

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

**H.W. Pirkey Power Plant
East Bottom Ash Pond
Hallsville, Texas**

Submitted to



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LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SPLP	Synthetic Precipitation Leaching Profile
SSL	Statistically Significant Level
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
VAP	Vertical Aquifer Profiling
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 cobalt and lithium in the groundwater monitoring network at the H.W. Pirkey Plant East Bottom Ash Pond (EBAP), located in Hallsville, Texas, following the first semi-annual assessment monitoring event of 2021. The EBAP is registered as a surface impoundment 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 EBAP (**Figure 1**). In May 2021, a semi-annual assessment monitoring event was conducted at the EBAP 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 the United States Environmental Protection Agency's (USEPA's) *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 the Appendix IV parameters at the compliance wells to assess whether these parameters were present at a statistically significant level (SSL) above the 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, 2021a):

- The LCLs for cobalt exceeded the GWPS of 0.0094 mg/L at AD-2 (0.0100 mg/L), AD-31 (0.00960 mg/L), and AD-32 (0.025 mg/L).
- The LCL for lithium exceeded the GWPS of 0.0590 mg/L at AD-31 (0.0669 mg/L) and AD-32 (0.0789 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 cobalt and lithium 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 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 cobalt and lithium were based on a Type IV cause and not by a release from the Pirkey EBAP.

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 cobalt and lithium and the proposed alternative sources 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 cobalt and lithium 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 the underlying geology, which is a Type IV (natural variation) issue.

2.1.1 Cobalt

Previous ASDs for cobalt at the EBAP provided evidence that cobalt is present in the aquifer media at the site and that the observed cobalt concentrations were due to natural variation (Geosyntec, 2019a; Geosyntec, 2019b; Geosyntec, 2020b; Geosyntec, 2020c; Geosyntec 2021b). The previous ASDs discussed how the EBAP did not appear to be 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 SPLP ash leachate above the reporting limit of 0.01 mg/L, which is lower than the average concentrations observed at the wells of interest (**Table 1**).

Surface water samples were previously collected from the EBAP and West Bottom Ash Pond (WBAP) to characterize the total cobalt concentrations. The EBAP and WBAP receive the same process water, with the use of each pond dependent on available freeboard and cleaning schedule; thus, there is a basis for the equivalency between these two surface water samples. Cobalt was detected in a sample collected on June 2, 2020 from the EBAP at an estimated concentration of 0.000080 mg/L (**Table 1**). Cobalt was detected at a concentration of 0.000501 mg/L in a sample collected from the WBAP on November 4, 2020 (**Table 1**). No changes to material handling or plant operations have occurred which would change the anticipated cobalt concentrations in the ponds since these samples were collected. These concentrations are lower than all reported cobalt concentrations for in network wells from the most recent sampling event and over an order of magnitude lower than the average concentration in groundwater at the wells of interest (**Table 1**; **Figure 2**). Thus, the EBAP is not the likely source of cobalt at AD-2, AD-31, and 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 varying concentrations. 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 A**. Cobalt was detected at SB-2 at concentrations of 9.45 milligrams per kilogram (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 (**Table 1**). Both samples correlate to the depth of the monitoring well screen of AD-2 (20-40 feet bgs), indicating that cobalt is present in aquifer solids within the AD-2 screened interval. Cobalt was also identified in the aquifer solids at varying concentrations at other locations throughout the site, with the highest value of 23.5 mg/kg reported at AD-41, which is upgradient of the EBAP (**Figure 3**).

In addition to total cobalt, soil samples were submitted for mineralogical analysis to evaluate the presence of cobalt-containing minerals. 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 aquifer solids at SB-2 are distinctly red in color at shallow depths, as illustrated in the photolog of soil cores provided in **Attachment B**. 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 weathering of pyrite to goethite 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 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, an existing well within the EBAP groundwater monitoring network. Solid phases 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 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 involving iron and sulfur were identified in the EDS spectrum, which further support the identification of pyrite (**Attachment C**). While cobalt was not identified in the EDS spectrum, it is likely present at concentrations below the detection limit.

Naturally occurring cobalt is known to substitute for iron in pyrite. The presence of pyrite has been confirmed at AD-2 and across the Site. This suggests that pyrite, and the weathering of pyritic minerals, may be providing a source for aqueous cobalt in groundwater. Additionally, the pond 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.

2.1.2 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. These native lithium-containing aquifer solids are ubiquitous in the aquifer based on the presence of lithium at upgradient locations and in the solid phase (Geosyntec, 2019b; Geosyntec, 2020b; Geosyntec, 2020c; Geosyntec, 2021b). Data gathered in support of the prior ASDs and recent results provide additional evidence that the observed lithium concentrations at AD-31 and AD-32 are due to natural variation in the aquifer (Type IV ASD).

As discussed in Section 2.1.1, surface water samples were collected directly from the EBAP and WBAP. Lithium was detected in the June 2, 2020 EBAP sample at a concentration of 0.0295 mg/L, which is comparable to the concentration of 0.0274 mg/L reported for the WBAP water on November 4, 2020 (**Table 4**). The mobile fraction identified in the bottom ash by SPLP was even lower, with an estimated lithium concentration of 0.011 mg/L. These concentrations are lower than the average lithium concentrations at AD-31 (0.0841 mg/L) and AD-32 (0.1344 mg/L) (**Table 4**). Thus, the EBAP is not the source of lithium at AD-31 and AD-32.

Groundwater samples collected from upgradient wells B-2 and B-3 in May 2021 had total lithium concentrations of 0.0449 mg/L and 0.0627 mg/L, respectively; the reported concentration at B-3 is above the GWPS of 0.0590 mg/L (**Figure 5**). Because B-2 and B-3 were installed at locations upgradient to and unimpacted by site activities, their lithium concentrations suggest that 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 2.1.1, 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**).

2.1.2.1 Calculated Partition Coefficients

A previous ASD for lithium at the EBAP developed a proposed lithium mobility in groundwater due to desorption from clay minerals associated with 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**). These clay minerals, particularly smectite and illite, are known to retain positively charged ions such as lithium via cation exchange processes. SEM/EDS analysis identified the presence of silicon, aluminum and oxygen, all of which are indicative of clay minerals (**Attachment A**). 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.

Total metal concentrations in the solid materials separated from the groundwater samples during filtration and the filtered groundwater concentrations were used to calculate partition coefficients values (K_d) for lithium, potassium, and sodium. 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. Since the site-specific K_d values were calculated, lithium concentrations at the wells of interest have remained consistent, suggesting that this cation exchange mechanism is still controlling lithium groundwater concentrations (**Figure 6**).

These multiple lines of evidence show that elevated lithium concentrations at AD-31 and AD-32 are 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.

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 EBAP, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semiannual 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 for cobalt and lithium identified during assessment monitoring in May 2021 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 D**.

SECTION 4

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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	6/2/2020	mg/L	0.000080
WBAP Pond Water	11/4/2020	mg/L	0.000501
AD-2 - Average	May 2016 - May 2021	mg/L	0.0136
AD-31 - Average	May 2016 - May 2021	mg/L	0.0126
AD-32 - Average	May 2016 - May 2021	mg/L	0.0465

Notes:

mg/kg - milligram per kilogram

mg/L - milligram per liter

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

A sample was collected from the WBAP on 11/4/2020 as a surrogate for the EBAP, as the EBAP did not contain free water. The same process water is stored in both the WBAP or EBAP.

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

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:

mg/kg- milligram per kilogram

ft bgs - feet below ground surface

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.

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

**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:

ND: Not detected

VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

**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	6/2/2020	mg/L	0.0295
WBAP Pond Water	11/4/2020	mg/L	0.0274
AD-31 - Average	May 2016 - May 2021	mg/L	0.0841
AD-32 - Average	May 2016 - May 2021	mg/L	0.1344

Notes:

mg/kg - milligram per kilogram

mg/L - milligram per liter

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

A sample was collected from the WBAP on 11/4/2020 as a surrogate for the EBAP, as the EBAP did not contain free water. The same process water is stored in both the WBAP or EBAP.

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

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

Location ID	Sample Depth (ft bgs)	Lithium (mg/kg)
Bulk Soil Samples		
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:

J - estimated value

mg/kg- milligram per kilogram

ft bgs - feet below ground surface

For AD-32, 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-X locations were collected from cores removed from the borehole during well lithology logging.

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

VAP - vertical aquifer profiling

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

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:

mg/L: milligrams per liter

mg/kg: milligrams per kilogram

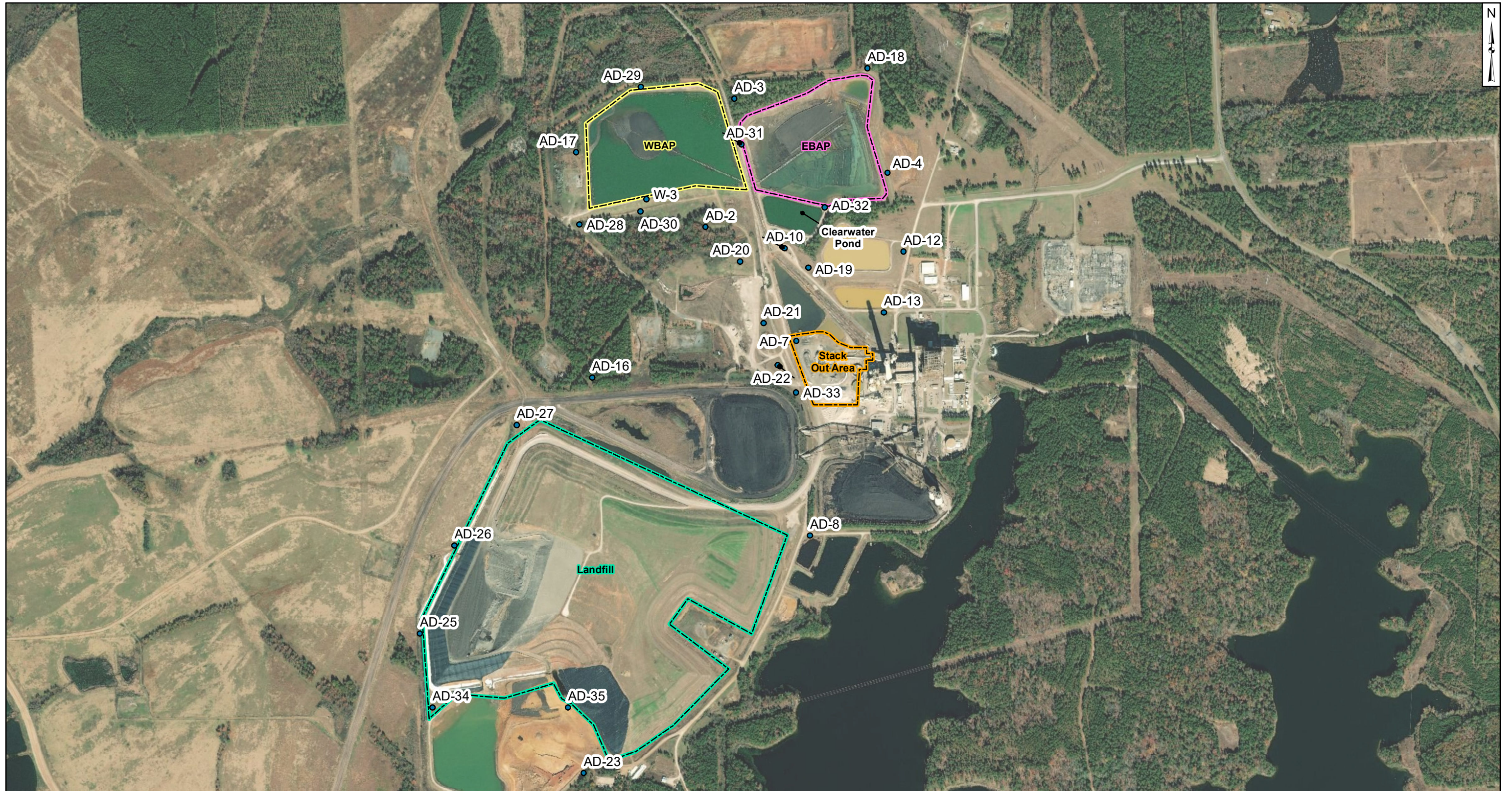
L/kg: liters per kilogram

Kd: partition coefficient

Adsorbed values are total metals concentrations reported by USEPA Method 6010B.

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).

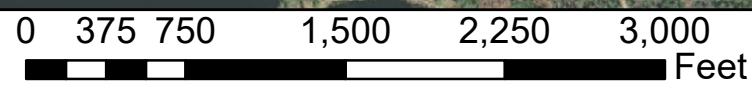
FIGURES



Legend

- Monitoring Wells
- EBAP
- Landfill
- Stack Out Area
- WBAP

Notes
 - Monitoring well coordinates provided by AEP.
 - Data provided by AEP, 2019



Site Layout

AEP Pirkey Power Plant
 Hallsville, Texas

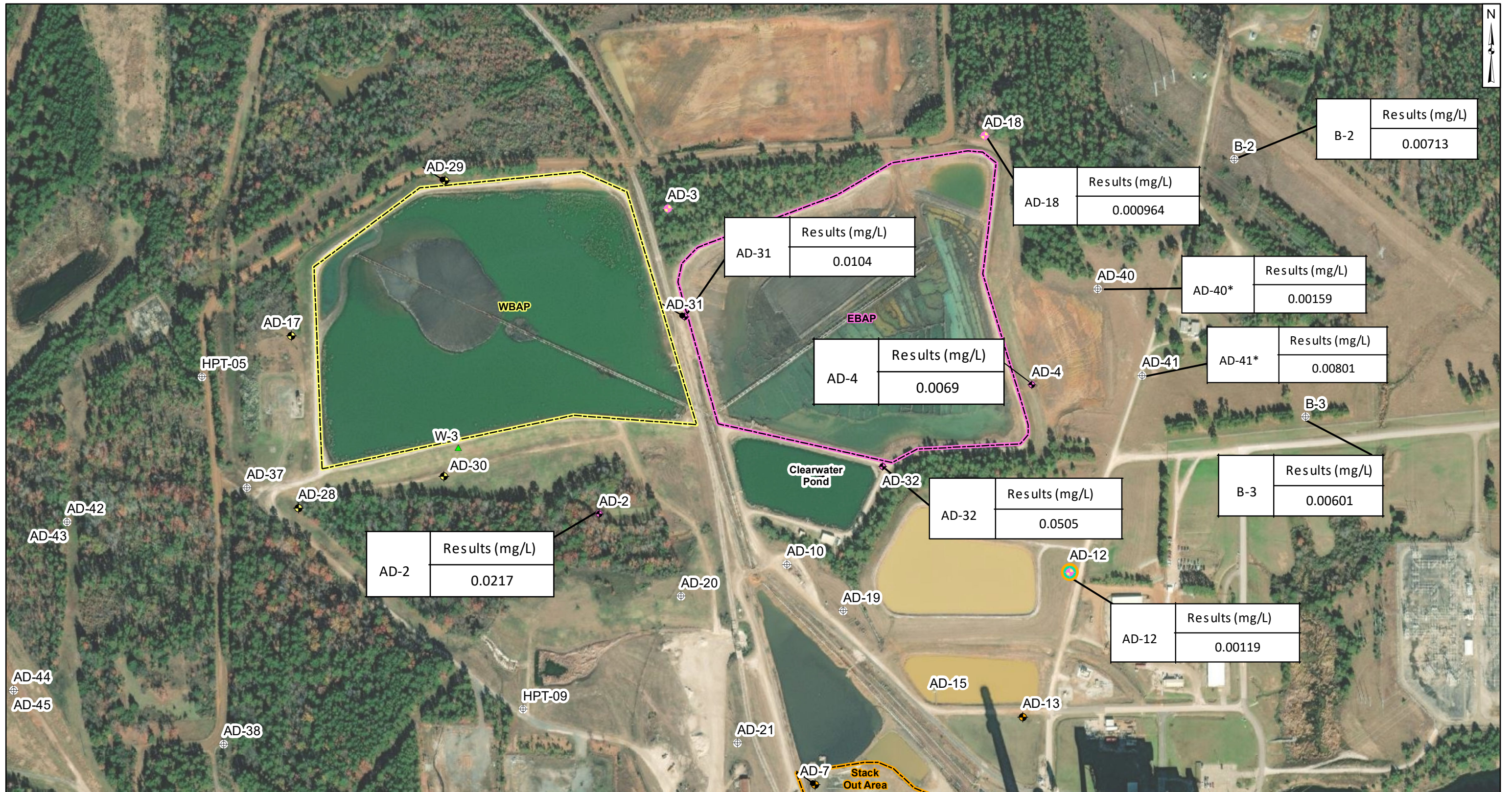
Geosyntec
 consultants

Columbus, Ohio

2020/03/24

Figure

1



Legend

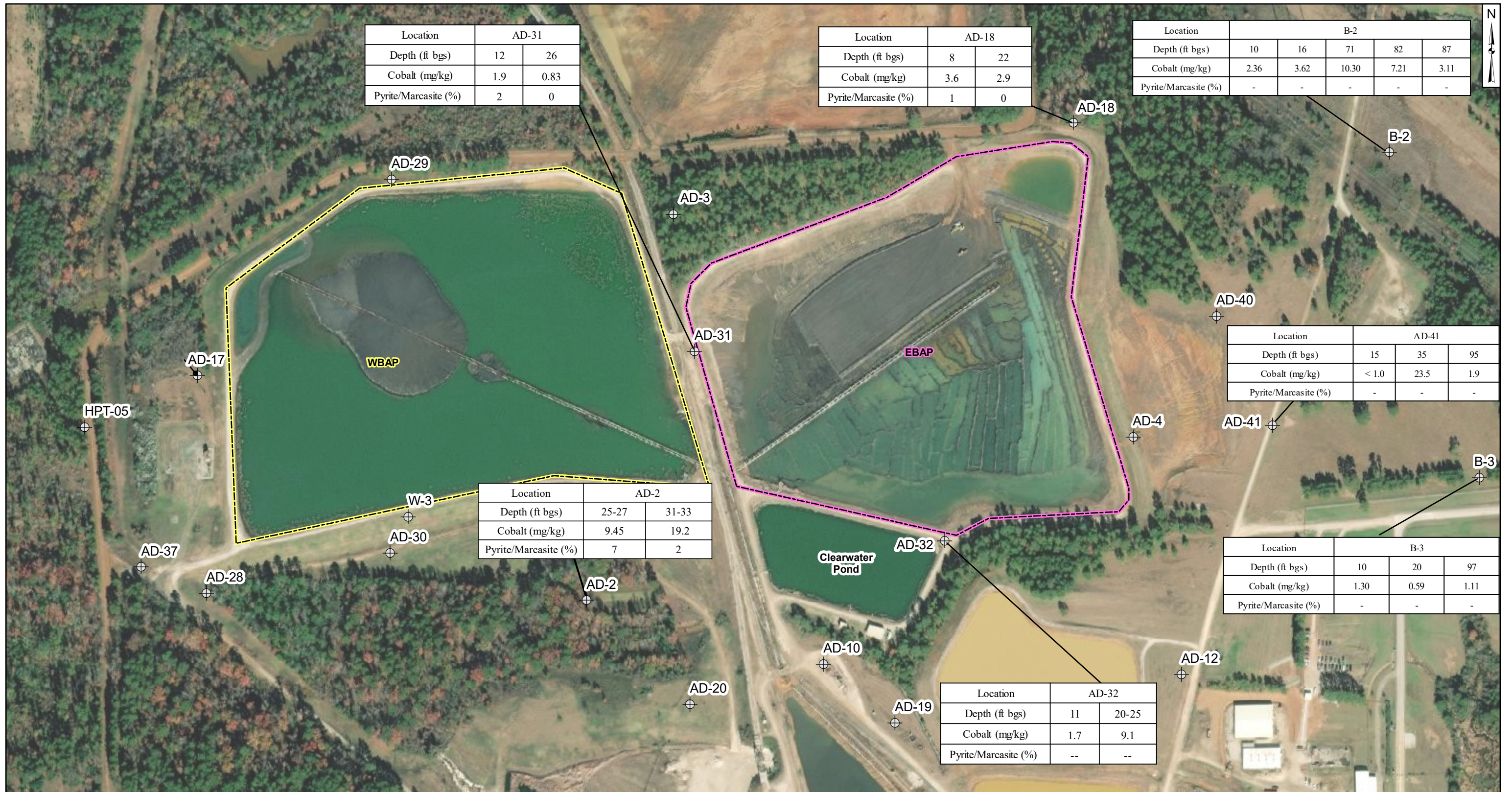
⊕ Out of Network	◆ Stackout Area	▭ EBAP
◆ EBAP	◆ EBAP and WBAP	▭ Stack Out Area
◆ WBAP	⊕ All CCR Unit Networks	▭ WBAP
◆ Landfill	▲ Piezometer	

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- AD-15 location is approximated
- Samples collected in May 2021
- * - Well most recently sampled August 2019



Cobalt Distribution in Groundwater	
AEP Pirkey Power Plant Hallsville, Texas	
Geosyntec consultants	
Columbus, Ohio	2021/10/27
Figure 2	



Location	AD-31	
Depth (ft bgs)	12	26
Cobalt (mg/kg)	1.9	0.83
Pyrite/Marcasite (%)	2	0

Location	AD-18	
Depth (ft bgs)	8	22
Cobalt (mg/kg)	3.6	2.9
Pyrite/Marcasite (%)	1	0

Location	B-2				
Depth (ft bgs)	10	16	71	82	87
Cobalt (mg/kg)	2.36	3.62	10.30	7.21	3.11
Pyrite/Marcasite (%)	-	-	-	-	-

Location	AD-2	
Depth (ft bgs)	25-27	31-33
Cobalt (mg/kg)	9.45	19.2
Pyrite/Marcasite (%)	7	2

Location	AD-41		
Depth (ft bgs)	15	35	95
Cobalt (mg/kg)	< 1.0	23.5	1.9
Pyrite/Marcasite (%)	-	-	-

Location	B-3		
Depth (ft bgs)	10	20	97
Cobalt (mg/kg)	1.30	0.59	1.11
Pyrite/Marcasite (%)	-	-	-

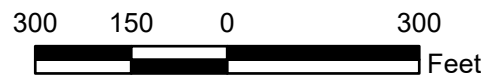
Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

Legend

- Monitoring Wells
- EBAP
- WBAP

Notes

- Monitoring well coordinates provided by AEP.
- AD-2 sample collected on April 20, 2020
- All other data provided by AEP, 2019.
- ft bgs: feet below ground surface.
- mg/kg: milligrams per kilogram.
- -- not analyzed.



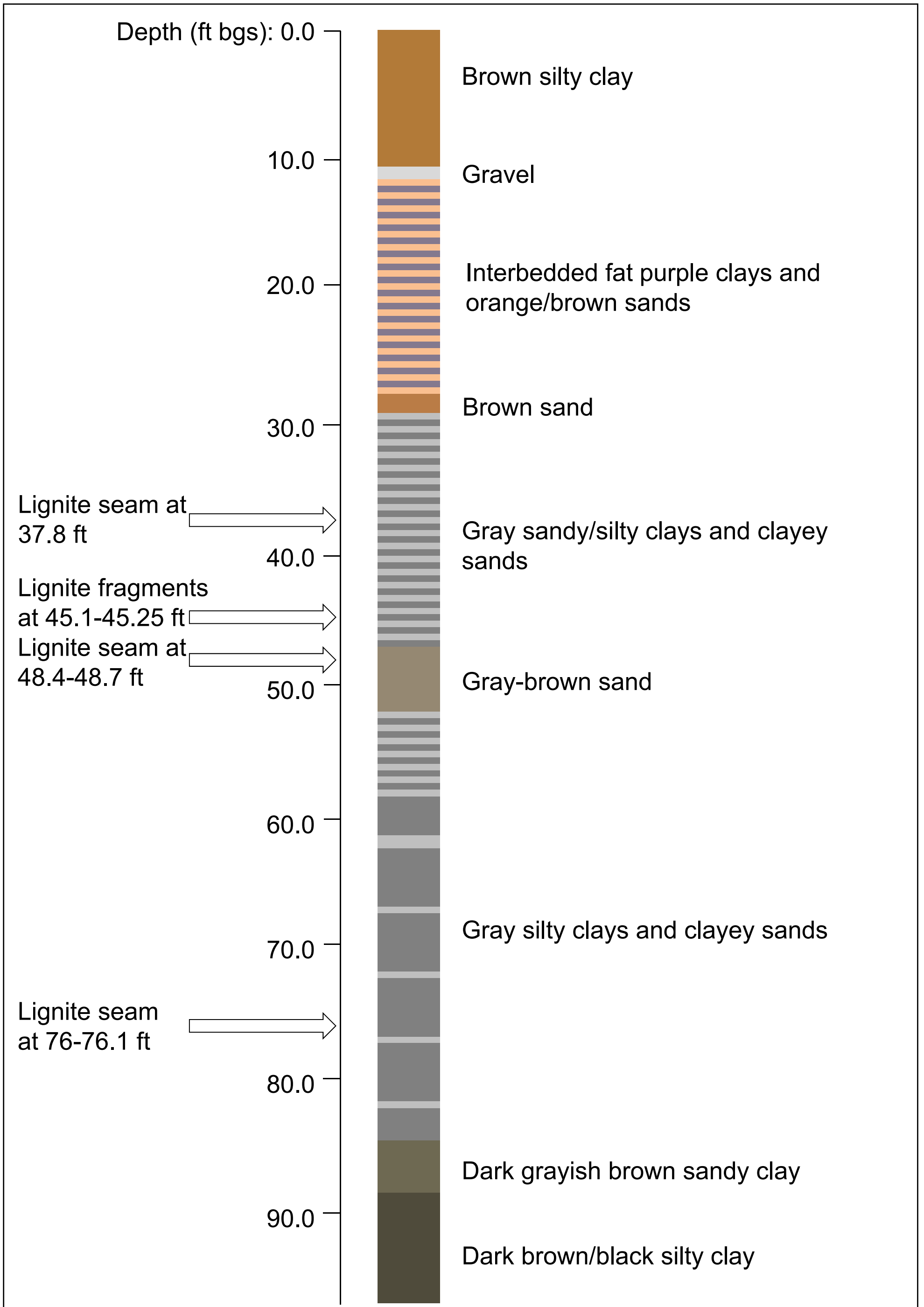
Cobalt Distribution in Soil

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio 2020/12/22

Figure 3



- Notes:
- Ft = feet
 - Bgs = below ground surface
 - Boring completed May 2019
 - Total depth of 97.5 ft bgs
 - Well installed in offset boring screened at 29-34 ft bgs

B-3 Visual Boring Log

AEP Pirkey Powerplant
Hallsville, TX

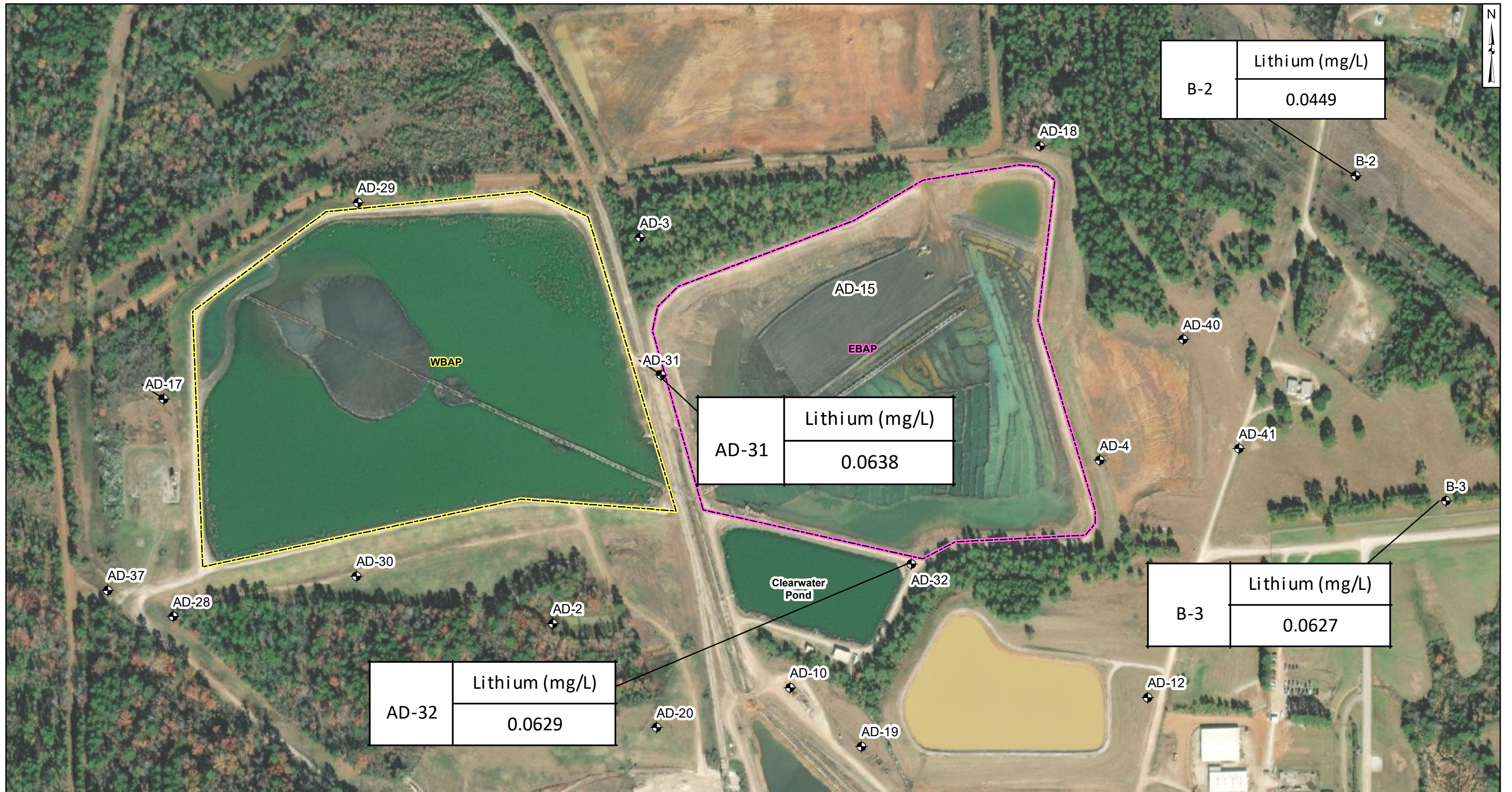
Geosyntec
consultants

Figure

4

CHA8462

March 2020

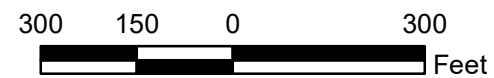


Legend

- ◆ Monitoring Well
- ▭ EBAP
- ▭ Landfill
- ▭ Stack Out Area
- ▭ WBAP

Notes

- Lithium concentrations in micrograms per liter ug/L.
- Monitoring well coordinates, site features, and data provided by AEP.
- Groundwater samples were collected in May 2021.



Lithium Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

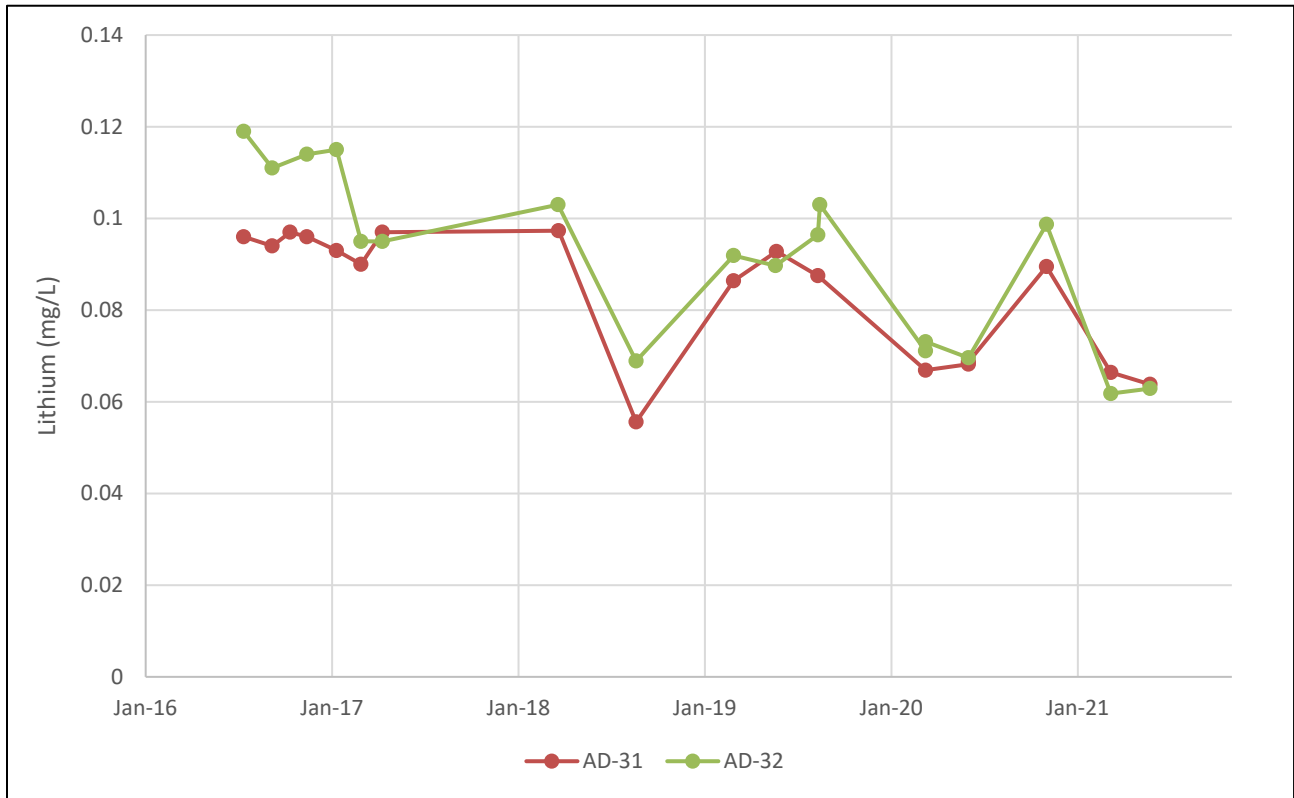
Geosyntec
consultants

Columbus, Ohio

2021/12/15

Figure

5



Notes: Lithium concentrations are shown in milligrams per liter (mg/L). An outlier lithium value reported for AD-32 on 10/12/16 was excluded from the time series graph.

Lithium Time Series Graph
Pirkey East Bottom Ash Pond



Figure

6

Columbus, Ohio

27-October-2021

ATTACHMENT A
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	0	<2	Dk ... Dark ... Bk ... Black	Si ... Silt, Silty	M ... Medium		Co ... Coarse		Lig ... Lignite	
Lo ... Loose	4-10	So ... Soft	0.25 - 0.5	2 - 4		G ... Grey ... Bl ... Blue	Sa ... Sand, Sandy	Co ... Coarse		Si ... Silty		Org ... Organic	
MDe ... Med. Dense	10-30	Mst. Stiff	0.5 - 1.0	4 - 8		T ... Tan ... Gr ... Green	Ls ... Limestone					Lam ... Laminate	
De ... Dense	30-50	St ... Stiff	1.0 - 2.0	8 - 15		R ... Red ... Y ... Yellow	Gr ... Gravel					Sl ... Slickensided	
VDe ... Very Dense	>50	VSt. Very Stiff	2.0 - 4.0	15 - 30		Rdsh. Reddish. Wh ... White	SiS ... Siltstone					SL ... Slightly	
		H ... Hard	> 4.0	>30			SS ... Sandstone					Sm(s) ... Seam(s)	
							Sh ... Shale, Shaley					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'		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)	
CI 14.5'		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'	Rd Br, Ylw, Br, Gray	Si, Cl	Sa	silty sand - some sandvicks, iron cemented sands @ 16.5' and ironstone @ 17' (1.5")					v. moist to moist (15-20)	
		20-25	* No Rec.					- cemented sand seams in silty sand @ 20-25'					v. moist (20-25)	
SC		25-30	2.5' Rec		Gray - dk Gray, dk Br			- gravel & cemented sand seam @ 25' (6") sat. @ 25'-25.5'					moist 25.5-27	
		30-35	3' Rec					- dark gray silty sat sand seam @ 27" e 27"					sat. @ 27' (2")	
		35-39	4' Rec					- sat. silty sand seam @ 30.5' (1") - sat. silty sand seam @ 32' (3") * some u.f. gypsum crystals in clayey sand between sat. sand seams (25-40')					sat. @ 30.5' (1") 32.0' (3") v. moist (to 39')	
ML		35-40	4' Rec	39-40	Lt. Gray, Gray Cl, Br	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 B
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.

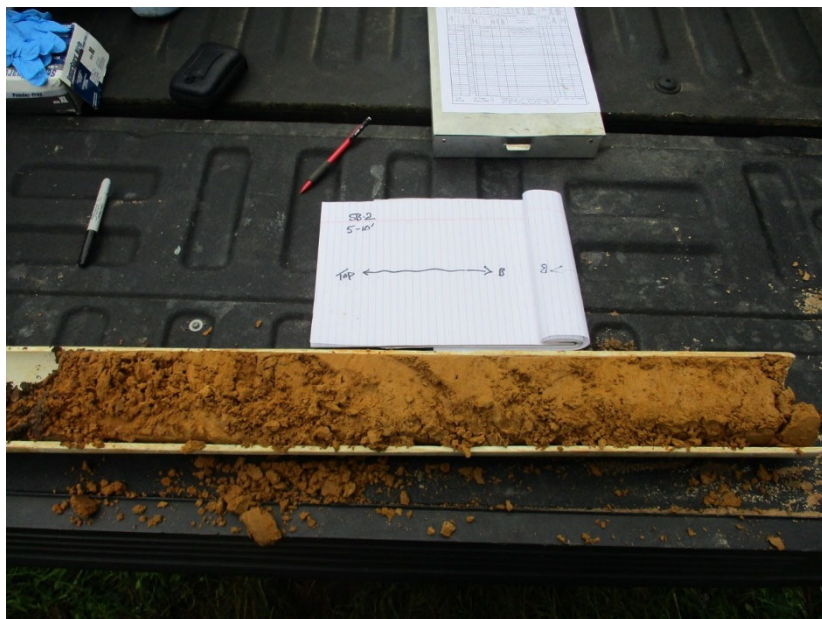


Photograph 2

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.

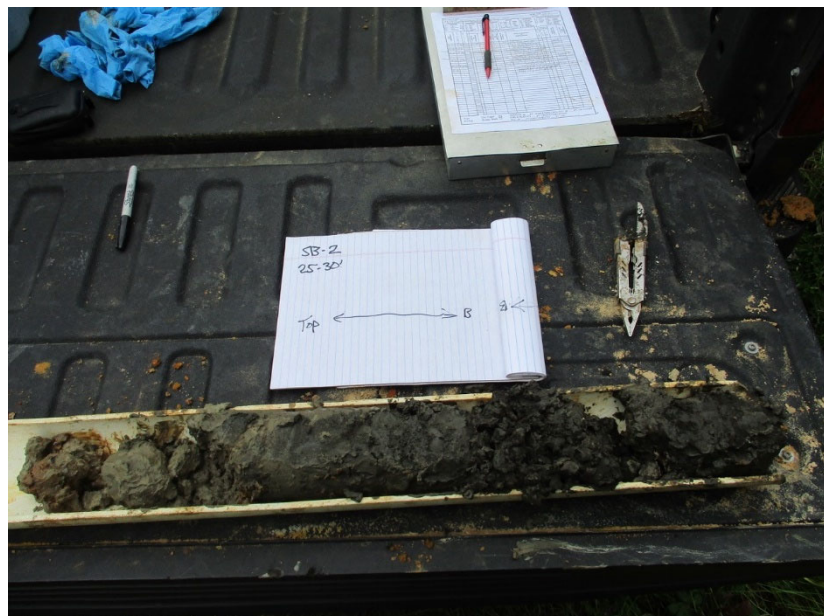


Photograph 6

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

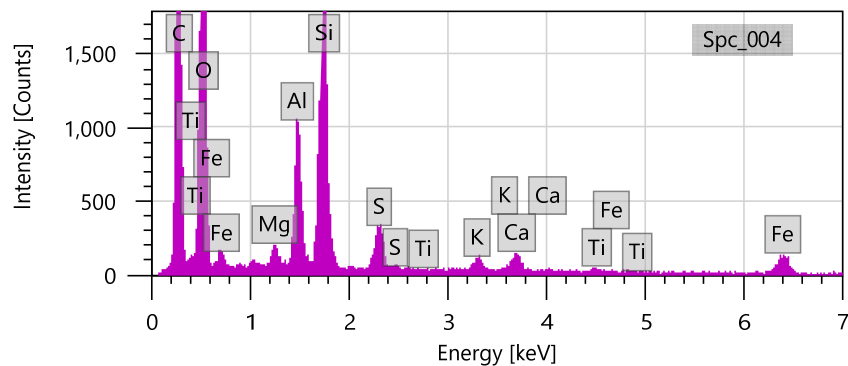
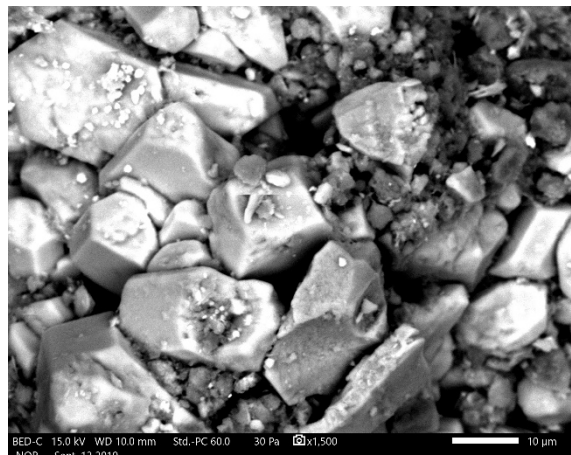
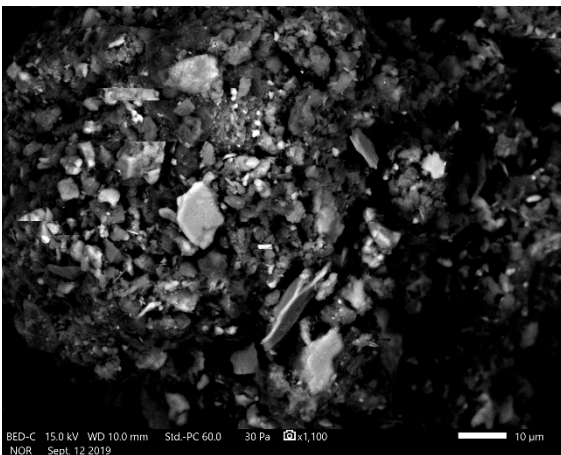
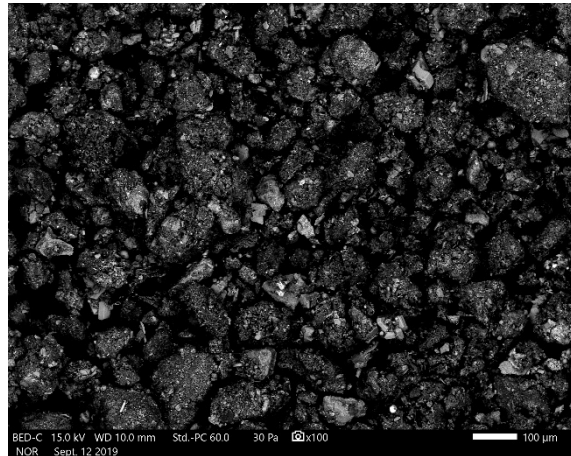
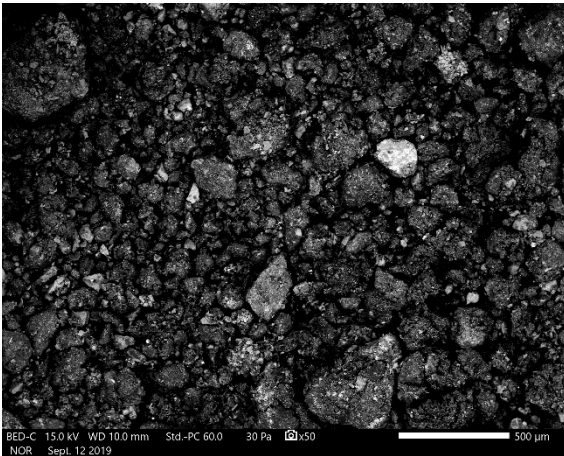


ATTACHMENT C
SEM/EDS Analysis

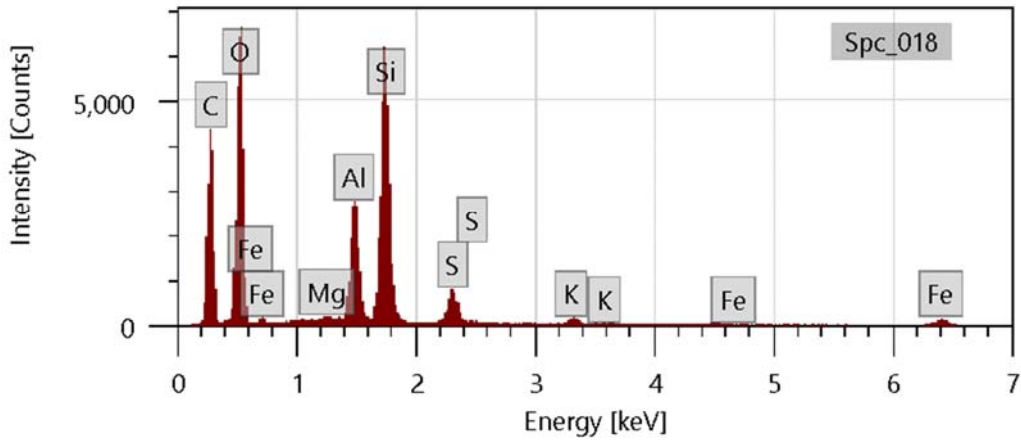
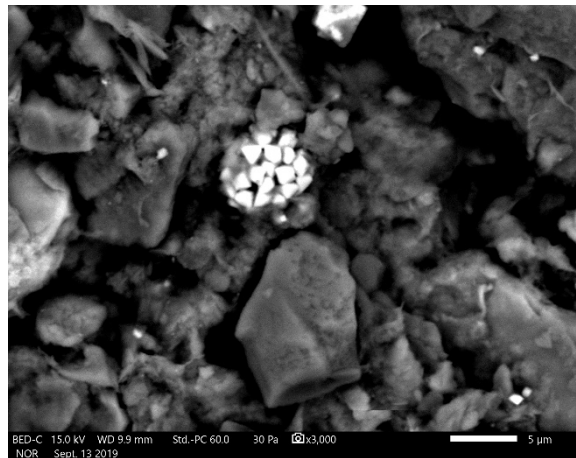
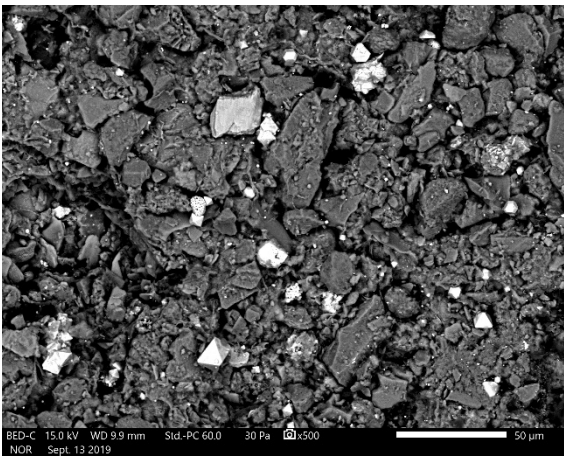
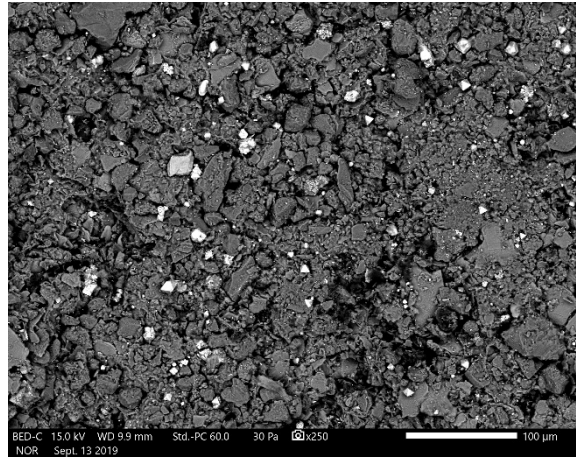
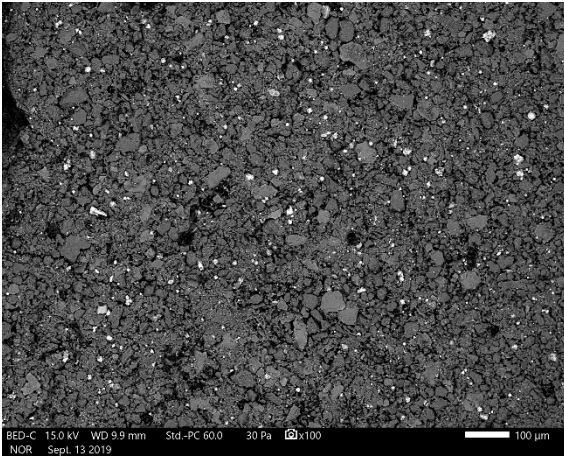
September 16, 2019

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

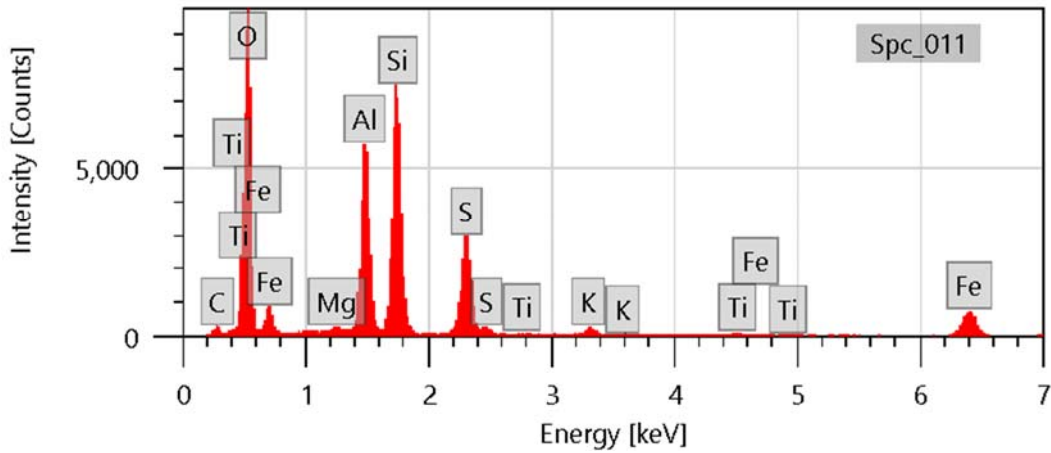
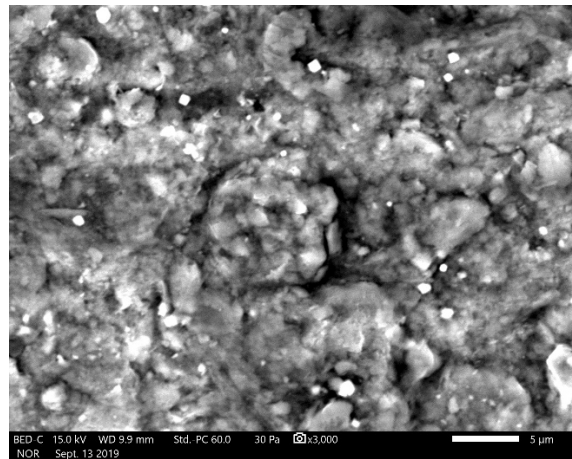
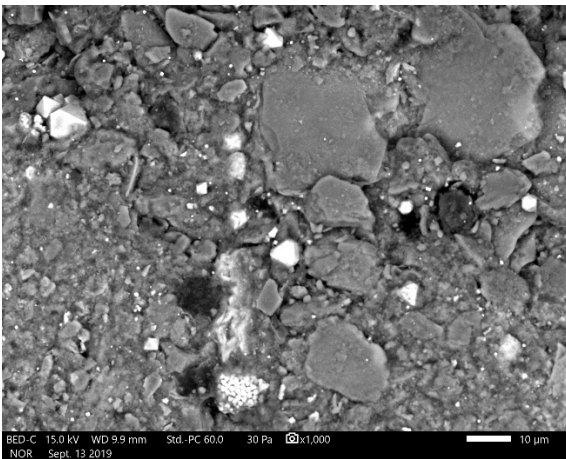
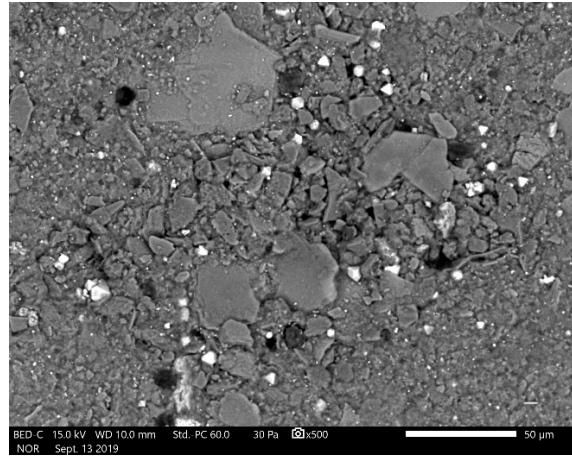
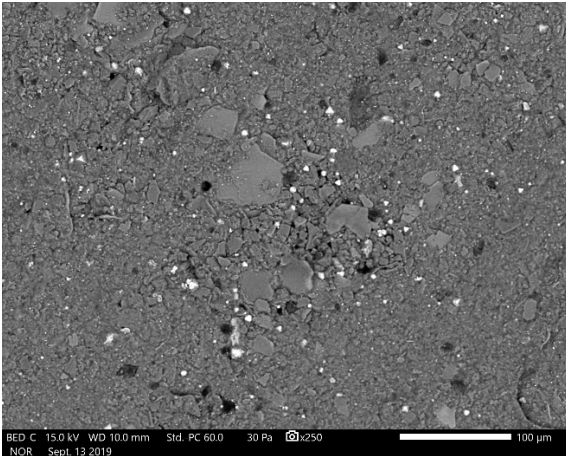
via Email: BSass@geosyntec.com



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 D

Certification by 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 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

12/22/2021
Date