8.65**	**5.63**	**7.01**	**7.3**	**8.16**	NA	NA	**7.15**	**8.89**

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* A sample was not collected because there was insufficient groundwater in monitor well S-17 during the sampling event.

** Analysis was performed outside of laboratory holding time. The June 29, 2022 resample result is used for evaluations.

NA Not Analyzed

Bold Detection

Table 4-6. Downgradient Well Monitoring Results - Second Semi-Annual Event, Cardinal Plant, FAR I RSW Landfill, Brilliant, Ohio

Sample Name		S-1	S-7	S-7	S-10	S-18	S-20	S-GS-1	S-GS-1 Dup	S-GS-2
Sample Date		10/20/2022	10/25/2022	12/20/2022	10/26/2022	11/2/2022	11/1/2022	10/26/2022	10/26/2022	10/26/2022
Laboratory	Concentration	Pace Analytical	Pace Analytical	Field Reading	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical
Lab ID	Units	50329057002	50329465002	S-7: 12/20/2022	50329669001	50330302001	50330108003	50329645001	50329645002	50329645003
APPENDIX III CONSTITUENTS										
Boron	MG/L	**0.725**	**1.92**	NA	**0.802**	**0.529**	**0.261**	**0.874**	**0.884**	**0.464**
Calcium	MG/L	**317**	**269**	NA	**306**	**120**	**297**	**97.4**	**102**	**5.56**
Chloride	MG/L	**5.3**	**31.6**	NA	**17.4**	**2.5**	**3.2**	**24.1**	**25.5**	**102**
Fluoride	MG/L	**0.23**	**0.09**	NA	**0.26**	**0.34**	**0.26**	**0.57**	**0.58**	**2.7**
Sulfate	MG/L	**946**	**1060**	NA	**1130**	**430**	**870**	**865**	**843**	**12.2**
Total Dissolved Solids	MG/L	**1730**	**1930**	NA	**1720**	**874**	**1660**	**1730**	**1730**	**1580**
pH	SU	**7.17**	**7.01**	**7.21**	**6.97**	**7.04**	**6.71**	**7.35**	NA	**8.18**

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NA Not Analyzed

Bold Detection

Table 4-7. Background Well Monitoring Results - Second Semi-Annual Event, Cardinal Plant, FAR I RSW Landfill, Brilliant, Ohio

Sample Name		CA-0623A*	OAE-2005-10-C	S-2	S-4	S-5	S-6	S-17*	S-19A	S-GS-3
Sample Date		11/3/2022	11/2/2022	10/20/2022	10/24/2022	10/21/2022	10/21/2022	11/2/2022	10/18/2022	10/26/2022
Laboratory	Concentration	NA	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	Pace Analytical	NA	Pace Analytical	Pace Analytical
Lab ID	Units	NA	50330302002	50329057001	50329465001	50329057003	50329060001	NA	50328836001	50329645004
APPENDIX III CONSTITUENTS										
Boron	MG/L	NA	**0.462**	**2.32**	**0.241**	**0.0225**	**0.722**	NA	**0.455**	**0.314**
Calcium	MG/L	NA	**4.88**	**405**	**451**	**302**	**54.7**	NA	**367**	**5.57**
Chloride	MG/L	NA	**11.9**	**4.7**	**3.9**	**8**	**15.2**	NA	**2.3**	**517**
Fluoride	MG/L	NA	**1.2**	**0.37**	**0.14**	**0.12**	**0.45**	NA	**0.28**	**1.8**
Sulfate	MG/L	NA	**228**	**1720**	**1520**	**669**	**437**	NA	**1660**	**24.9**
Total Dissolved Solids	MG/L	NA	**1230**	**2820**	**3570**	**1270**	**1120**	NA	**2580**	**1970**
pH	SU	NA	**8.22**	**6.98**	**6.68**	**6.85**	**7.49**	NA	**6.88**	**8.54**

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* A sample was not collected because there was insufficient groundwater in monitor wells S-17 and CA-0623A during the sampling event.

Bold - Detection

Table 4-8. Appendix III Constituent Background Levels, Cardinal Plant, FAR I RSW Landfill, Brilliant, Ohio

	Concentration Units	S-1 Intrawell Upper Prediction Limit Oct. 2021	S-7 Intrawell Upper Prediction Limit Oct. 2021	S-10 Intrawell Upper Prediction Limit Oct. 2021	S-18 Intrawell Upper Prediction Limit Oct. 2021	S-20 Intrawell Upper Prediction Limit Oct. 2021	S-GS-1 Intrawell Upper Prediction Limit Oct. 2021	S-GS-2 Intrawell Upper Prediction Limit Oct. 2021
APPENDIX III CONSTITUENTS								
Boron	MG/L	1.02	2.211	2.137	0.642	0.3461	1.079	0.7161
Calcium	MG/L	356.9	273.1	334.8	235.9	388	133.2	18.63
Chloride	MG/L	7.095	39.5	30.87	3.761	4.1	28.6	122.3
Fluoride	MG/L	0.2547	0.2431	0.2878	0.4174	0.3719	0.7788	3.23
pH*	SU	6.692 / 7.504	7.039 / 7.746	6.612 / 7.601	6.62 / 7.385	6.3 / 7.94	6.72 / 8.86	7.356 / 8.642
Sulfate	MG/L	1400	1164	1105	1162	1255	1044	208.1
Total Dissolved Solids	MG/L	1926	1971	1835	1982	2175	1964	2083

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* Both Upper Prediction Limit and Lower Prediction Limit