
**ALTERNATIVE SOURCE
DEMONSTRATION REPORT
TEXAS STATE CCR RULE**

**H.W. Pirkey Power Plant East Bottom Ash Pond
Registration No. CCR104
Hallsville, Texas**

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LIST OF ACRONYMS

Å	angstrom
ASD	alternative source demonstration
bgs	below ground surface
CCR	coal combustion residuals
EBAP	East Bottom Ash Pond
EDS	energy-dispersive spectroscopy
EPRI	Electric Power Research Institute
GWPS	groundwater protection standard
LCL	lower confidence limit
mg/kg	milligram per kilogram
mg/L	milligram per liter
SEM	scanning electron microscopy
SPLP	Synthetic Precipitation Leaching Procedure
SSL	statistically significant level
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
USEPA	United States Environmental Protection Agency
VAP	vertical aquifer profiling
WBAP	West Bottom Ash Pond
XRD	X-ray diffraction

1. INTRODUCTION AND SUMMARY

This Alternative Source Demonstration (ASD) report has been prepared to address statistically significant levels (SSLs) for cobalt and lithium in the groundwater monitoring network at the H.W. Pirkey Plant East Bottom Ash Pond (EBAP) in Hallsville, Texas, following the first semiannual assessment monitoring event of 2023. The H.W. Pirkey Plant has four coal combustion residuals (CCR) storage units, including the EBAP, regulated by the Texas Commission on Environmental Quality (TCEQ) under Registration No. CCR104 (**Figure 1**).

In June 2023, a semiannual assessment monitoring event was conducted at the EBAP in accordance with Title 30 §352.951(a) of the Texas Administrative Code (TAC). The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Confidence intervals were recalculated for the Appendix IV parameters at the compliance wells to assess whether these parameters were present at an SSL above previously calculated groundwater protection standards (GWPSs). 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 EBAP (Geosyntec 2023a):

- The LCLs for cobalt exceeded the GWPS of 0.00939 mg/L at AD-2 (0.0132 mg/L), AD-31 (0.00959 mg/L), and AD-32 (0.0310 mg/L).
- The LCL for lithium exceeded the GWPS of 0.0520 mg/L at AD-31 (0.0760 mg/L) and AD-32 (0.0766 mg/L).

No other SSLs were identified.

1.1 CCR Rule Requirements

TCEQ regulations regarding assessment monitoring programs for CCR landfills and surface impoundments provide owners and operators with the option to make an ASD when an SSL is identified:

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. (30 TAC §352.951(e))

Pursuant to 30 TAC §352.951(e), Geosyntec Consultants, Inc. (Geosyntec) has prepared this ASD report to document that the SSLs identified for cobalt and lithium in the groundwater monitoring network for the EBAP are from a source other than the EBAP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSLs could be attributed. Alternative sources were categorized into the following five types, based on methodology provided by the Electric Power Research Institute (EPRI 2017):

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

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

2. SUMMARY OF SITE CONDITIONS

The EBAP design and construction, regional geology and site hydrogeology, and groundwater monitoring system and flow conditions are described below.

2.1 EBAP Design and Construction

The EBAP is a 31.5-acre CCR surface impoundment located at the north end of the Pirkey Plant, immediately east of the West Bottom Ash Pond (WBAP) (**Figure 1**). It was constructed while the Pirkey Plant was being developed in 1983 and 1984 and placed into operation in 1985 to receive bottom ash and economizer ash sluiced from the plant boiler. Bottom ash and economizer ash were periodically excavated from the EBAP and either removed via truck to the on-site landfill or sold for off-site beneficial reuse.

The EBAP was developed by excavating part of its perimeter into native soils to create an embankment height of approximately 4 feet, constructing compacted clay perimeter embankments, and constructing a compacted clay liner over the base of the pond (Arcadis 2016). Multiple lithological borings advanced after the installation of the clay liner confirm that at least 6 feet of clay was present below the base of the EBAP (Arcadis 2016). The bottom elevation of the EBAP was approximately 347 feet above mean sea level, and the elevation of the top of the pond embankment was approximately 357 feet above mean sea level. The unit was designed to have a maximum storage capacity of 188 acre-feet.

A Closure Plan was developed in October 2016 and revised in December 2021 (AEP 2021). This document detailed the closure activities which were to take place throughout the closure of the EBAP. AEP submitted a certified notification that the receipt of CCR materials had ceased as of April 25, 2023 and the closure activities had been initiated (AEP 2023). As of October 2023, the EBAP has been dewatered and CCR materials plus one foot of underlying soil have been removed.

2.2 Regional Geology / Site Hydrogeology

The EBAP is positioned on an outcrop of the Eocene-age Recklaw Formation, which consists predominantly of clay and fine-grained sand (Arcadis 2016). The Recklaw Formation is underlain by the Carrizo Sand, which crops out in the topographically lower southern portion of the plant. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay.

The very-fine- to fine-grained clayey and silty sand found beneath an upper silty to silty sandy clay layer in the vicinity of the EBAP is considered to be the Uppermost Aquifer below this CCR unit (Arcadis, 2016). Here it is approximately 15-feet thick and located between an elevation of 325 and 340 feet mean sea level.

2.3 Groundwater Monitoring History and Flow Conditions

The EBAP monitoring well network monitors groundwater within the Uppermost Aquifer. Geologic cross section A-A' from the EBAP Groundwater Monitoring Well Network Report (Arcadis 2016), provided herein as **Attachment A**, shows the subsurface geometry of the

Uppermost Aquifer (indicated on the figure as clayey silty sand, tan to gray) underlying the EBAP and the WBAP and demonstrates lateral continuity of the Uppermost Aquifer spanning the entire length of the EBAP.

Groundwater flow direction in the area of the EBAP is west-southwesterly (**Figure 1**). Seasonal variability in groundwater flow has not been observed since the monitoring well network was installed. Groundwater flow velocities in the uppermost aquifer in the vicinity of the EBAP have been reported as approximately 10 to 44 feet per year. The EBAP monitoring well network consists of upgradient monitoring wells AD-4, AD-12, and AD-18 and compliance wells AD-2, AD-3, AD-31, and AD-32, all of which are screened within the Uppermost Aquifer.

3. ALTERNATIVE SOURCE DEMONSTRATION

The ASD evaluation method and proposed alternative source of cobalt or lithium in AD-2, AD-31, and AD-32 and the future groundwater sampling requirements are described below.

3.1 Proposed Alternative Source

An initial review of site geochemistry, site historical data, and laboratory quality assurance and quality control data did not identify alternative sources for cobalt and lithium due to Type I (sampling), Type II (laboratory), Type III (statistical evaluation), or Type V (anthropologic) 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 2020). As described below, the SSLs have been attributed to natural variation associated with the underlying geology, which is a Type IV (natural variation) issue.

3.1.1 Cobalt

Previous ASDs for cobalt at the EBAP provided evidence that cobalt is present in the aquifer geologic media at the site and that the observed cobalt concentrations in groundwater were due to natural variation of native geogenic sources (Geosyntec 2019a, Geosyntec 2019b, Geosyntec 2020a, Geosyntec 2020b, Geosyntec 2021a, Geosyntec 2021b, Geosyntec 2022b, Geosyntec 2023b, Geosyntec 2023c). The previous ASDs demonstrated how the EBAP was not a source for cobalt in downgradient groundwater, based on observed concentrations of cobalt both in the ash material and in leachate from Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-846 Test Method 1312 [USEPA, 1994]) of the ash material. Cobalt was not detected in the most recent SPLP ash leachate sample, collected in 2019, above the reporting limit of 0.01 mg/L, which is lower than the average concentrations observed at the wells of interest (**Table 1**). No changes to material handling or plant operations have occurred which would have changed the anticipated cobalt concentrations in CCR ash since this sample was collected.

In a February 2023 surface water sample collected from the EBAP to characterize the total cobalt concentrations, cobalt was detected at a concentration of 0.00350 mg/L (**Table 1**). The surface water sample data from the February 2023 sampling event was used during this evaluation as the EBAP had been dewatered prior to the June 2023 sampling event. This concentration is lower than the reported cobalt concentrations for multiple in-network wells from the June 2023 sampling event, including the upgradient monitoring well AD-4 (0.00389 mg/L; **Figure 2**). The EBAP sample was also found to be lower than the average concentration in groundwater at the wells of interest, including almost an order of magnitude lower than the average concentration at AD-32 (**Table 1**). Therefore, the EBAP is not the likely source of cobalt at AD-2, AD-31, or AD-32.

As noted in the previous ASDs, soil samples collected across the site, including from locations near the EBAP, identified cobalt in the aquifer solids at concentrations ranging from 0.59 – 23.5 milligrams per kilogram (mg/kg) with the highest value reported at AD-41, which is upgradient of the EBAP (**Figure 3**). SB-2 was advanced in the vicinity of AD-2 in April 2020 to re-log the

geology at AD-2 and collect samples for laboratory analysis of total metals and mineralogy. The SB-2 field boring log, which was generated by Auckland Consulting LLC, is provided as **Attachment B**. Cobalt was detected at SB-2 at concentrations of 9.45 mg/kg at 25-27 feet below ground surface (bgs) and 19.2 mg/kg at 31-33 feet bgs (**Table 2**). These cobalt concentrations are greater than the concentration of cobalt present in the bottom ash (6.1 mg/kg; **Table 1**). Both samples correlate to the depth of the monitoring well screen of AD-2 (20-40 feet bgs), indicating that naturally occurring cobalt is present in aquifer solids within the AD-2 screened interval.

In addition to the analysis of total cobalt, soil samples were submitted for mineralogical analysis to determine the mineral composition of soils near the EBAP. X-ray diffraction (XRD) analysis of soils from SB-2 identified pyrite (an iron sulfide) in samples collected at 25-27 feet bgs and 31-33 feet bgs at concentrations up to 7% by weight (**Figure 3**). Cobalt is known to undergo isomorphic substitution for iron in crystalline iron minerals such as pyrite due to their similar ionic radii of approximately 1.56 angstroms (Å) for iron vs. 1.52 Å for cobalt (Clementi and Raimondi 1963; Krupka and Serne 2002; Hitzman et al. 2017). The presence of iron-bearing minerals in soil near the EBAP constitutes a potential source of naturally occurring cobalt.

The aquifer solids at SB-2 are distinctly red in color at shallow depths, as illustrated in the photolog of soil cores provided in **Attachment C**. While shallow samples were not collected for mineralogical analysis, red color in soils is often associated with the presence of oxidized iron-bearing minerals such as hematite and goethite. The red color of the soil suggests the presence of iron oxide and hydroxide minerals within the shallow depth interval. The alteration of pyrite to these iron oxide and hydroxide minerals under oxidizing conditions is also a well-understood phenomenon, including in formations in east Texas (Senkayi et al. 1986, Dixon et al. 1982). It is likely that the pyrite weathering process is resulting in the release of isomorphically substituted cobalt from the pyrite crystal structure as it undergoes oxidative transformation to iron oxide/hydroxide minerals.

As described in the previous ASDs, vertical aquifer profiling (VAP) was used to collect groundwater samples from upgradient locations B-2 and B-3 during the soil boring and sample collection process (Geosyntec 2019b). A groundwater sample was also collected from AD-32, one of the existing compliance-wells within the EBAP groundwater monitoring network where a cobalt SSL was identified. Solid phase materials within these groundwater samples were separated and submitted for analysis of chemical composition. For the VAP samples, separation was completed using a centrifuge due to the high abundance of suspended solids. For the groundwater sample at AD-32, the sample was filtered using a 1.5-micron filter. Based on total metals analysis, cobalt was identified both in the centrifuged solid material collected from upgradient VAP location B-3 [VAP-B3-(40-45)] and in the material retained on the filter after processing groundwater from permanent monitoring wells B-2 and B-3 (**Table 2**). The concentrations of cobalt in the solid material retained after filtration were comparable to the bulk soil samples collected from the same locations.

The solid sample [VAP-B3-(40-45)] was submitted for mineralogical analysis via XRD and scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS). The XRD results identified pyrite as approximately 3% of the solid phase (**Table 3**). Pyrite was identified during SEM/EDS analysis of lignite which is mined immediately adjacent to the site. Logging completed while the VAP boring was advanced identified coal at several intervals, including 45 and 48 feet bgs (**Figure 4**). Furthermore, SEM/EDS of both centrifuged solid samples [VAP-B3-(40-45) and VAP-B3-(50-55)] identified pyrite in backscattered electron micrographs by the distinctive framboidal morphology (Harris et al. 1981; Sawlowicz 2000). Major peaks representing iron and sulfur were identified in the EDS spectrum, which further support the identification of pyrite (**Attachment D**). While cobalt was not identified in the EDS spectrum, it is likely present at concentrations below the detection limit.

The EBAP was not identified as the source of cobalt at wells in the EBAP network based on the low concentrations of cobalt in the pond itself and the ubiquity of naturally occurring cobalt, especially in soil and groundwater samples upgradient from the EBAP. Cobalt in the EBAP network groundwater is believed to be a result of natural variability within the aquifer. Naturally occurring cobalt is known to substitute for iron in iron-bearing minerals. The presence of iron sulfide (as pyrite) and iron oxides/hydroxides hematite and goethite have been confirmed at AD-2 and across the Site. The weathering of pyritic minerals to iron oxide/hydroxide minerals may be resulting in the release of cobalt into groundwater from the crystal structure of these aquifer minerals.

3.1.2 Lithium

Previous ASDs for lithium at the EBAP attributed the observed lithium exceedances to variations in lithium associated with the suspended native aquifer solids that likely originate from naturally occurring lignite present in these soils. These native lithium-containing aquifer solids are ubiquitous in the aquifer based on the presence of both solid-phase and dissolved lithium at upgradient locations (Geosyntec 2019b, Geosyntec 2020a, Geosyntec 2020b, Geosyntec 2021a, Geosyntec 2021b, Geosyntec 2022a, Geosyntec 2022b, Geosyntec 2023b, Geosyntec 2023c). Data gathered in support of the prior ASDs and recent results provide additional evidence that the observed lithium groundwater concentrations at AD-31 and AD-32 are naturally occurring and are due to natural variation in the aquifer (Type IV ASD).

As discussed in Section 3.3.1, a surface water sample was collected directly from the EBAP in February 2023. Lithium was detected in the February 2023 EBAP sample at a concentration of 0.0653 mg/L (**Figure 5, Table 4**). The labile fraction identified in the bottom ash by SPLP from a February 2019 sample was even lower, with an estimated (J-flagged) lithium concentration of 0.011 mg/L. These concentrations are below the average lithium concentrations at AD-31 (0.0818 mg/L) and AD-32 (0.0843 mg/L) (**Table 4**). Thus, the EBAP is not the likely source of lithium at AD-31 and AD-32.

Groundwater samples collected from upgradient wells B-2 and B-3 in June 2023 had total lithium concentrations of 0.0485 mg/L and 0.0641 mg/L, respectively. The reported concentration at B-3

is greater than the GWPS of 0.0520 mg/L and only slightly lower than the concentration of lithium observed at AD-31 (0.089 mg/L). Furthermore, the lithium concentration detected at B-3 is greater than the value found at AD-32 (0.0500 mg/L) (**Figure 5**). Because B-2 and B-3 were installed at locations upgradient to and unimpacted by site activities, these lithium concentrations suggest that aqueous lithium is naturally present at concentrations above the GWPS across the site at variable concentrations and not limited to AD-31 and AD-32. It is noted that B-2 and B-3 are not part of the monitoring network for the EBAP, and as such the lithium concentrations in groundwater from these wells are not considered in calculating the GWPS for the CCR unit.

As described in Section 3.3.1, groundwater samples were collected from B-2, B-3, and AD-32 and filtered to separate solids. Groundwater was also collected from a VAP boring (VAP-B3-(40-45)) and centrifuged to separate solids. Lithium was detected in the solid material separated from these groundwater samples at concentrations comparable to bulk soil at all locations, providing evidence that the particulates captured during groundwater sampling contain lithium (**Table 5**).

3.1.2.1 Calculated Partition Coefficients

A previous ASD for lithium at the EBAP discussed lithium mobility in groundwater due to desorption from cation exchange complexes associated with clay minerals within naturally occurring lignite material. This mechanism was posited as the source of lithium in both upgradient and downgradient wells at the EBAP (Geosyntec 2019b). Previously completed XRD analysis of centrifuged solid material samples (VAP-B3-(40-45)) found that clay minerals, including kaolinite, smectite, and illite/mica, made up at least 60% of the aquifer solid (**Table 3**). SEM/EDS analysis also identified the presence of silicon, aluminum, and oxygen, all of which are components of clay minerals (**Attachment D**). The backscattered electron micrographs of these samples also identified clay particles by morphology. The largest clay particles (> 5 μm) are likely kaolinite, while smectite and illite dominate the smaller size fraction. These clay minerals, particularly smectite and illite, are known to retain cations such as lithium via incorporation into the octahedral layer of the mineral structure and through cation exchange processes.

Partition coefficients values (K_d) for lithium, potassium, and sodium were calculated using mass measurements and total metal concentrations in the solid materials separated from the groundwater samples during filtration and the filtered groundwater concentrations. Details about the K_d calculation are provided in the previous ASD (Geosyntec 2019b). K_d values for groundwater and particulates collected from wells B-2, B-3, and AD-32 were comparable to literature K_d values reported for organic-rich media such as bogs and peat beds (Sheppard et al. 2009, Sheppard et al. 2011), providing further evidence that lithium mobility in site groundwater is similar to other sites with organic-rich soils (**Table 6**). Additionally, the calculated K_d values for Pirkey soils were consistent with the literature, with potassium having the highest K_d (greatest affinity for sorption) and sodium the lowest K_d (least affinity for sorption). Furthermore, the values are similar for groundwater from all three wells, suggesting a universal mechanism controlling lithium, sodium, and potassium mobility in groundwater.

These multiple lines of evidence show that elevated lithium concentrations at AD-31 and AD-32 are likely not due to a release from the EBAP, and instead can be attributed to natural variation (Type IV ASD). This variation appears related to the distribution of clay fractions associated with lignite materials in the soil aquifer material.

3.2 Sampling Requirements

As the ASD presented above supports the position that the identified SSLs are not due to a release from the Pirkey EBAP, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters semiannually.

4. 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 for cobalt and lithium identified during assessment monitoring in June 2023 were not due to a release from the EBAP. The identified SSLs should instead be attributed to natural variation in the underlying geology. Therefore, no further action is warranted, and the Pirkey EBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in **Attachment E**.

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TABLES

**Table 1: Summary of Key Cobalt Analytical Data
East Bottom Ash Pond - H.W. Pirkey Plant**

Sample	Sample Date	Unit	Cobalt Concentration
Bottom Ash (Solid Material)	2/11/2019	mg/kg	6.1
SPLP Leachate of Bottom Ash	2/11/2019	mg/L	<0.01
EBAP Pond Water	2/28/2023	mg/L	0.0035
AD-2 - Average	May 2016 - June 2023	mg/L	0.0155
AD-31 - Average	May 2016 - June 2023	mg/L	0.0121
AD-32 - Average	May 2016 - June 2023	mg/L	0.0413

Notes:

1. Average values were calculated using all cobalt data collected under 40 CFR 257 Subpart D, excluding any identified outliers.

mg/kg : milligram per kilogram

mg/L : milligram per liter

SPLP : synthetic precipitation leaching procedure

Table 2: Soil Cobalt Data
East Bottom Ash Pond - H.W. Pirkey Plant

Location ID	Location	Sample Depth (ft bgs)	Cobalt (mg/kg)
Bulk Soil Samples			
AD-2	EBAP Network	25-27	9.45
		31-33	19.2
AD-18	EBAP Network	8	3.60
		22	2.90
AD-31	EBAP Network	12	1.90
		26	0.83
AD-32	EBAP Network	11	1.70
		20-25	9.10
AD-41	Upgradient	15	< 1.0
		35	23.5
		95	1.90
B-2	Upgradient	10	2.36
		16	3.62
		71	10.30
		82	7.21
		87	3.11
B-3	Upgradient	10	1.30
		20	0.59
		97	1.11
Solid Material Retained After Filtration			
AD-32	EBAP Network	13-33	5.4
B-2	Upgradient	38-48	4.3
B-3	Upgradient	29-34	12.0
		VAP 40-45	18.0

Notes:

1. For AD-XX locations, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation. Samples for B-2 and B-3 locations were collected from cores removed from the borehole during well lithology logging.
2. Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.
 ft bgs: feet below ground surface
 mg/kg: milligram per kilogram

**Table 3: X-Ray Diffraction Results
East Bottom Ash Pond - H. W. Pirkey Plant**

Geosyntec Consultants, Inc.

Constituent	VAP-B3-(40-45)
Quartz	15
Plagioclase Feldspar	0.5
Orthoclase	ND
Calcite	ND
Dolomite	ND
Siderite	0.5
Goethite	ND
Hematite	2
Pyrite	3
Kaolinite	42
Chlorite	4
Illite/Mica	6
Smectite	12
Amorphous	15

Notes:

1. Results given in units of relative % abundance
2. VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

ND: Not detected

**Table 4: Summary of Key Lithium Analytical Data
East Bottom Ash Pond - H.W. Pirkey Plant**

Sample	Sample Date	Unit	Lithium Concentration
Bottom Ash (Solid Material)	2/11/2019	mg/kg	0.82 J
SPLP Leachate of Bottom Ash	2/11/2019	mg/L	0.011 J
EBAP Pond Water	2/28/2023	mg/L	0.0653
AD-31 - Average	May 2016 - June 2023	mg/L	0.0818
AD-32 - Average	May 2016 - June 2023	mg/L	0.0843

Notes:

1. Average lithium values for monitoring wells AD-31 and AD-32 were calculated using all lithium data collected under 40 CFR 257 Subpart D, excluding statistically identified outliers.

J : Estimated value. Result is less than the reporting limit but greater than or equal to the method detection limit.

mg/kg : milligram per kilogram

mg/L : milligram per liter

Table 5: Soil Lithium Data
East Bottom Ash Pond - H.W. Pirkey Plant

Location ID	Sample Depth (ft bgs)	Lithium (mg/kg)
Bulk Soil Sample		
AD-32*	11	0.53
	20-25	1.60
B-2	10	5.30
	16	3.97
	71	7.42
	87	13.10
B-3	10	3.64
	20	2.59
	97	11.10
Lignite	N/A	2.9 J
Solid Material Retained After Filtration		
AD-32*	13-33	9.8 J
B-2	38-48	6.5 J
B-3	29-34	7.8 J
	VAP 40-45	13.0

Notes:

1. Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.

* : AD-32 samples were collected from a separate borehole advanced near monitoring well AD-32

ft bgs : feet below ground surface

J : estimated value

mg/kg : milligram per kilogram

VAP : vertical aquifer profiling

**Table 6: Calculated Site-Specific Partition Coefficients
Pirkey Plant - East Bottom Ash Pond**

Source	B-2			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	Aqueous Phase	Adsorbed	Kd	Kd
Li	0.081	6.5	80	43-370
K	2.6	1100	423	42-1200
Na	14	130	9	5.2-82

Source	B-3			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	Aqueous Phase	Adsorbed	Kd	Kd
Li	0.097	7.8	80	43-370
K	2.9	1100	379	42-1200
Na	32	240	8	5.2-82

Source	AD-32*			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	Aqueous Phase	Adsorbed	Kd	Kd
Li	0.11	9.8	89	43-370
K	3.9	1800	462	42-1200
Na	57	220	4	5.2-82

Notes:

1. Adsorbed values are total metals concentrations reported by USEPA Method 6010B.
2. Literature values represent maximum and minimum values for the parameter as reported in Sheppard et al, 2009 (Table 4-1, all sites) and Sheppard et al, 2011 (Table 3-3 cultivated peat and wetland peat only).

* : AD-32 samples were collected from a separate borehole advanced near monitoring well AD-32

Kd : partition coefficient

L/kg : liters per kilogram

mg/kg : milligrams per kilogram

mg/L : milligrams per liter

FIGURES



Legend

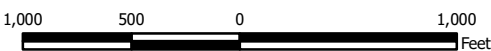
Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Groundwater Elevation Contours (Inferred)
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on June 26 and 27, 2023) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluation Update (Arcadis 2022) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- AD-10, AD-19, AD-20, AD-21, AD-29, and W-3 were not gauged during the June 2023 event.
- AD-35 was abandoned on November 13, 2018.
- Removal of CCR plus one foot of material was completed on July 26, 2022, for the WBAP

- AEP: American Electric Power
- CCR: coal combustion residuals
- EBAP: East Bottom Ash Pond
- WBAP: West Bottom Ash Pond



Beth Ann Gross
 10/16/2023
 Geosyntec Consultants, Inc.
 Texas Firm
 Registration No. 1182

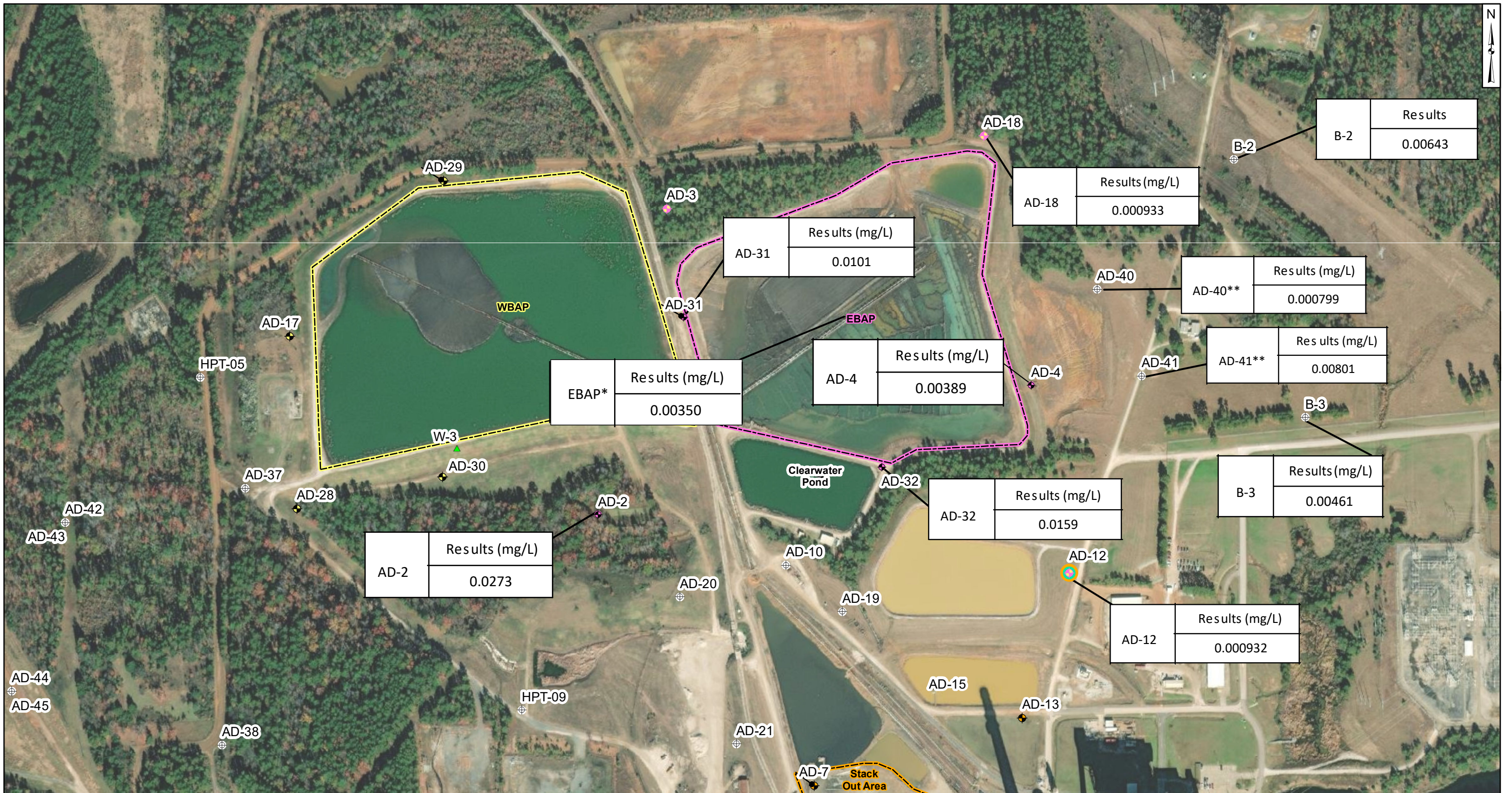
**Potentiometric Contours: Uppermost Aquifer
 June 2023**

AEP Pirkey Power Plant
 Hallsville, Texas

Geosyntec
 consultants

Columbus, Ohio 2023/10/06

Figure 1



Legend

- ⊕ Out of Network
- ◆ Stackout Area
- ◆ EBAP
- ◆ WBAP
- ◆ Landfill
- ◆ EBAP and WBAP
- ⊕ All CCR Unit Networks
- ▲ Piezometer
- ▭ EBAP
- ▭ WBAP

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- AD-15 location is approximated.
- Samples collected in June 2023.
- *: Porewater sample from East Bottom Ash Pond (EBAP) was collected in February 2023.
- ** : Well most recently sampled August 2019.
- Samples show in milligrams per liter (mg/L)

AEP: American Electric Power
 CCR: coal combustion residuals
 EBAP: East Bottom Ash Pond
 mg/L: milligrams per liter
 WBAP: West Bottom Ash Pond



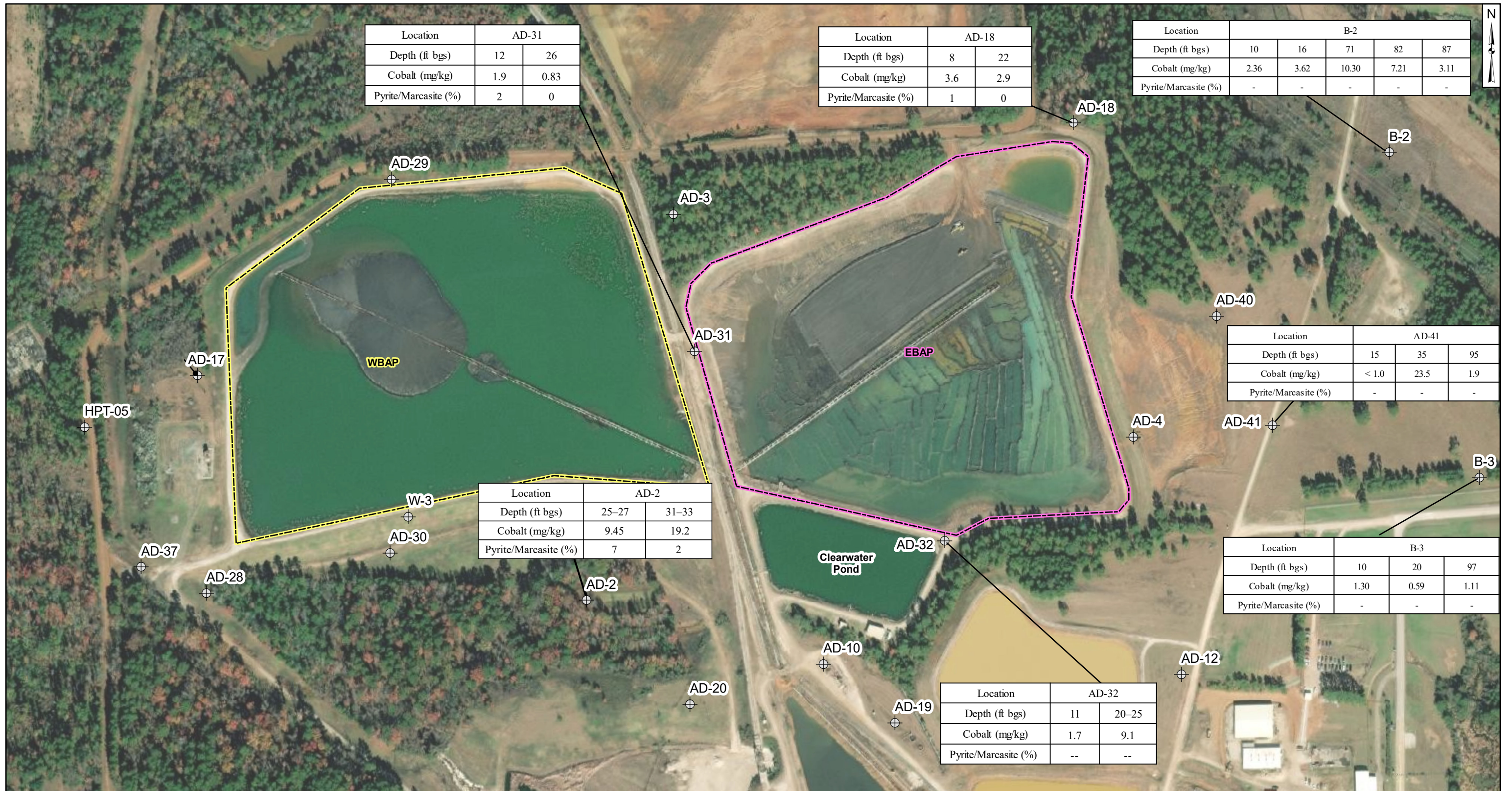
Aqueous Cobalt Distribution

AEP Pirkey Power Plant
Hallsville, Texas




Geosyntec
consultants

Figure 2

Columbus, Ohio 2023/10/02



Legend

-  Monitoring Wells
-  EBAP
-  WBAP

Notes

1. Monitoring well coordinates provided by AEP.
 2. AD-2 sample collected on April 20, 2020
 3. All other data provided by AEP, 2019.
- : not analyzed.
 AEP: American Electric Power
 EBAP: East Bottom Ash Pond
 ft bgs: feet below ground surface.
 mg/kg: milligrams per kilogram.
 WBAP: West Bottom Ash Pond



Cobalt Distribution in Soil

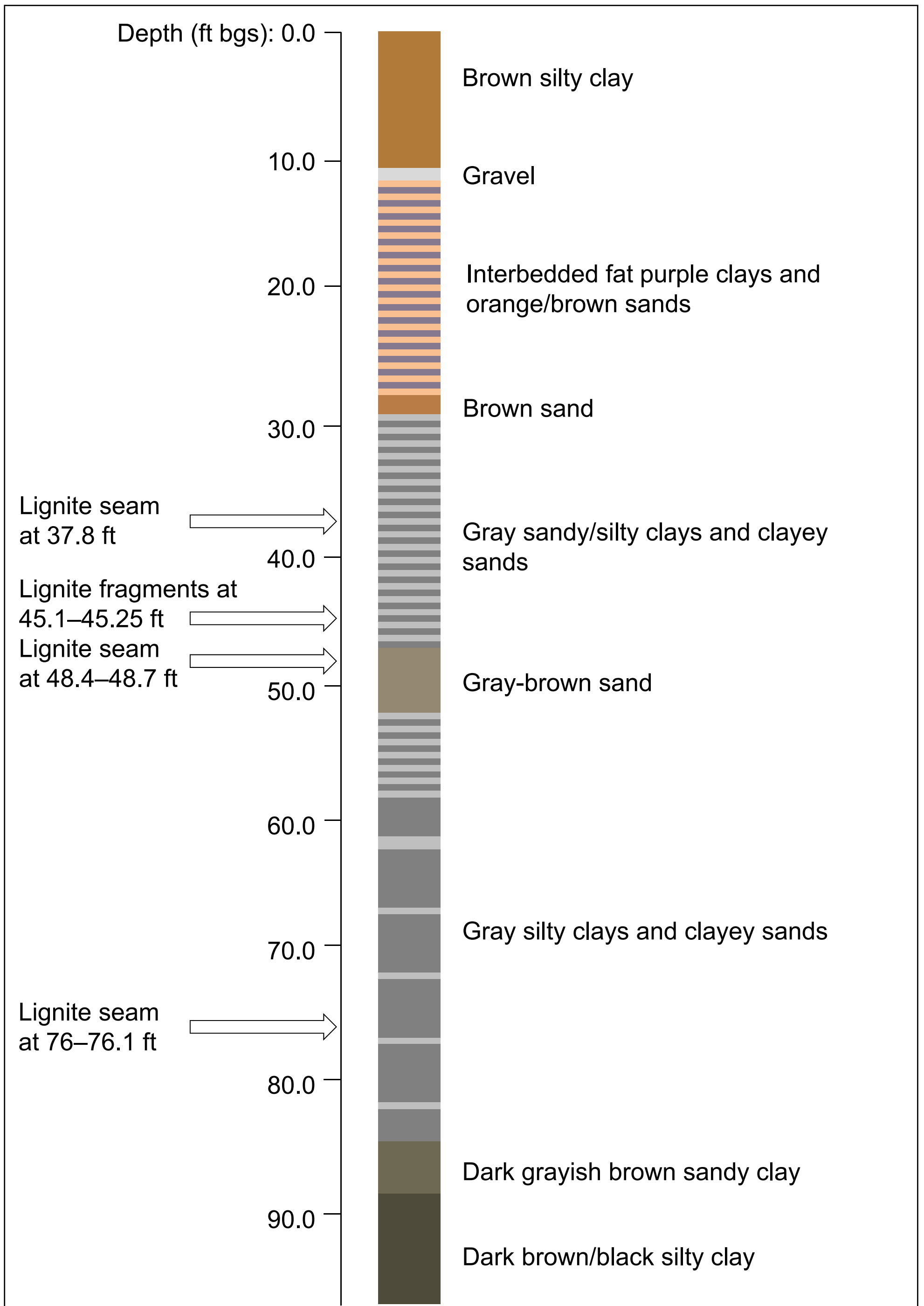
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
3

Columbus, Ohio

2023/10/13



Notes:
 1. Well installed in offset boring screened at 29-34 ft bgs
 2. Boring completed May 2019
 3. Total depth of 97.5 ft bgs
 AEP: American Electric Power
 bgs: below ground surface
 ft: feet

B-3 Visual Boring Log

AEP Pirkey Powerplant
 Hallsville, Texas

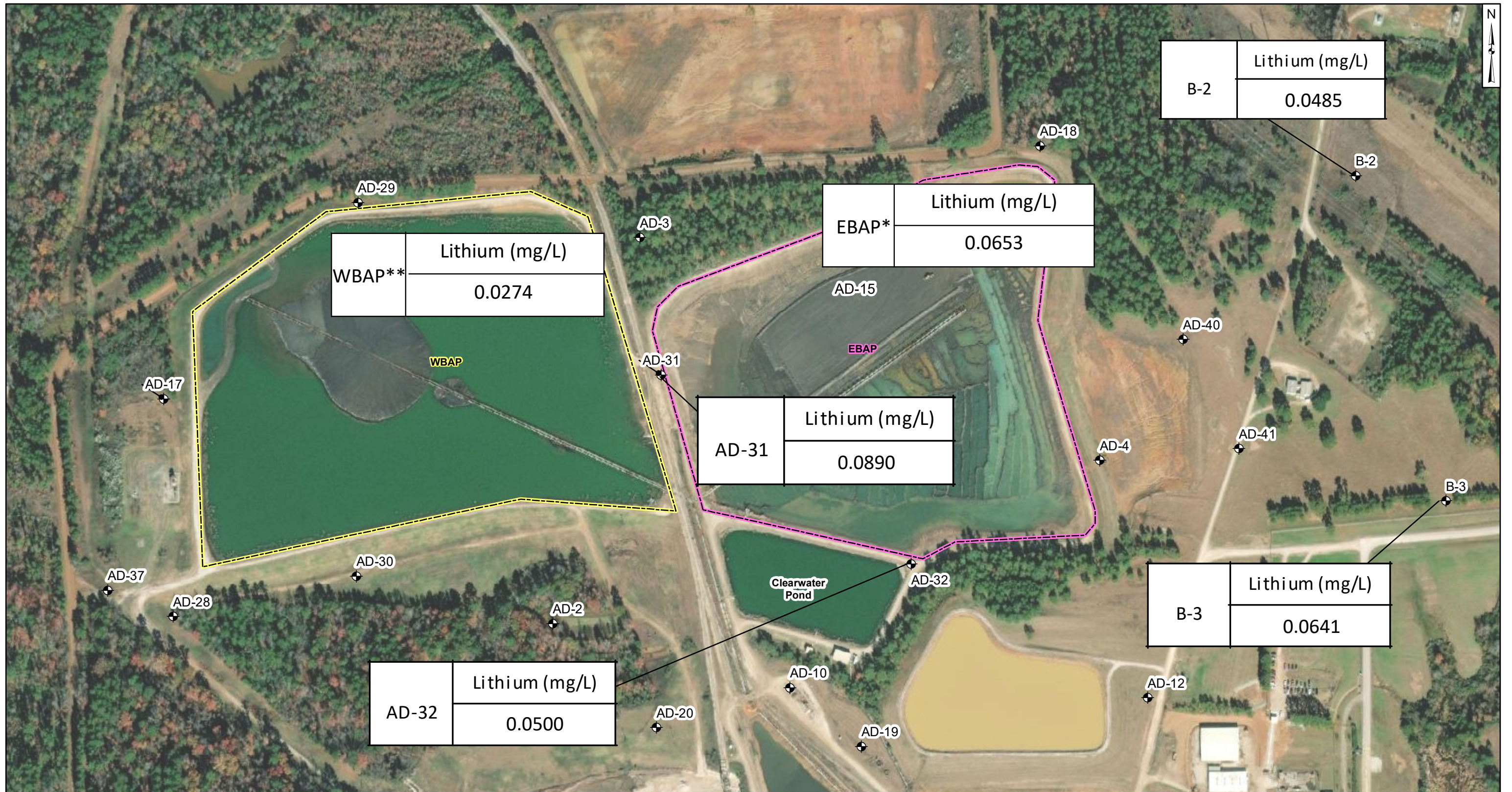
Geosyntec
 consultants

Columbus, Ohio

October 2023

Figure

4



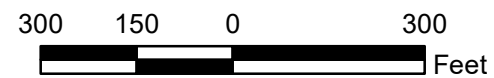
Legend

- ◆ Monitoring Well
- ▭ EBAP
- ▭ WBAP

Notes

1. Lithium concentrations in milligrams per liter (mg/L).
2. Monitoring well coordinates, site features, and data provided by AEP.
3. Groundwater samples were collected in June 2023.
4. *: Porewater sample from East Bottom Ash Pond (EBAP) was collected in February 2023.
5. **: Porewater sample from West Bottom Ash Pond (WBAP) was collected in 2022.

AEP: American Electric Power



Aqueous Lithium Distribution

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

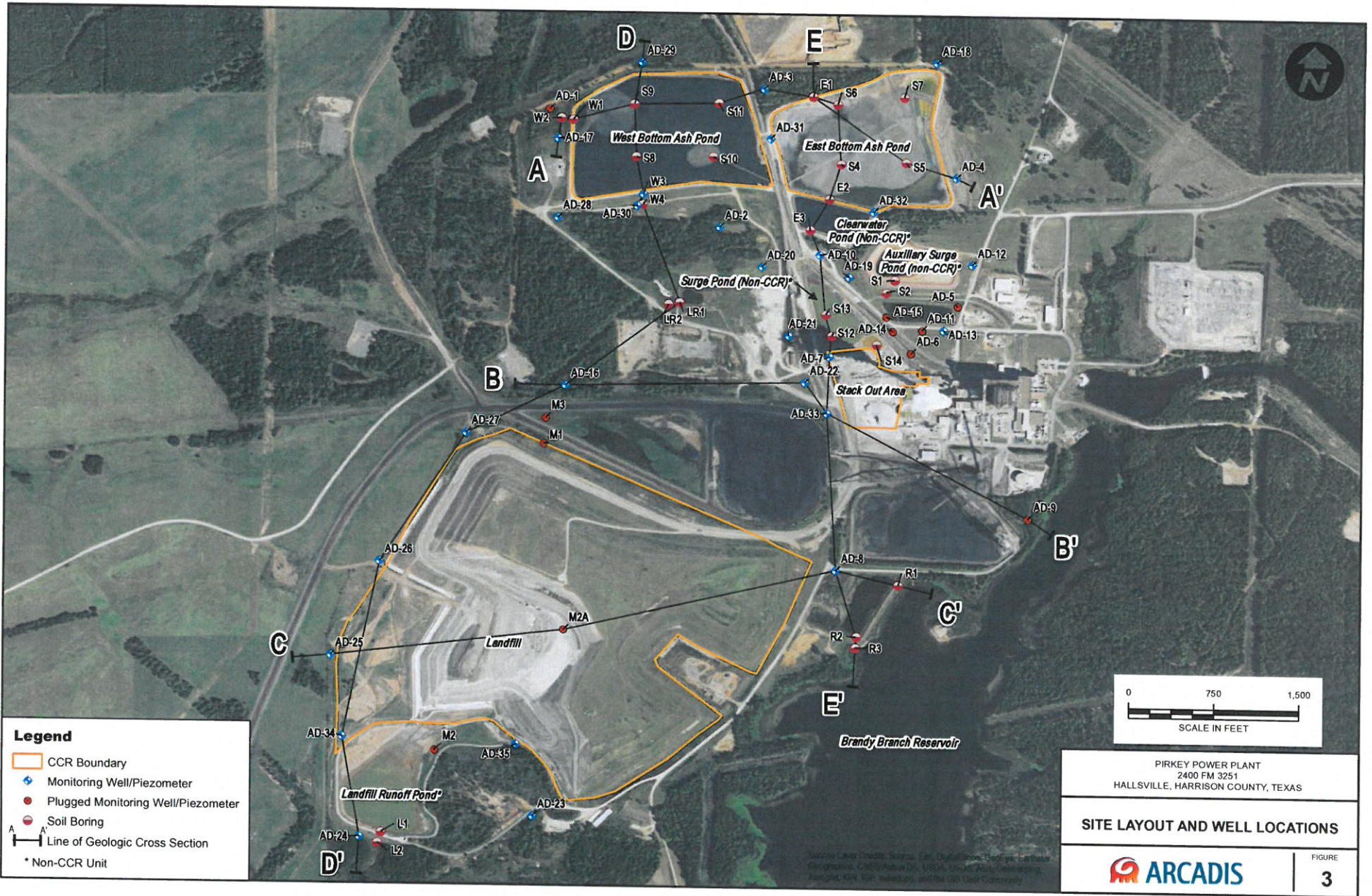
Columbus, Ohio

2023/10/02

Figure
5

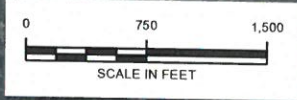
ATTACHMENT A

Geologic Cross Section A-A'



Legend

- CCR Boundary
- ◆ Monitoring Well/Piezometer
- Plugged Monitoring Well/Piezometer
- Soil Boring
- Line of Geologic Cross Section
- * Non-CCR Unit

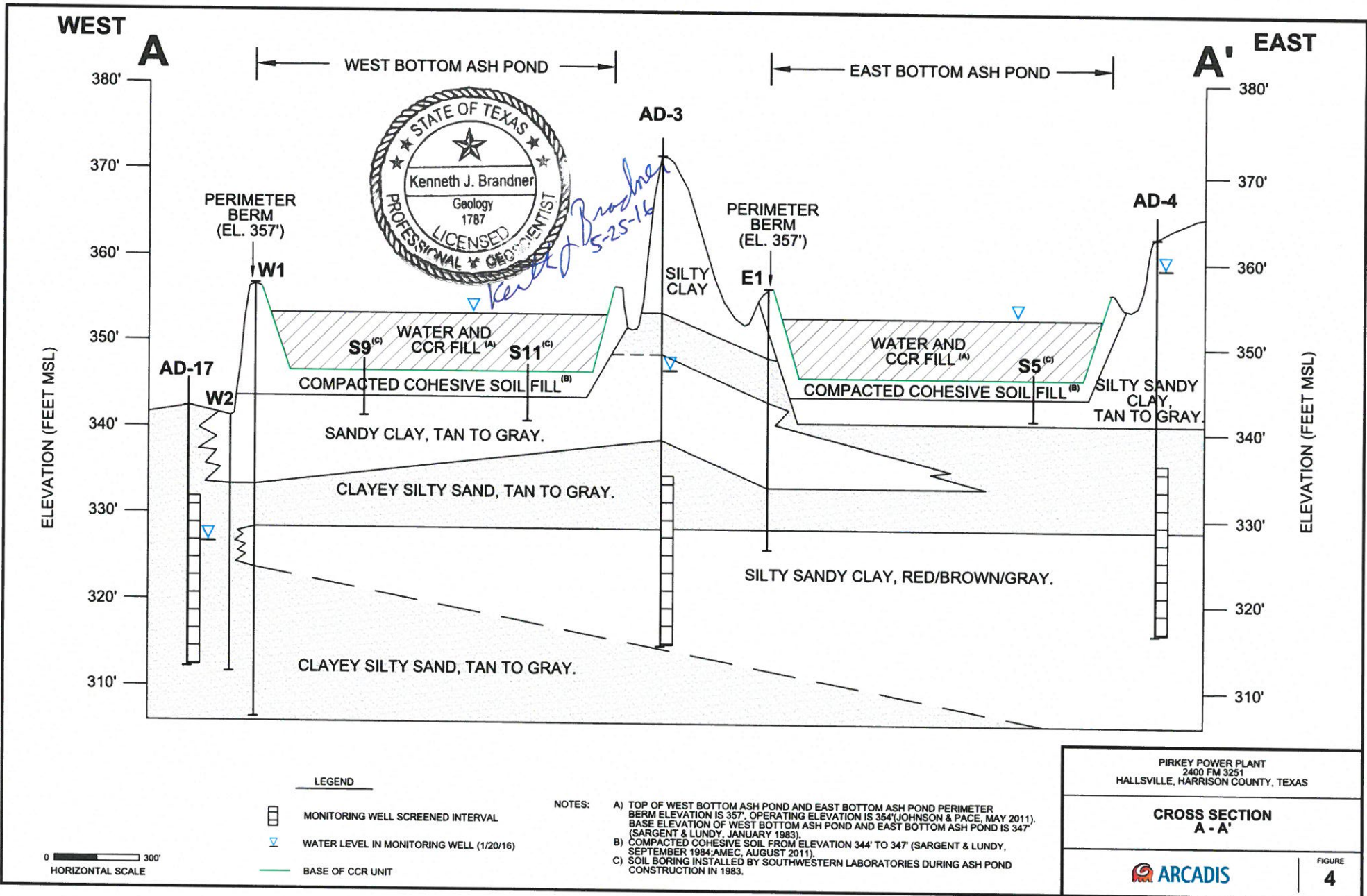


PIRKEY POWER PLANT
 2400 FM 3251
 HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

FIGURE
3

CITY: DFW GROUP; DR: LD; AM: PD; TM: TR: LYRON-M-2016-REF; PIRKEY POWER PLANT; 2016 REPORT; WEST BOTTOM ASH POND LOCATION; HARRISON COUNTY, TEXAS; CROSS SECTION A-A; LAYOUT; MODEL: 2192016.218 PM; ACADVER: 19.16 (LMS TECH); PAGESETUP: - PLOTSTYLETABLE; PLOTTED: 2/22/2016 11:17 AM; BY: LEASE, DANA



ATTACHMENT B

SB-2 Boring Log

PROJECT NO. _____ PROJ. _____ BOR. NO. SB-2
 LOCATION AD-2/MW-2-Pitney Power Plant ELEV. _____ DATE 4/20/20

SILTS & SANDS		COHESIVE SOILS - CLAYS			COLORS		MATERIALS		SAND ADI.	CHARACTERISTICS
CONDITION		CONSISTENCY	PENETROMETER	N - VALUE	Li ... Light ... Br ... Brown	Cl ... Clay, Clayey	F ... Fine	Calc ... Calcareous		
VLo ... Very Loose	0-4	Vso... Very Soft	0 - 0.25	< 2	Dk ... Dark ... Bk ... Black	Si ... Silt, Silty	M ... Medium	Lig ... Lignite		
Lo ... Loose	4-10	So... Soft	0.25 - 0.5	2 - 4	G ... Grey ... Bl ... Blue	Sa ... Sand, Sandy	Co ... Coarse	Org ... Organic		
MDe ... Med. Dense	10-30	Mst. Stiff	0.5 - 1.0	4 - 8	T ... Tan ... Gr ... Green	Ls ... Limestone	Si ... Silty	Lam ... Laminate		
De ... Dense	30-50	St... Stiff	1.0 - 2.0	8 - 15	R ... Red ... Y ... Yellow	Gr ... Gravel	SS ... Siltstone	SlS ... Slickensided		
VDe ... Very Dense	>50	VSt... Very Stiff	2.0 - 4.0	15 - 30	Rdish.Reddish.Wh ... White	SS ... Sandstone	Sh ... Shale, Shaley	SL ... Slightly		
		H... Hard	> 4.0	>30				Sm(s) ... Seam(s)		
								Nod ... Nodules		

Sample Interval FEET ASSIGNMENT	S-A-M-P-L-E-N-O. RECOVERY	DEPTH FT.	SAMPLES	STRATUM DESCRIPTION					STANDARD PENETROMETER			UNIFIED SOIL CLASSIFICATION	N - VALUE OR HAND PENETROMETER	
				CONDITION OR CONSISTENCY	COLOR	MINOR MATERIALS OR ADJECTIVES	PREDOMINATE MATERIAL	CHARACTERISTICS OR MODIFICATIONS	SEAT - 6"	1st - 6"	2nd - 6"			
SM 8' CI 14.5'		0-5	2' Rec	0-8'	Br, Lt. Rd Br	Si	Sa	Silty Sand - trace clay, trace root hairs, moist					moist (0-5)	
		5-10	2.5' Rec		Lt. Rd Br			- thin lenses (less than 1/4") at 7.5', trace iron staining					moist (5-10)	
		10-15	4' Rec	8-14.5	Lt. Rd Br, Br, Gray	Sa, Si	Cl	Clayey sand in interbeds to 14.5', trace iron ore gravel in sand seams @ 10.5', 12', 12.5'					moist (10-15)	
		15-20	2' Rec	14.5-39'	Lt. Br, Ylw. Br, Gray	Si, Cl	Sa	silty sand - some sandwicks, iron cemented sands @ 16.5' and ironstone @ 1.5"					v. moist to moist (15-20)	
		20-25	* No Rec.					- cemented sand seams in silty sand @ 20-25'					v. moist (20-25)	
		25-30	2.5' Rec		Gray - dk Gray, dk. Br			- gravel & cemented sand seam @ 25' (6")					sat. @ 25'-25.5'	
					(25-39')			- clayey silty sand @ 25.5' - dark gray silty sat sand seam @ 27" e 27"					moist 25.5-27 sat @ 27'0" (2")	
		30-35	3' Rec					- sat. silty sand seam @ 30.5' (1") - sat. silty sand seam @ 32' (3")					sat @ 30.5' (1") 32.0' (3")	
								* some u.f. gypsum crystals in clayey sand between sat. sand seams (25-40')					v. moist to moist (4 39')	
		35-40	4' Rec	39-40	Lt. Gray, Gray	Cl, Si	Si	clayey sandy silt - interbedded silt & clay @ 39' to 40'					moist (39-40)	
								S.O.T. @ 40'						
								* 25-27' collected @ 1015						
								* 31-33' collected @ 1035						

Type HSA Dry Auger Rotary Wash
 SEEPAGE @ 25 FT. WHILE DRILLING, W.L. @ _____ FT. ON COMPL. (OR) BAILED TO _____ FT. UPON COMPLETION.
 W.L. @ _____ FT AND CAVED TO _____ FT. ON _____

* GPS: 32,46522, -94,49032 (12' E, 3.5' N) of AD-2/MW-2

ATTACHMENT C

SB-2 Boring Photographic Log

GEOSYNTEC CONSULTANTS
Photographic Record



Client: AEP

Project Number: CHA8495

Site Name: Pirkey East Bottom Ash Pond

Site Location: Hallsville, Texas

Photograph 1

Date: 4/21/2020

Direction: N/A

Comments:
0-5 foot interval of SB-2.

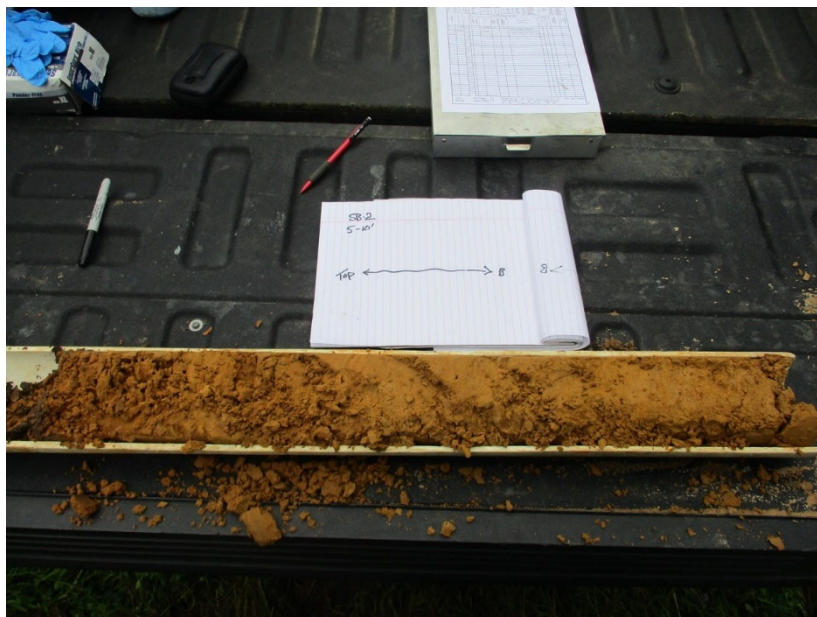


Photograph 2

Date: 4/21/2020

Direction: N/A

Comments:
5-10 foot interval of SB-2.



GEOSYNTEC CONSULTANTS
Photographic Record



Client: AEP

Project Number: CHA8495

Site Name: Pirkey East Bottom Ash Pond

Site Location: Hallsville, Texas

Photograph 3

Date: 4/21/2020

Direction: N/A

Comments:
10-15 foot interval of SB-2.



Photograph 4

Date: 4/21/2020

Direction: N/A

Comments:
15-20 foot interval of SB-2. Recovery of this interval was limited.



GEOSYNTEC CONSULTANTS
Photographic Record



Client: AEP

Project Number: CHA8495

Site Name: Pirkey East Bottom Ash Pond

Site Location: Hallsville, Texas

Photograph 5

Date: 4/21/2020

Direction: N/A

Comments:
20-25 foot interval of SB-2. Recovery of this interval was limited.

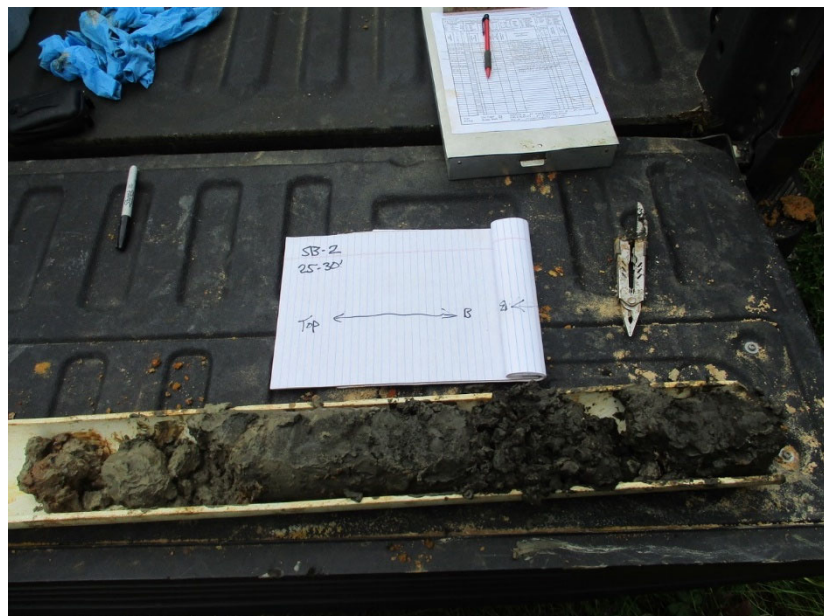


Photograph 6

Date: 4/21/2020

Direction: N/A

Comments:
25-30 foot interval of SB-2. Very little of this interval was recovered. A color change was observed from red to dark brown/black. A sample was collected from this interval.



GEOSYNTEC CONSULTANTS
Photographic Record



Client: AEP

Project Number: CHA8495

Site Name: Pirkey East Bottom Ash Pond

Site Location: Hallsville, Texas

Photograph 9

Date: 4/21/2020

Direction: N/A

Comments:
30-35 foot interval of SB-2. Very little of this interval was recovered.. A sample was collected from this interval.



Photograph 10

Date: 4/21/2020

Direction: N/A

Comments:
35-40 foot interval of SB-2



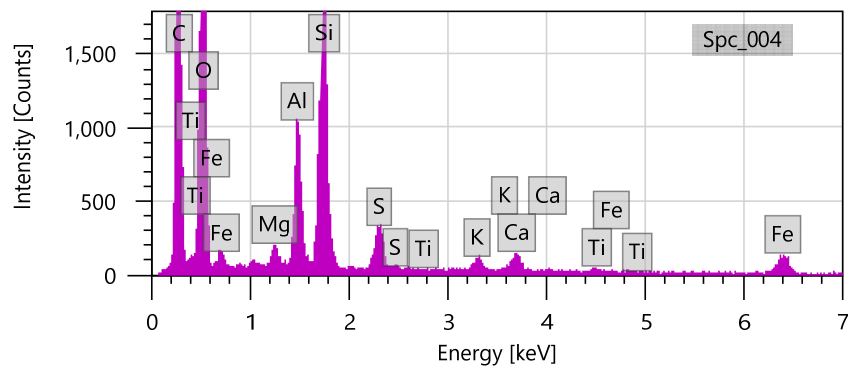
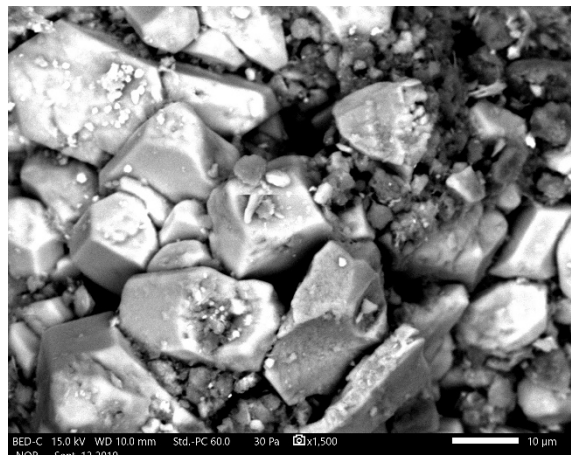
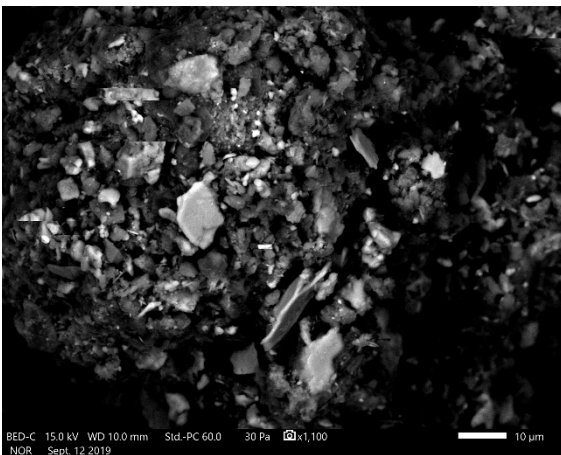
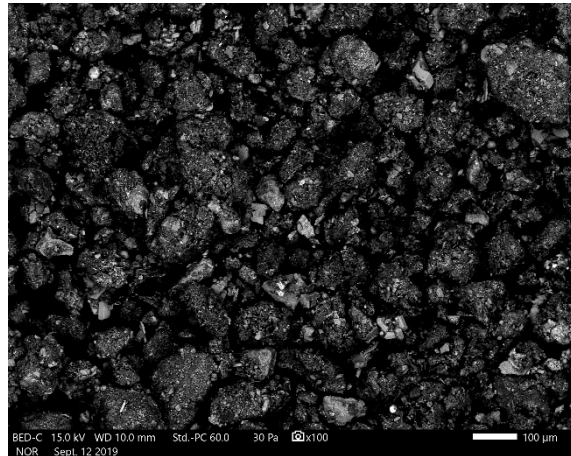
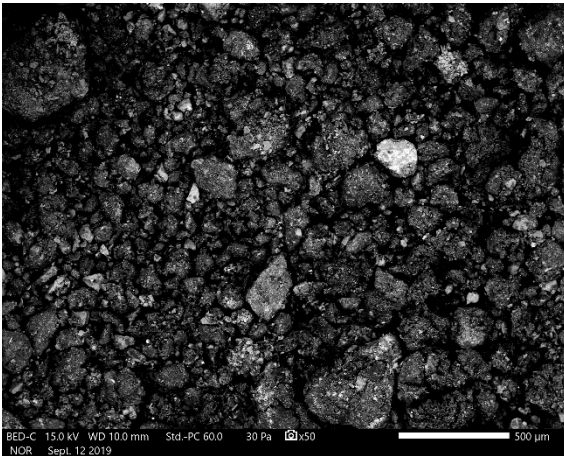
ATTACHMENT D

SEM/EDS Analysis

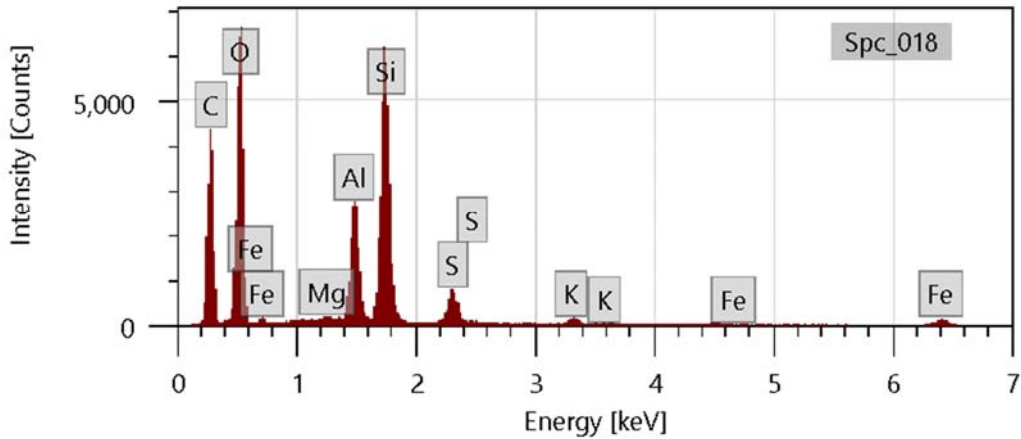
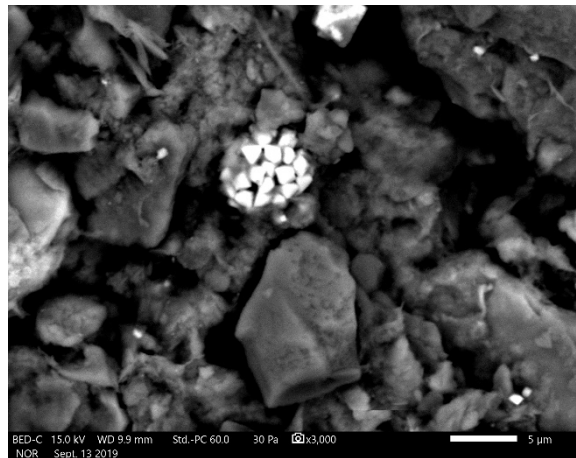
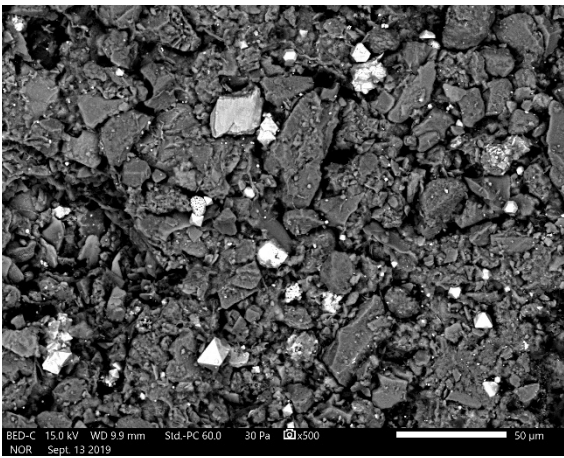
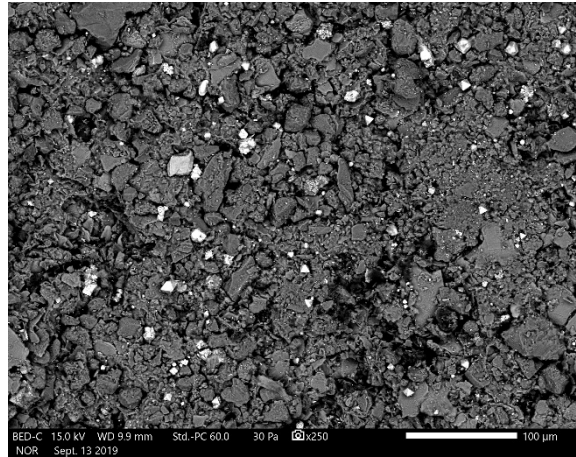
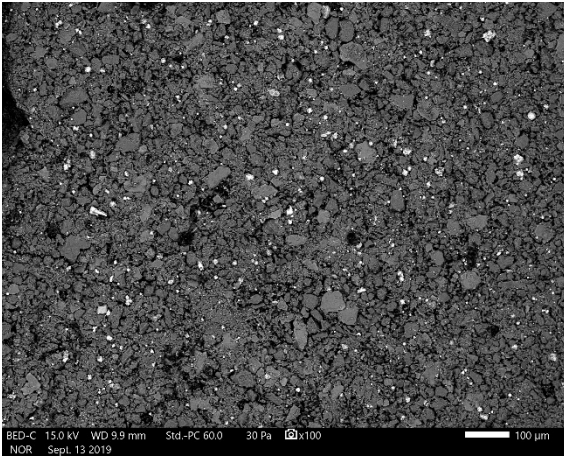
September 16, 2019

Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221

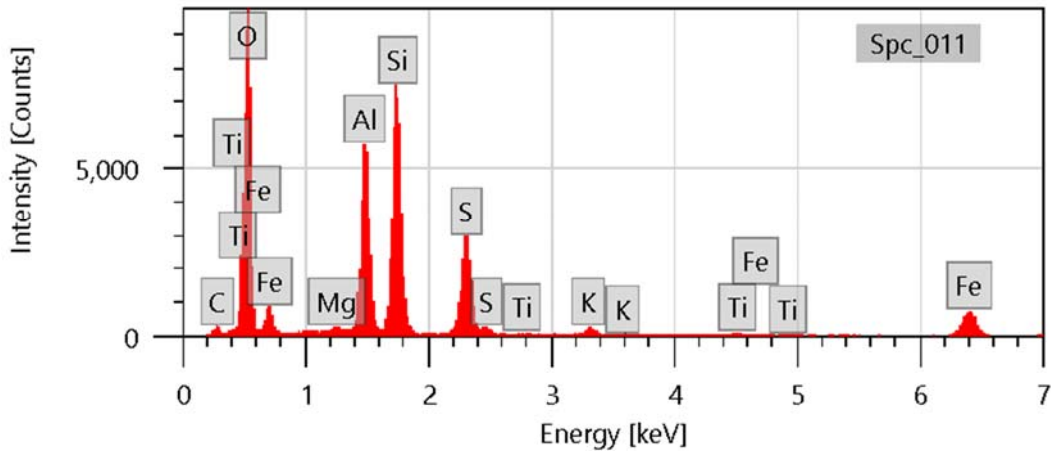
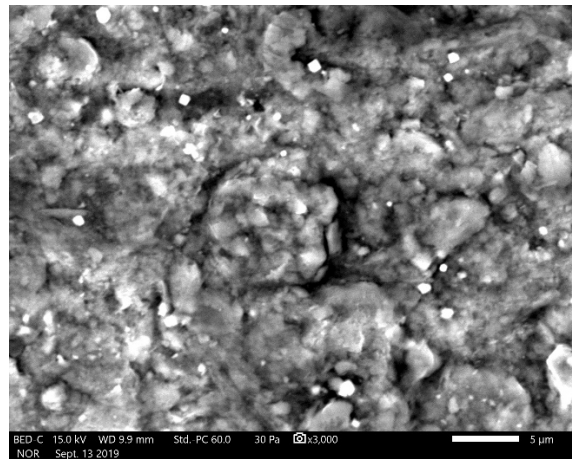
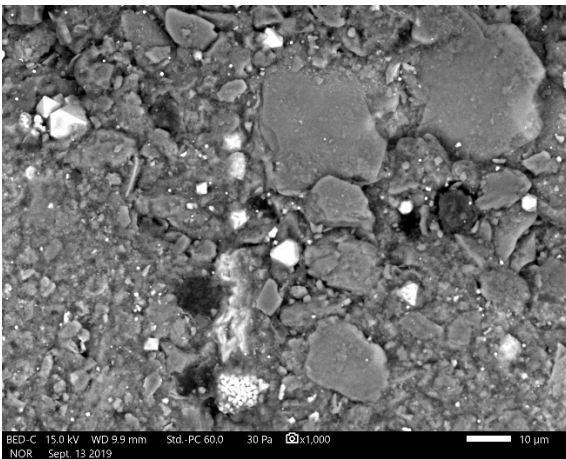
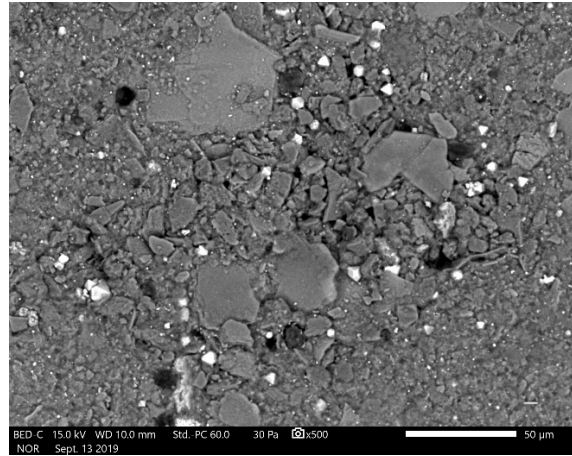
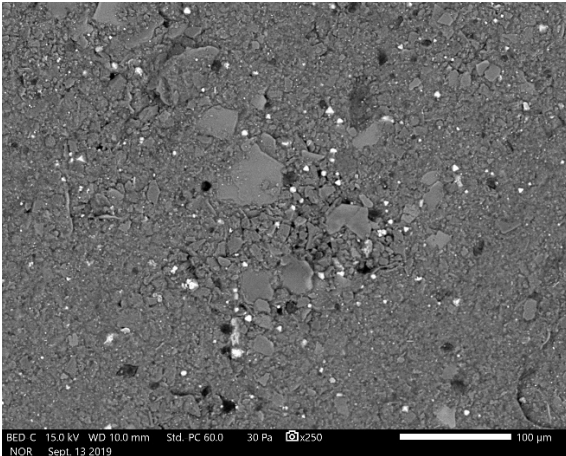
via Email: BSass@geosyntec.com



Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.



Sample VAP B3 40-45. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 500X. Bright particles are pyrite (framboid in bottom right micrograph). Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.



Sample VAP B3 50-55. Backscattered electron micrographs show the sample at 250X, 500X, 1000X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 3000X. Bright particles are mostly pyrite (framboid in bottom left micrograph); occasional particles of Fe-Ti oxide are detected. Major peaks for oxygen, silicon, and aluminum suggest clay. Large blocky particles are mostly quartz, feldspar, and clay.

ATTACHMENT E

Certification by a Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

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

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

October 16, 2023
Date