ALTERNATIVE SOURCE DEMONSTRATION REPORT TEXAS STATE CCR RULE

H.W. Pirkey Power Plant Flue Gas Desulfurization (FGD) Stackout Area Hallsville, Texas

Submitted to

AMERICAN
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POWER

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LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
EBAP	East Bottom Ash Pond
EPRI	Electric Power Research Institute
FGD	Flue Gas Desulfurization
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SPLP	Synthetic Precipitation Leaching Profile
SSL	Statistically Significant Level
SU	Standard Unit
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
WBAP	West Bottom Ash Pond
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

This Alternative Source Demonstration (ASD) report has been prepared to address statistically significant levels (SSLs) for beryllium and cobalt in the groundwater monitoring network at the H.W. Pirkey Plant Flue Gas Desulfurization (FGD) Stackout Area, located in Hallsville, Texas, following the first semi-annual detection monitoring event of 2021. The FGD Stackout Area is registered as a waste pile under Texas Commission on Environmental Quality (TCEQ) Industrial and Hazardous Waste Solid Waste Registration No. 33240.

The H.W. Pirkey Plant has four regulated coal combustion residuals (CCR) storage units, including the FGD Stackout Area (**Figure 1**). In May 2021, a semi-annual assessment monitoring event was conducted at the FGD Stackout Area in accordance with 30 TAC §352.951(a). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the unit (Geosyntec, 2020a) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of either the background concentration or, for constituents with a maximum contaminant level (MCL), the MCL. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were re-calculated for Appendix IV parameters at the compliance wells to assess whether these parameters were present at a statistically significant level (SSL) above the GWPSs. Seasonal patterns were observed for beryllium, cadmium, cobalt, combined radium, fluoride, and lithium at AD-22 (Geosyntec, 2021a). To correctly account for seasonality, confidence intervals for these wells and constituents were constructed using deseasonalized values. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). The following SSLs were identified at the Pirkey FGD Stackout Area (Geosyntec, 2021a):

- The deseasonalized LCL for beryllium exceeded the GWPS of 0.0040 mg/L at AD-22 (0.00577 mg/L); and

- The deseasonalized LCL for cobalt exceeded the GWPS of 0.0560 mg/L at AD-22 (0.0723 mg/L).

No other SSLs were identified.

1.1 CCR Rule Requirements

TCEQ regulations regarding assessment monitoring programs for CCR landfills and surface impoundments (TCEQ, 2020a) provide owners and operators with the option to make an ASD when an SSL is identified (30 TAC §352.951(e)):

> *… In making a demonstration under this subsection, the owner or operator must, within 90 days of detecting a statistically significant level above the groundwater protection standard of any constituent listed in Appendix IV adopted by reference in §352.1431 of this title, submit a report prepared and certified in accordance with §352.4 of this title (relating to Engineering and Geoscientific Information) to the executive director, and any local pollution agency with jurisdiction that has requested to be notified, demonstrating that a source other than a CCR unit caused the exceedance or that the exceedance resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.*

Pursuant to 30 TAC §352.951(e), Geosyntec Consultants, Inc. (Geosyntec) has prepared this ASD report to document that the SSLs identified for beryllium and cobalt at AD-22 are from a source other than the FGD Stackout Area.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSLs identified for beryllium and cobalt were based on a Type IV cause and not by a release from the Pirkey FGD Stackout Area.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The TCEQ CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSLs identified for beryllium and cobalt and the proposed alternative source are described below.

2.1 Proposed Alternative Source

An initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify alternative sources for beryllium and cobalt due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. Groundwater sampling, laboratory analysis, and statistical evaluations were generally completed in accordance with 30 TAC §352.931 and the draft TCEQ guidance for groundwater monitoring (TCEQ, 2020b). As described below, the SSLs have been attributed to natural variation associated with seasonal effects, which is a Type IV (natural variation) issue.

2.1.1 Beryllium

An SSL was identified for beryllium at AD-22 using deseasonalized statistics (Geosyntec, 2021a). According to the Unified Guidance, "seasonal correction should be done both to minimize the chance of mistaking a seasonal effect for evidence of contaminated groundwater, and also to build more powerful background to compliance point tests. Problems can arise, for instance, from measurement variations associated with changing recharge rates during different seasons" (USEPA, 2009).

The seasonal effects observed in the statistical analysis occur in roughly annual cycles, with somewhat higher beryllium concentrations occurring in early spring and lower concentrations in early fall. For example, the beryllium concentration in 2021 at AD-22 was 0.00852 milligrams per liter (mg/L) in March 2021, in contrast to 0.00239 mg/L in November 2020. Previous ASDs for the FGD Stackout Area showed that beryllium concentrations at AD-22 appear to correlate with groundwater elevations at the well (Geosyntec, 2019; Geosyntec, 2020b; Geosyntec, 2020c; Geosyntec 2021b). This relationship still holds true (**Figure 2**). Beryllium concentrations at AD-22 are correlated with seasonal changes in other constituents, including calcium (**Figure 3**) and lithium (**Figure 4**). The correlation between beryllium and both monovalent (lithium) and divalent (calcium) cations suggests that the variability in observed beryllium concentrations is related to cation exchange behavior with clay minerals present in the native soil.

Soil boring SP-B4, which was advanced in March 2020 to re-log AD-22, found that clay materials were identified in the seasonally saturated zones above the permanent water table. The boring log for SP-B4 is provided in **Attachment A,** and the original boring log and well construction diagram is provided in **Attachment B**. At AD-22, the depth to water fluctuated between approximately 3 and 12 ft below ground surface (bgs). Clay was identified from approximately 1.5 ft bgs to 13.3 ft bgs, where it transitioned to a clayey silt (**Figure 5**). Analysis by X-ray diffraction (XRD) confirmed the presence of clays within the seasonal water table and sand within the screened interval, as summarized in **Table 1**. The clay fraction of the uppermost sample collected from within the seasonal water table was further analyzed to identify the type of clays present. Smectite-type clays, which are 2:1-layer high-activity clays with characteristic cation exchange capacity, make up the majority of the clay minerals present at that interval.

Sorption and desorption of beryllium from smectite-type clays is well documented (Boschi and Willenbring, 2016a; You, et al., 1989). Desorption was found to be affected by pH, with 75% of beryllium desorbed from a smectite-type clay as pH decreased from 6.0 standard units (SU) to 3.0 SU (Boschi and Willenbring, 2016b). The pH values recorded at AD-22 for groundwater samples collected under the Federal CCR Rule ranged from 3.6 to 5.1 SU, suggesting that conditions are favorable for beryllium desorption from smectite-type clays. The presence of these exchangeable clays provides further evidence that the exceedance of beryllium at AD-22 can be attributed to the effects of seasonal groundwater elevation changes, and the resulting cation exchange between groundwater and the exchangeable clay within the seasonal water table, on groundwater quality.

2.1.2 Cobalt

An SSL was identified for cobalt at AD-22 using deseasonalized statistics (Geosyntec, 2021a). As shown in previous ASDs (Geosyntec, 2020b; Geosyntec, 2020c; Geosyntec, 2021b), the cobalt concentrations at AD-22 also appear to correlate with seasonal changes in groundwater elevation (**Figure 6**). In addition, the cobalt concentrations are well correlated with changes in other cations, including calcium and lithium (**Figure 7**), suggesting natural variability associated with interactions with the aquifer solids.

The concentration ratio between calcium and cobalt is consistently on the order of 1000:1 at both upgradient and downgradient locations (**Figure 8**). A sample was collected of the solid FGD sludge material accumulated on the FGD Stackout Area. The solid phase sample was leached using both USEPA's Synthetic Precipitation Leaching Profile (SPLP) testing procedure (SW-846 Test Method 1312 [USEPA, 1994]) and TCEQ's 7-Day Distilled Water Leachate Test Procedure (30 TAC 335.521 Appendix 4). While cobalt concentrations in both of the leached samples are consistent with those observed in the groundwater samples, the leached calcium concentrations are approximately two to three orders of magnitude higher. However, calcium concentrations in groundwater are generally consistent between AD-22 and upgradient well AD-13 (**Figure 9**). The different ratio between calcium and cobalt in the leached FGD sludge material (about 45,000:1) as compared to the ratio for groundwater indicate that dissolved calcium concentrations at AD-22 would be significantly higher if the groundwater at this location were affected by leachate. The similarity between upgradient and downgradient calcium concentrations provides an additional line of evidence that the exceedances observed at the FGD Stackout Area are not due to a release from the unit.

Siderite and pyrite, both reduced iron-bearing minerals, were identified below the seasonal water table (within the saturated zone) at AD-22. Cobalt is known to undergo isomorphic substitution for iron in both siderite and pyrite (Gross, 1965; Hitzman, et al., 2017; Krupka and Serne, 2002). This is due to the similarity of their ionic radii (approximately 1.56 angstrom (Å) for iron vs. 1.52 Å for cobalt [Clementi and Raimondi, 1963). The proposed substitution of cobalt for iron in the crystal lattice of pyrite has been documented in other ASDs prepared for the Pirkey Plant's East Bottom Ash Pond (EBAP; Geosyntec, 2021c) and West Bottom Ash Pond (WBAP; Geosyntec, 2021d).

Goethite (an iron oxide) was identified within the seasonally saturated zone and the screened interval at AD-22 (**Table 1**). The weathering of siderite and pyrite to goethite under oxidizing conditions is a well-understood phenomenon, including in formations in east Texas (Senkayi, et al., 1986; Dixon, et al., 1982) and may have occurred within the seasonally saturated zone. A review of geochemical conditions at AD-22 shows that the conditions observed at AD-22 are favorable for goethite formation (**Figure 10**). During weathering from reduced (pyrite or siderite) to oxidized (goethite) iron minerals, cobalt would be released from the mineral structure. The contribution of cobalt to groundwater via dissolution of siderite or pyrite within the saturated aquifer is not likely to change seasonally. However, the mobilization of cobalt which was released during weathering of siderite or pyrite to goethite in the seasonally saturated zone may explain the variability in aqueous cobalt concentrations and their correlation with the groundwater elevation.

2.1.3 Conceptual Site Model

The seasonal fluctuations in beryllium and cobalt concentrations at AD-22 can be attributed to variations in the amount of the aquifer solids that are in contact with groundwater as the water table elevation changes. When the water table is higher, more clay material is in contact with groundwater, allowing greater desorption of cations (including beryllium) from the cation exchange sites on the clay. In the case of cobalt, more iron oxides are in contact with groundwater as the water table rises, allowing for the release of cobalt from mineral phases where it has isomorphically substituted for iron. Thus, the observed SSLs were attributed to natural variation associated with seasonal desorption of beryllium and cobalt as the amount of aquifer solids that are saturated increases.

2.2 Sampling Requirements

As the ASD presented above supports the position that the identified SSLs are not due to a release from the Pirkey FGD Stackout Area, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 30 TAC §352.951(e) and supports the position that the SSLs of beryllium and cobalt at AD-22 identified during the first semiannual assessment monitoring event of 2021 were not due to a release from the FGD Stackout Area. The identified SSLs were, instead, attributed to natural variation related to seasonal desorption or dissolution of beryllium and cobalt from the aquifer solids. Therefore, no further action is warranted, and the Pirkey FGD Stackout Area will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in **Attachment C.**

SECTION 4

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TABLES

Table 1: X-Ray Diffraction Results
FGD Stackout Pad - H. W. Pirkey Plant

Boring Location	**SP-B4**		
Associated Well	**AD-22**		
Depth (ft bgs)	**6-8**	**18-20**	**28-30**
Sample Location	**Within Seasonal Water Table**	**Below Seasonal Water Table**	**Within Screened Interval**
Quartz	28	47.5	95
Plagioclase Feldspar	<0.5	<0.5	1
K-Feldspar	1	0.5	-
Goethite	1	-	2
Hematite	-	-	-
Chlorite	1	-	-
Siderite	-	10	-
Pyrite	-	2	-
Clays	*	40	2
Kaolinite	13		
Illite/Mica	2		
Smectite	43		
Mixed-Layered Illite/Smectite	11		

Notes:

-: not detected

Mineral constituents are reported in percentage.

Values shown as less than indicate the mineral constituent is present but below the quantification limit.

*The clay fraction at SP-B4-6-8 was further analyzed to characterize the types of clays present, as listed below.

FIGURES

Legend

⊕ Downgradient Monitoring Well

⊕ Upgradient Monitoring Well

⊕ 2020 Soil Borings

▭ Stackout Pad

Notes

- Soil boring locations are approximate.
- Monitoring well locations are provided by AEP.

500 250 0 500 Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

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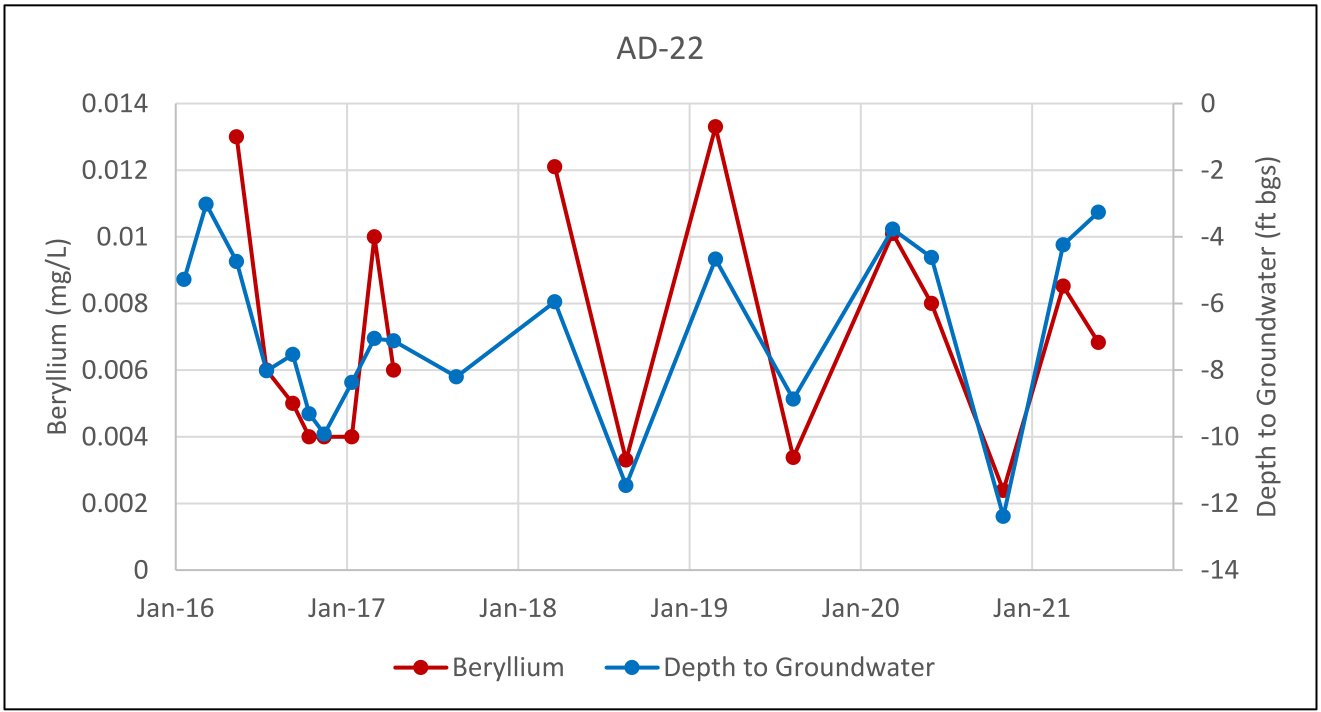
Figure

1

Columbus, Ohio

2020/03/27

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\Mike's GIS Files\Pirkey\MXDs\AEP-Pirkey_Stacker_Site_Layout.mxd. BAres. 3/27/2020. Project/Phase/Task.



Notes: Beryllium concentrations are shown in milligrams per liter (mg/L). Depth to water is shown as feet below ground surface (ft bgs). The gap in beryllium data represents the time period in which detection monitoring took place and samples were not analyzed for beryllium.

Beryllium v. Depth to Groundwater

Pirkey FGD Stackout Pad

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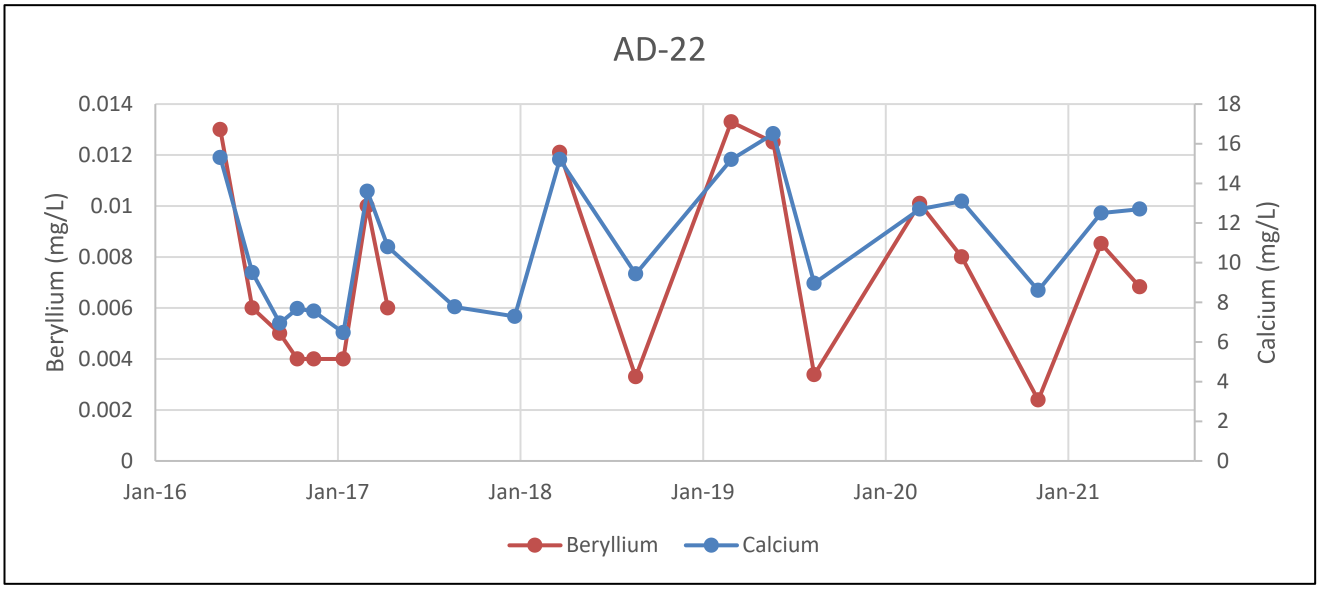
25-October-2021

Figure

2



Notes: Beryllium and calcium concentrations are shown in milligrams per liter (mg/L). The gaps in beryllium data represent the time period in which detection monitoring took place and samples were not analyzed for beryllium.

Beryllium v. Calcium Concentrations

Pirkey FGD Stackout Pad

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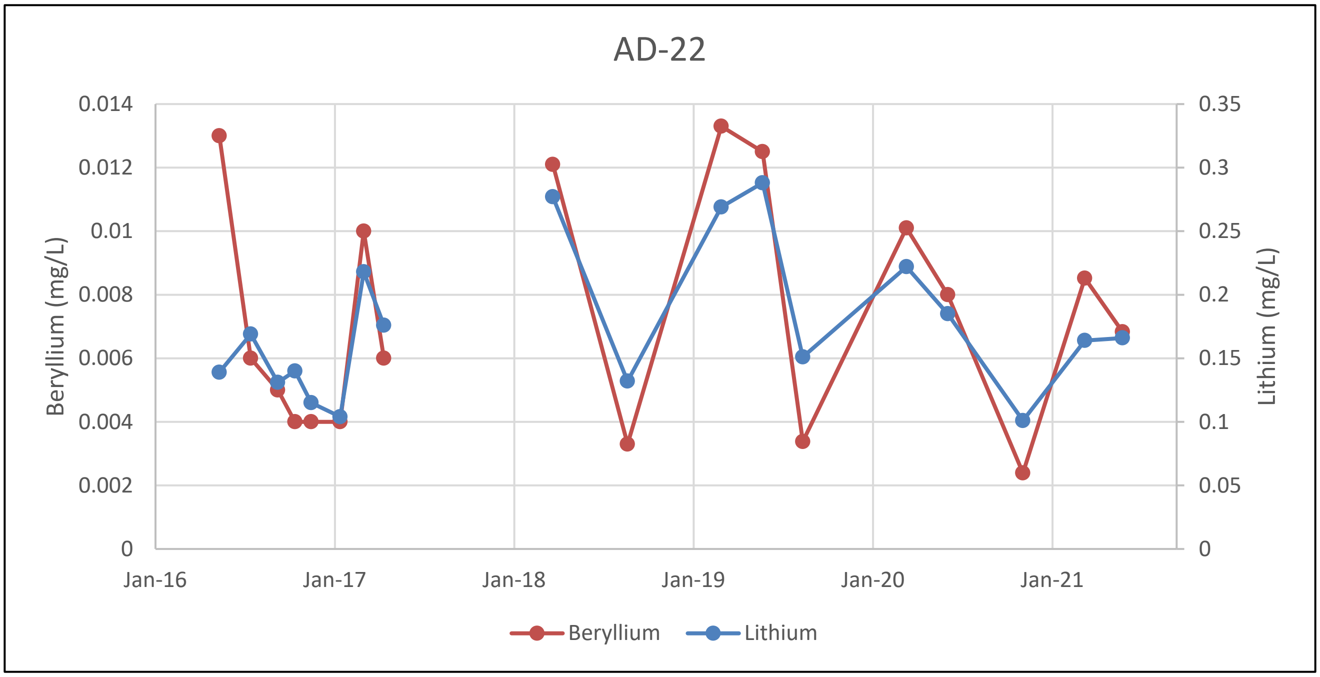
Figure

3



Notes: Beryllium and lithium concentrations are shown in milligrams per liter (mg/L). The gaps in data represents the time period in which detection monitoring took place and samples were not analyzed for beryllium or lithium.

Beryllium v. Lithium Concentrations

Pirkey FGD Stackout Pad

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Figure

4

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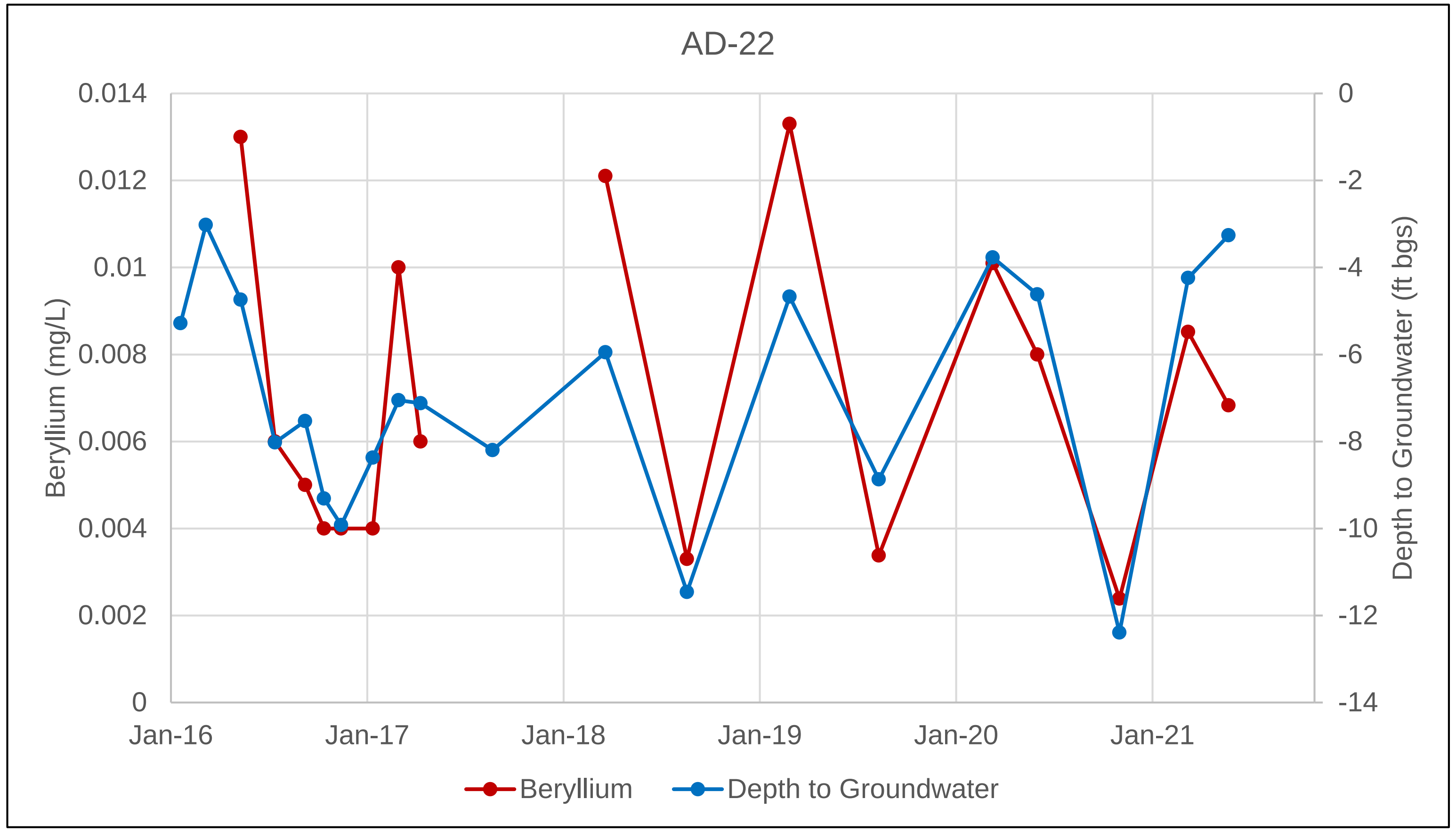

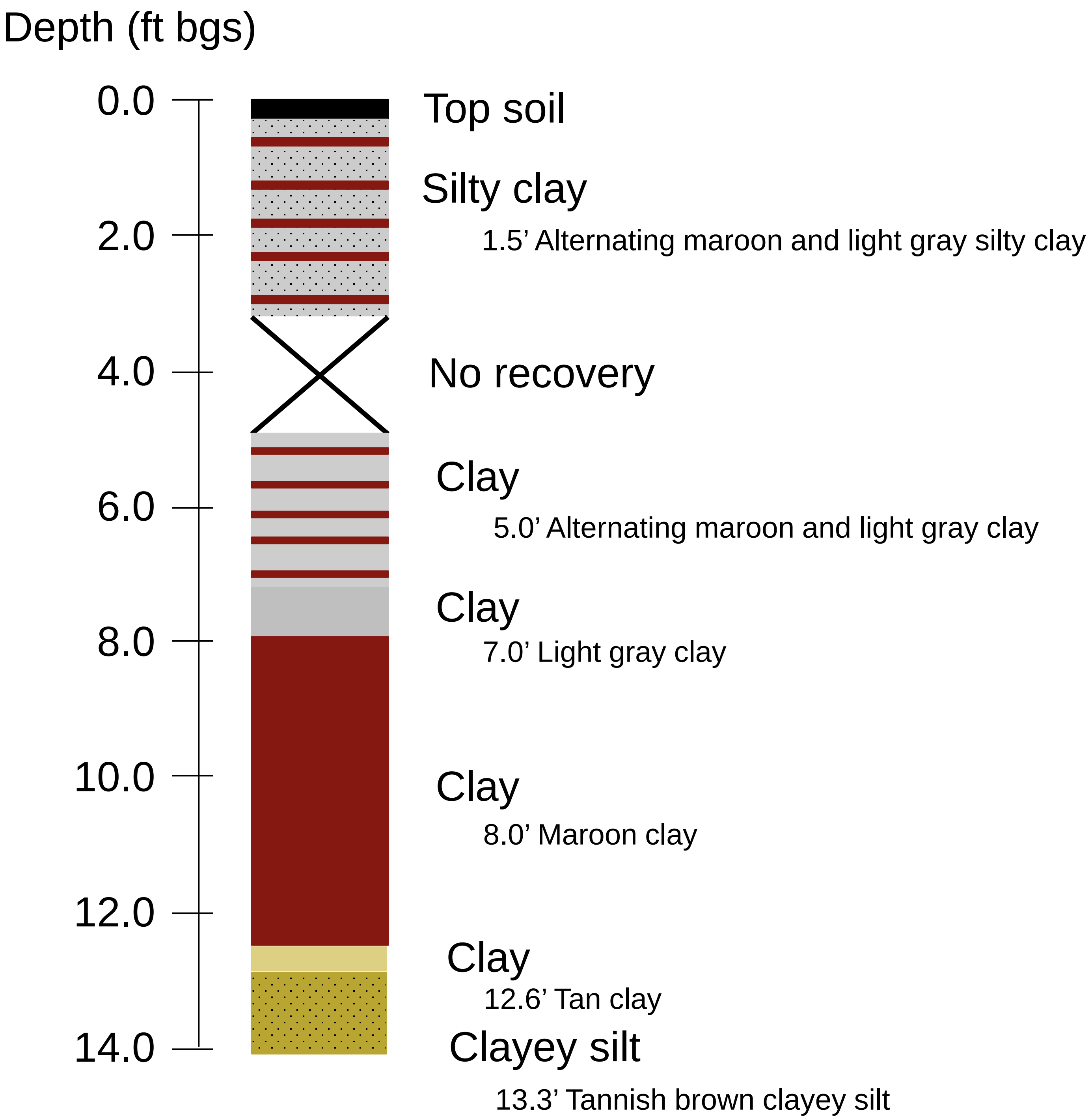

Notes:
-A sample was collected for analysis of mineralogy from 6-8 ft bgs.
-The full boring log is available in Attachment A.

Internal info: Path, date revised, author

AD-22 Seasonal Water Table Geology
H. W. Pirkey Plant – FGD Stackout Pad

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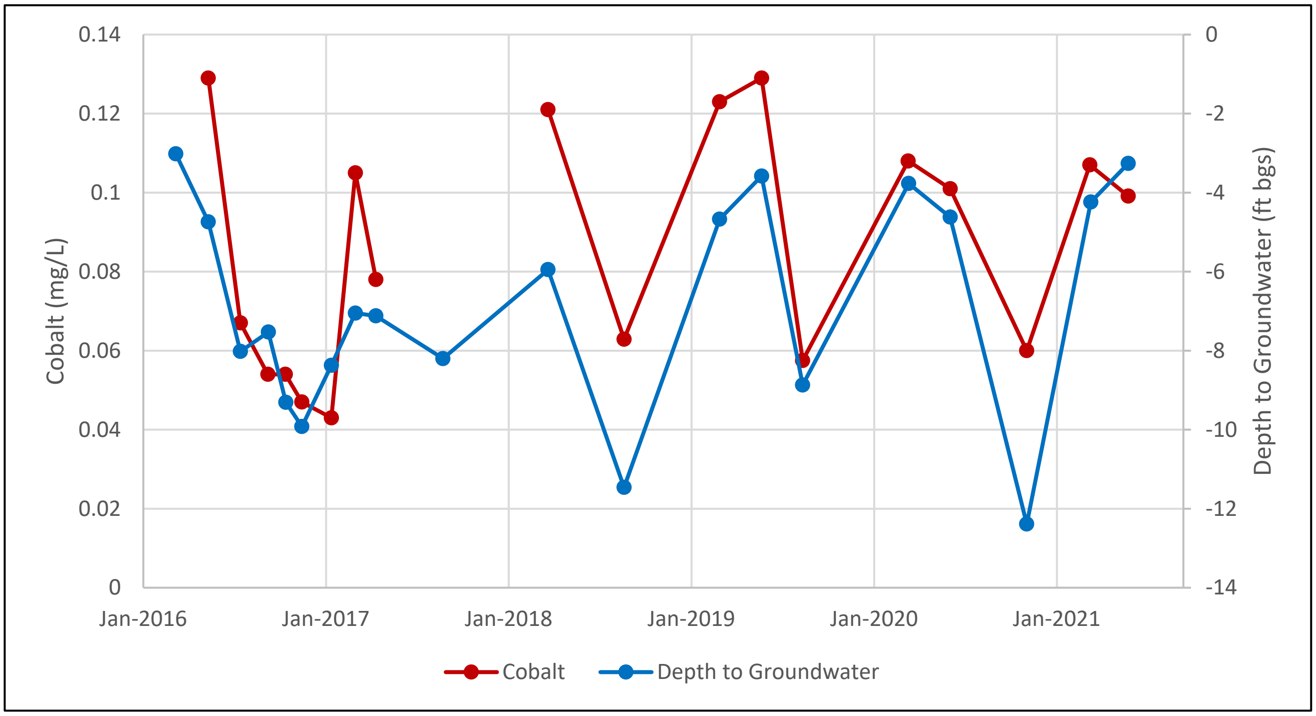
Figure
5

Columbus, OH
02-Nov-2020



Notes: Cobalt concentrations are shown in milligrams per liter (mg/L). Depth to water is shown as feet below ground surface (ft bgs). The gap in cobalt data represents the time period in which detection monitoring took place and samples were not analyzed for cobalt.

AD-22 Cobalt v. Depth to Groundwater

Pirkey FGD Stackout Pad

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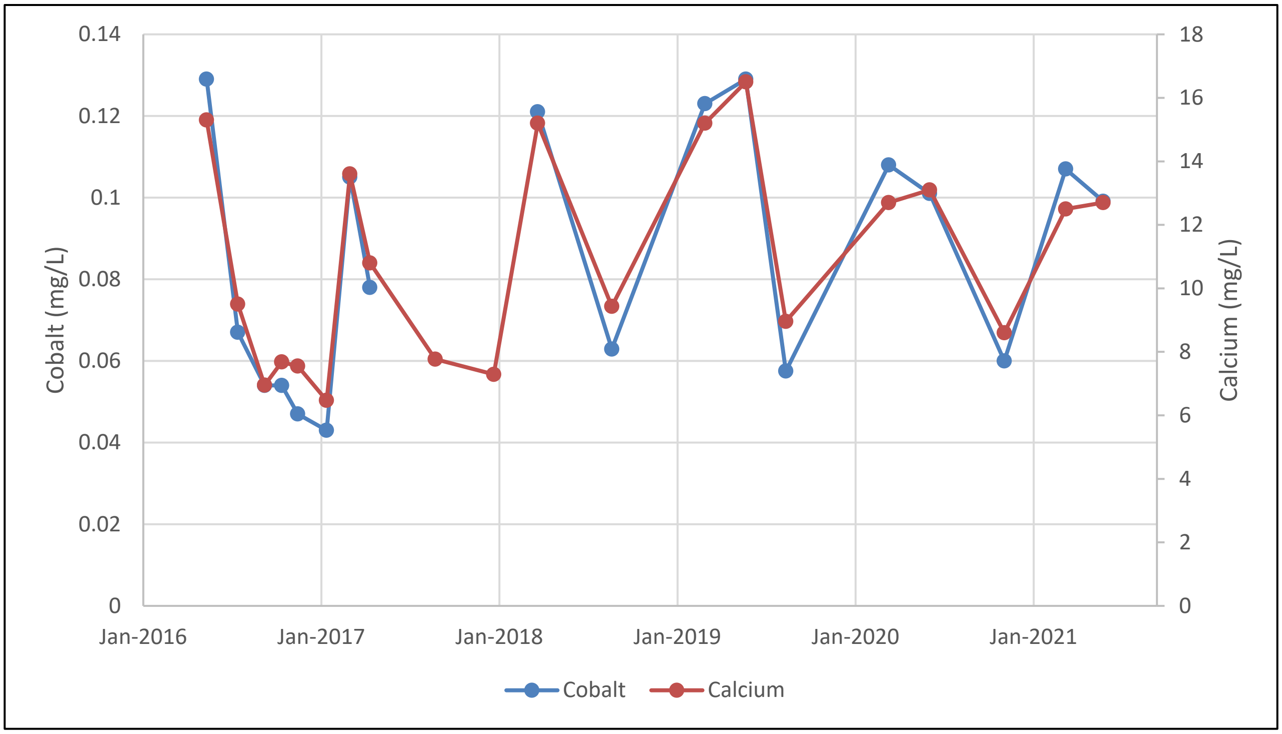
Figure

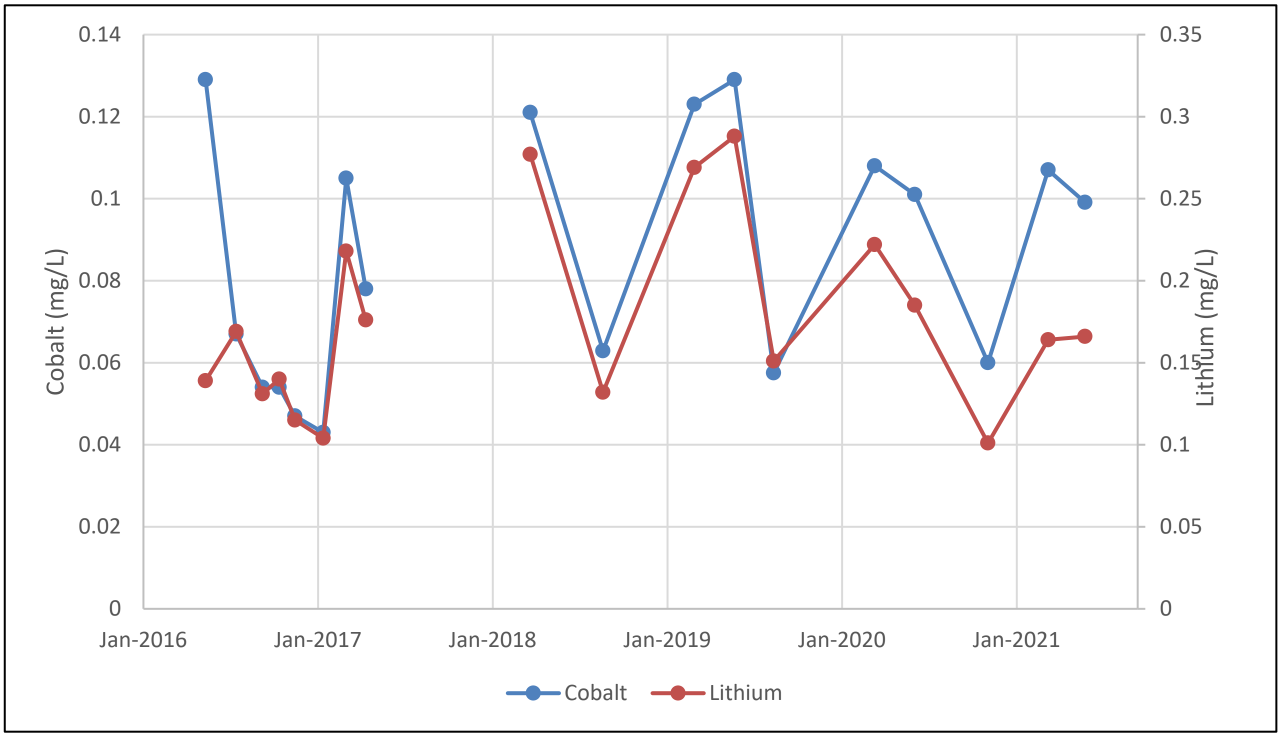
6

Columbus, Ohio

26-October-2021

internal info: path, date revised, author





Notes: Cobalt, calcium, and lithium concentrations are shown in milligrams per liter (mg/L). The gaps in cobalt and lithium data represent the time period during which detection monitoring took place and samples were not analyzed for cobalt and lithium.

AD-22 Cobalt v. Calcium and Lithium

Pirkey FGD Stackout Pad

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Figure

7

Columbus, Ohio

26-October-2021

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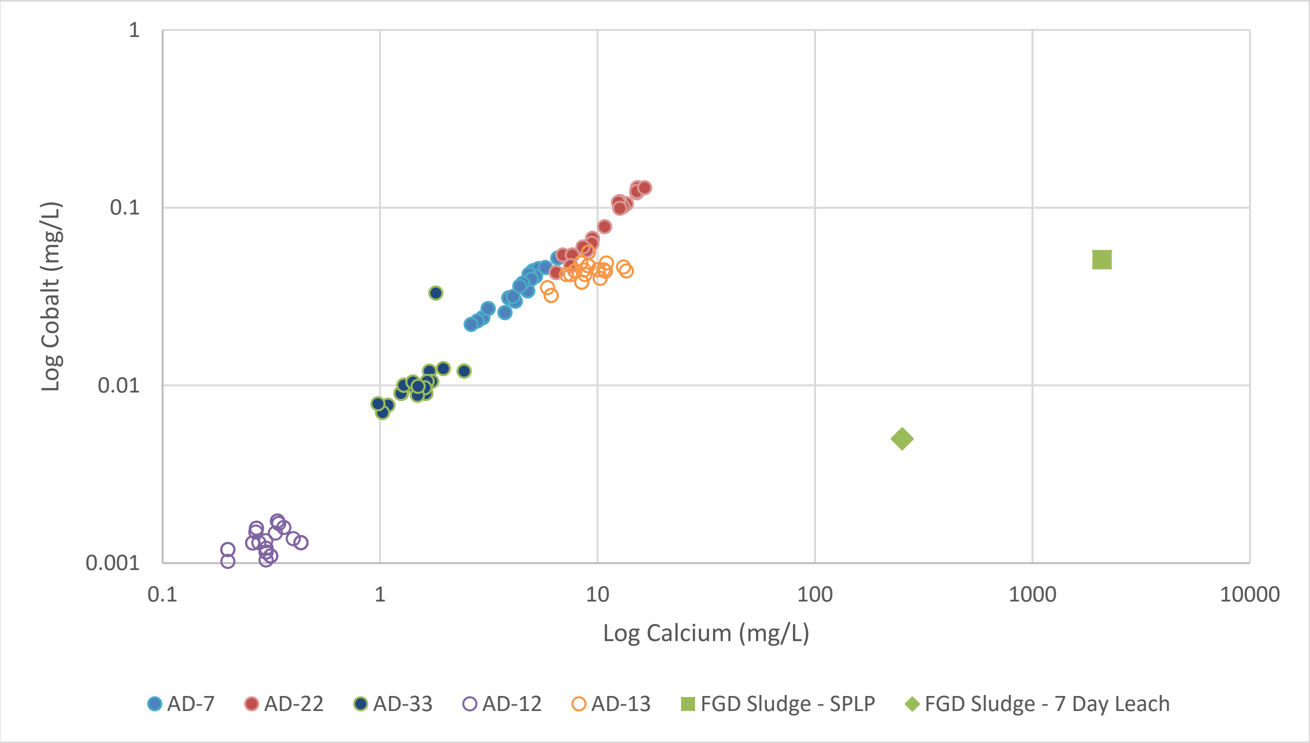

Notes: Cobalt and calcium concentrations are shown in milligrams per liter (mg/L). Upgradient wells are shown with hollow circles. ‘FGD Sludge-SPLP’ and ‘FGD Sludge 7 Day Leach’ present the leached concentrations of cobalt and calcium using the Synthetic Precipitation Leaching Procedure (SW-846 Test Method 1312) and the 7-Day Distilled Water Leachate Test Procedure (30 TAC 335.521 Appendix 4), respectively.

Cobalt and Calcium Concentration Distribution

Pirkey FGD Stackout Pad

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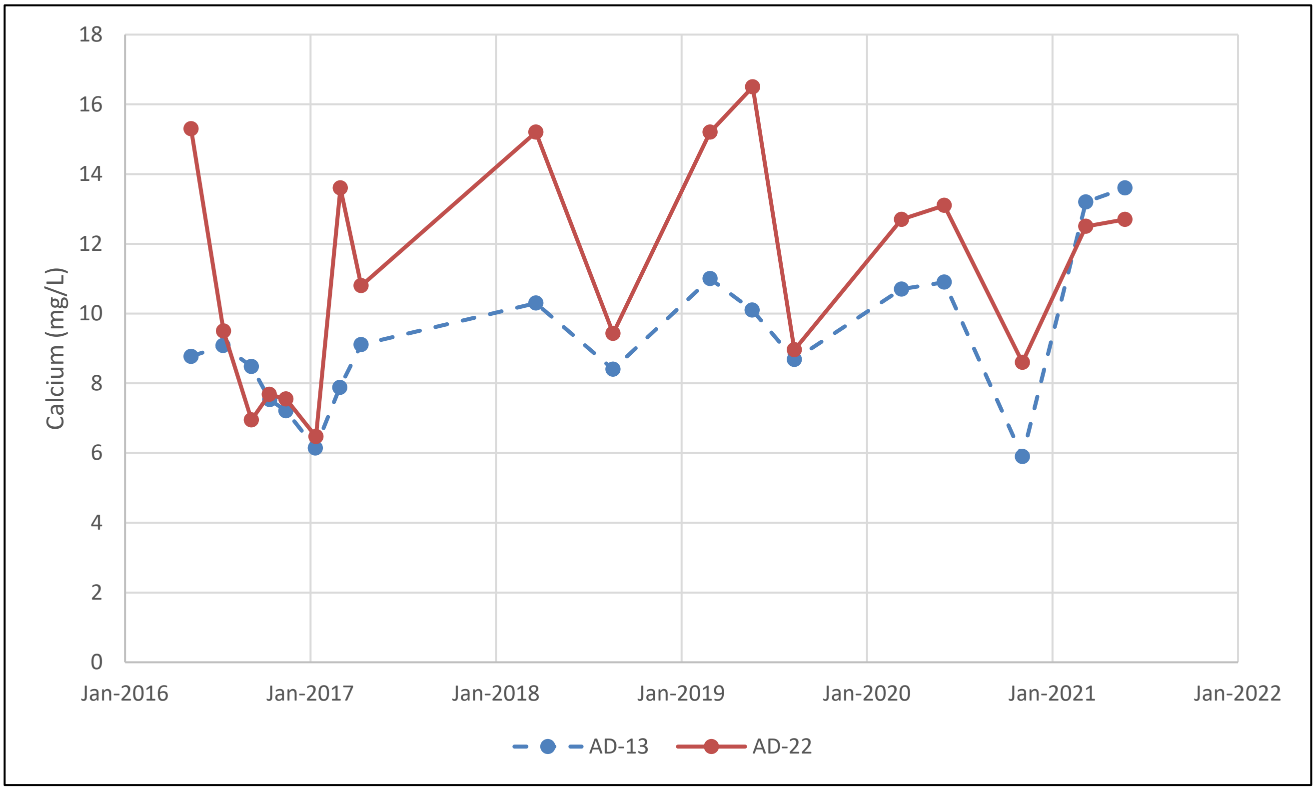
Columbus, Ohio

26-October-2021

Figure

8



Notes: Calcium concentrations are shown in milligrams per liter (mg/L). AD-13 is shown with a dashed line because it is an upgradient location.

Calcium Time Series Graph

Pirkey FGD Stackout Pad

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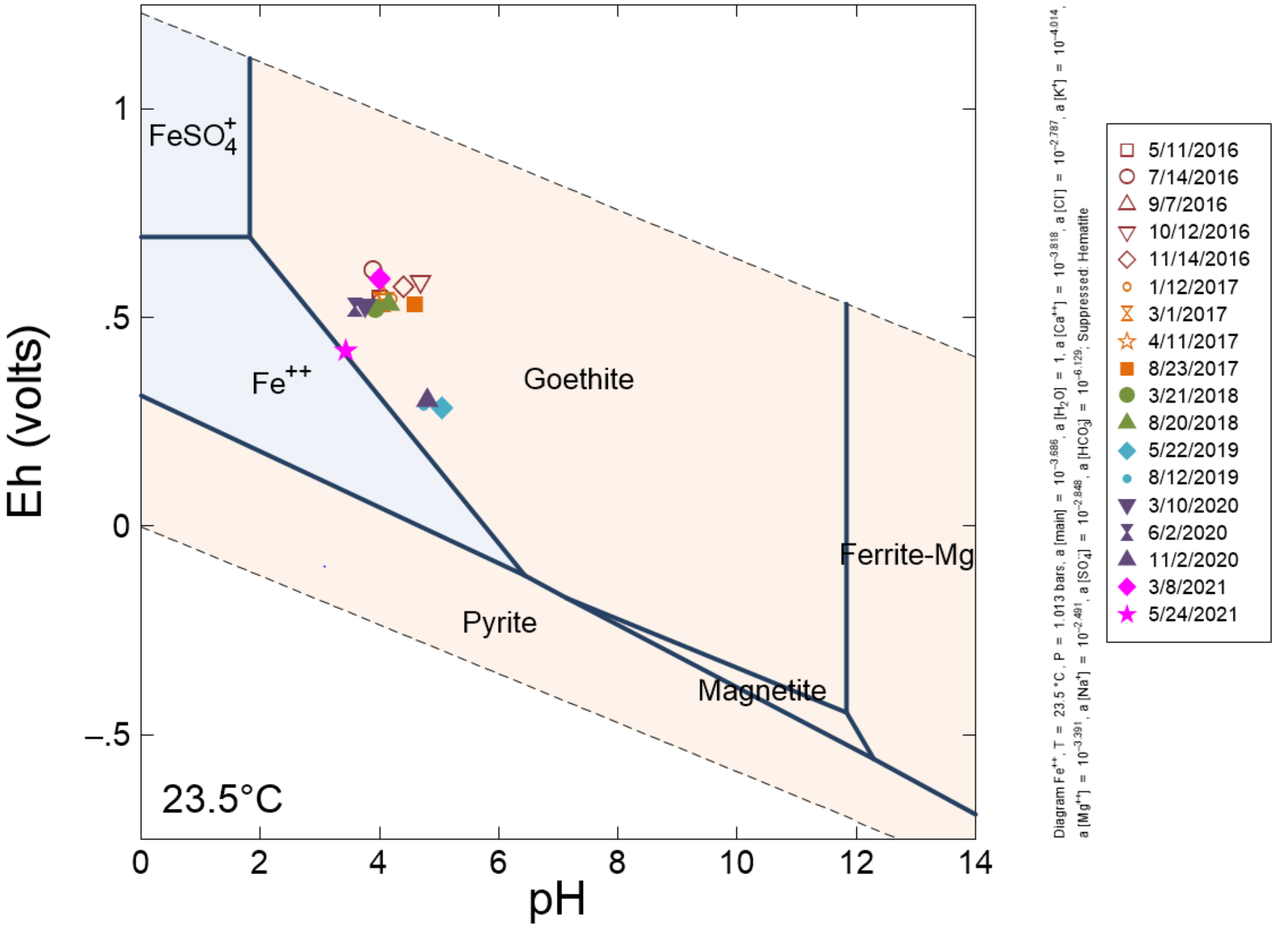
Columbus, Ohio

26-October-2021

Figure

9



Notes: Average groundwater concentrations of major cations and anions at AD-22 were used to establish baseline conditions for the diagram. Eh and pH values for sampling dates at AD-22 are shown on the diagram.

AD-22 Eh-pH Diagram
Pirkey FGD Stackout Pad

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Figure

10

Columbus, Ohio

28-October-2021

internal info: path, date revised, author

ATTACHMENT A
SP-B4 Boring Logs

Soil Boring Log

Project: AEP Pirkey
Boring/Well Name:______ SP-B4
Project Location:____ Hallsville, TX
Boring Date:__ 3/3/2020

Depth Scale Feet | Water Table | Soil Profile | Description | PID*

pp= pocket penetrometer

0.0'-0.4': Top soil, black silt, vegetation
0.4'-0.7': Brown clayey silt, good cohesion
0.7'-1.5': Red and light gray silty clay, moderate stiffness (pp. 2.5), high plasticity
1.5'-3.7': Maroon and light gray clay, high stiffness (pp. 4.5-5.0), low plasticity; iron ore present 3.1'-3.7'
3.7'-5.0': NO RECOVERY
5.0'-7.0': Maroon and light gray clay, high stiffness (pp. 4.5-5.0), low plasticity; iron ore present throughout
7.0'-8.0': Light gray clay with iron ore, moderate stiffness (pp.2.5-3.0), moderate plasticity
8.0'-10.0': Maroon clay, moderate stiffness (pp. 3.5), moderate plasticity; iron ore present; moist at 9'
10.0'-12.6': Maroon clay, moderate stiffness (pp. 3.5), moderate plasticity; iron ore present; wet at 12'
12.6'-13.3': Tan clay, low stiffness (pp.1.5), high plasticity; wet
13.3'-18.5': Tan and brown clayey silt, moderate cohesion; iron ore present; wet
18.5'-20.3': Maroon silty clay, low stiffness (pp. 1.0), moderate plasticity; iron ore; wet
20.3'-21.1': Dark gray/black clay, trace silt, low stiffness (pp. 1.5), high plasticity; wet
21.1'-21.3': Dark gray silt, good cohesion; wet
21.3'-21.9': Dark gray silty clay, low stiffness (pp. 1.5), high plasticity; wet
21.9'-22.3': Dark gray silt, moderate cohesion; wet
22.3'-22.7': light brown silt; low cohesion; wet
22.7'-24.4': Dark gray and dark green silty clay, moderate/high stiffness (pp.3.5), moderate plasticity; wet, glauconite present
24.4'-27.8': Dark green/gray fine grained sand, well sorted; wet; glauconite present
27.8'-30.0': Red and orange fine grained sand, well sorted, with iron ore; wet

Samples collected at 6-8'; 18-20'; 28-30'
TD at 30' bgs; refusal
*PID readings not collected

Drill Rig Geoprobe 3230 DT
Drilling Contractor:___ C&S
Driller:_ DJ Diduch

Geosyntec Consultants

ATTACHMENT B

AD-22 Boring Log and Well Installation Diagram

☐ BORING ■ MONITOR WELL

APEX PROJECT NO.: 110-089 **BORING NUMBER:** ____ **MONITOR WELL NUMBER:** AD-22

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

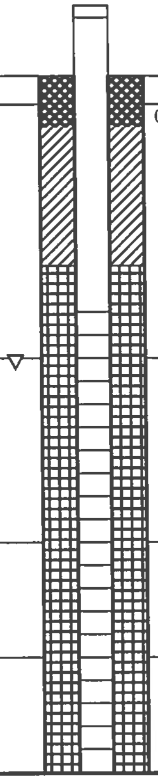
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/16/2010

PREPARED BY: David Bedford **LOGGED BY:** David Bedford

LATTITUDE: N 32°27'03.3" Datum: WGS-84 **WELL LOCATION:** Triangle- South side Quansit Hut
LONGITUDE: W94°29'41.3"



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-0.5	SC	Clayey sand, light brown, very fine grained	None	Moist
2 3 4 5 6 7 8 9 10 11 12			0.5-12	CL	Lean clay, light brown mottled with light gray Few iron ore (small) pebbles in clayey sandy streaks	None	Slightly Moist
13 14 15 16 17 18 19 20			12-20	SC	Clayey sand, grayish brown with orangish brown streaks, very fine grained Slightly wet @ 12.5' from seepage Large amount of iron ore 15-17' Very firm 18-18.5'	None	Slightly Wet
21 22 23 24 25			20-25	SC	(Dense crystalline rock 21-21.1'), light brown clayey sand, greenish black, mica, black clay streaks, very fine grained, wet @ 20'	None	Wet
26 27 28 29 30			25-30	SM	Sand, greenish brown (1') grading to orangish brown, silty, very fine grained	None	Wet
31 32 33 34 35 36 37 38 39 40					Boring Terminated at 30'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-10'
Screen Interval: 10-30'
Water level: 12.5'
Above Ground 3'

Note: This log is not to be used separate from this report.

ATTACHMENT C

Certification by a Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey FGD Stackout Area CCR management area and that the requirements of 30 TAC §352.951(e) have been met.

BETH ANN GROSS
79864

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
2039 Centre Pointe Blvd, Suite 103
Tallahassee, Florida 32308

Texas Registered Engineering Firm
No. F-1182

79864
License Number

Texas
Licensing State

12/22/2021
Date