Annual Groundwater Monitoring Report

Southwestern Electric Power Company

H. W. Pirkey Power Plant

West Bottom Ash Pond CCR Management Unit

Hallsville, Texas

January 2021

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SOUTHWESTERN ELECTRIC POWER COMPANY℠

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I. Overview

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2021.

In general, the following activities were completed:

- Groundwater samples were collected for AD-3, AD-12, AD-17, AD-18, AD-28, and AD-30 in March, June, and November 2020 and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 or 95 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Assessment Monitoring sampling was initiated on April 3, 2018;
- The unit was in assessment monitoring and the beginning and the end of 2020.
- Statistical analysis report dated January 3, 2020 was included in last year's Annual Groundwater Monitoring Report. The following Appendix IV parameters exceeded established groundwater protection standards:
    - Cobalt at AD-28

  The following Appendix III parameters exceeded background:
    - Boron at AD-28 and AD-30
    - Chloride at AD-17 and AD-30
    - Sulfate at AD-30
- An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 2, 2020.
- Statistical analysis report dated October 2, 2020 is included in **Appendix II**. The following Appendix IV parameters exceeded established groundwater protection standards:
    - Cobalt at AD-28

  The following Appendix III parameters exceeded background:
    - Boron at AD-28 and AD-30
    - Chloride at AD-17 and AD-30
    - Sulfate at AD-28 and AD-30

    - TDS concentrations at AD-30

- An alternate source for cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on December 31, 2020.
- Statistical evaluation of the groundwater data collected during the Second 2020 semi-annual groundwater monitoring event is underway.
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 40 CFR 257.93. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

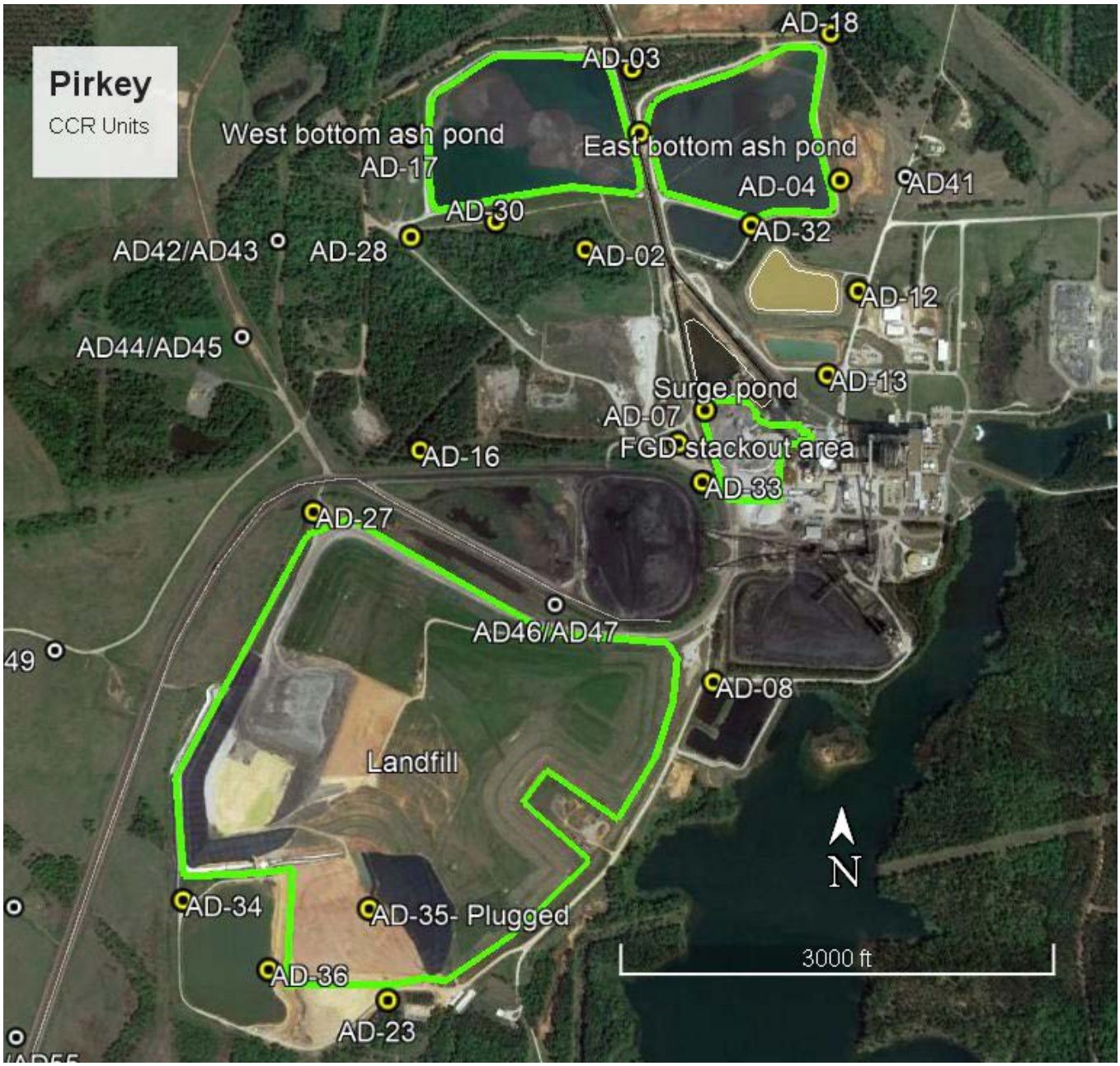
- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in **Appendix I**;
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations, if applicable.
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

West Bottom Ash Pond Monitoring Wells	
Up Gradient	Down Gradient
AD-3	AD-17
AD-12	AD-28
AD-18	AD-30



III. Monitoring Wells Installed or Decommissioned

One monitoring well (AD-7R) was installed to better understand spatial variability of constituents across the site, groundwater flow, and groundwater chemistry. The well installation reports can be found in **Appendix IV**.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality. Static water elevation data from each monitoring event also are shown in **Appendix I**, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

As required by the assessment monitoring rules, 40 CFR 257.95 et seq., a one round of sampling in March in accordance with 40 CFR 257.95(b). A June sampling event was conducted in accordance with 40 CFR 257.95(d)(1) followed by a November round of sampling in accordance with 40 CFR 257.95(d)(1). Assessment monitoring will continue in 2021.

V. Statistical Evaluation of 2020 Events

Statistical analysis report dated January 3, 2020 was included in last year's Annual Groundwater Monitoring Report. The following Appendix IV parameters exceeded established groundwater protection standards:

- Cobalt at AD-28

The following Appendix III parameters exceeded background:

- Boron at AD-28 and AD-30
- Chloride at AD-17 and AD-30
- Sulfate at AD-30

Statistical analysis report dated October 2, 2020 is included in **Appendix II**. The following Appendix IV parameters exceeded established groundwater protection standards:

- Cobalt at AD-28

The following Appendix III parameters exceeded background:

- Boron at AD-28 and AD-30
- Chloride at AD-17 and AD-30
- Sulfate at AD-28 and AD-30
- TDS concentrations at AD-30

Statistics have not been completed for the November sampling event, so no SSLs have been determined yet.

VI. Alternate Source Demonstration

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-28 on January 3, 2020. An alternate source for cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 2, 2020.

SSLs above the GWPS were determined for cobalt at wells AD-28 on October 2, 2020. An alternate source was identified in a report *(Alternative Source Demonstration Report Federal CCR Rule)* on December 31, 2020.

The supporting information are found in **Appendix III**.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

The unit transitioned from detection monitoring to assessment monitoring transition on April 3, 2018.

Assessment monitoring will continue in 2021.

Regarding defining an alternate monitoring frequency, no modification to the monitoring requirements is needed.

VIII. Other Information Required

On November 30, 2020, Pirkey Power Plant submitted a site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler by a date certain to US EPA. Pirkey Power Plant requested to allow the WBAP to continue to receive CCR and non-CR wastestreams after April 11, 2021.

Pirkey received TCEQ approval to extend the receipt of CCR waste and initiate closure activities April 11, 2021. Further extension can be obtained pending a successful demonstration to EPA under 40 CFR 257.103(f).

IX. Description of Any Problems Encountered in 2020 and Actions Taken

No significant problems were encountered.

X. A Projection of Key Activities for the Upcoming Year

Key activities for next year will include:

- Assessment monitoring sampling will be conducted;
- Evaluation of the assessment monitoring results from a statistical analysis viewpoint, looking for any SSLs above GWPS;
- Responding to any new data received in light of CCR rule requirements;
- Preparation of the next annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.

Table 1 - Groundwater Data Summary: AD-3
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.04	2.9	6	< 0.083 U	4.9	18	136
7/14/2016	Background	0.06	4.67	6	< 0.083 U	4.7	30	161
9/8/2016	Background	0.06	4.28	7	< 0.083 U	4.5	28	145
10/13/2016	Background	0.05	4.93	8	< 0.083 U	5.5	31	168
11/14/2016	Background	0.07	4.61	7	< 0.083 U	5.4	29	170
1/12/2017	Background	0.05	3.81	7	< 0.083 U	5.3	27	152
3/1/2017	Background	0.05	2.55	5	< 0.083 U	5.1	16	124
4/10/2017	Background	0.06	2.6	10	< 0.083 U	4.9	19	140
8/24/2017	Detection	0.08625	2.37	6	< 0.083 U	5.6	17	68
3/22/2018	Assessment	0.05508	3.41	5	< 0.083 U	5.3	26	140
8/21/2018	Assessment	0.055	4.79	9	< 0.083 U	5.6	34	166
2/27/2019	Assessment	0.034	3.46	6.16	0.04 J	5.3	21.8	50
5/23/2019	Assessment	0.045	6.19	5.99	0.09	4.9	29.5	154
8/13/2019	Assessment	0.05 J	5.08	6.83	0.19	5.1	32.5	168
3/11/2020	Assessment	0.04 J	2.84	5.76	0.04 J	4.8	19.5	124
6/3/2020	Assessment	0.04 J	4.56	6.44	0.09	5.3	29.2	171
11/3/2020	Assessment	0.054	4.58	6.32	0.08	5.0	30.1	167

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-3
Pirkey - WBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	< 1.05 U	59	0.412956 J	0.0947139 J	0.724945 J	3.12937 J	1.059	< 0.083 U	< 0.68 U	0.025	0.00992 J	0.774997 J	3.29747 J	< 0.86 U
7/14/2016	Background	< 0.93 U	2.10876 J	70	0.583927 J	< 0.07 U	1	7	1.69	< 0.083 U	< 0.68 U	0.095	0.025	1.16077 J	2.50173 J	< 0.86 U
9/8/2016	Background	< 0.93 U	< 1.05 U	70	0.502486 J	< 0.07 U	0.974129 J	7	1.491	< 0.083 U	< 0.68 U	0.087	0.00618 J	< 0.29 U	< 0.99 U	< 0.86 U
10/13/2016	Background	< 0.93 U	4.22879 J	82	0.591063 J	0.159178 J	2	9	3.42	< 0.083 U	< 0.68 U	0.991	0.0073 J	< 0.29 U	1.92667 J	< 0.86 U
11/14/2016	Background	< 0.93 U	1.98138 J	64	0.310985 J	< 0.07 U	0.42234 J	8	1.532	< 0.083 U	< 0.68 U	0.092	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
1/12/2017	Background	< 0.93 U	< 1.05 U	62	0.281878 J	< 0.07 U	0.551806 J	4.96138 J	2.01	< 0.083 U	< 0.68 U	0.079	0.0057 J	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	< 1.05 U	62	0.279961 J	< 0.07 U	< 0.23 U	2.54266 J	0.862	< 0.083 U	< 0.68 U	0.046	< 0.005 U	< 0.29 U	1.78128 J	1.13014 J
4/10/2017	Background	< 0.93 U	< 1.05 U	61	0.284613 J	< 0.07 U	0.250858 J	2.40319 J	0.991	< 0.083 U	< 0.68 U	0.046	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	57.94	0.22 J	< 0.07 U	0.86 J	3.74 J	0.739	< 0.083 U	< 0.68 U	0.06189	< 0.005 U	< 0.29 U	1.13 J	< 0.86 U
8/21/2018	Assessment	< 0.01 U	1.01	63.3	0.240	0.02 J	0.496	7.18	1.837	< 0.083 U	0.355	0.0876	< 0.005 U	0.1 J	0.1	0.057
2/27/2019	Assessment	0.04 J	0.13	54.2	< 0.4 U	0.03 J	0.04 J	2.31	0.3144	0.04 J	0.05 J	0.0525	< 0.005 U	< 0.4 U	0.05 J	< 0.1 U
5/23/2019	Assessment	< 0.4 U	< 0.6 U	61.8	< 0.4 U	< 0.2 U	< 0.8 U	4.94	0.988	0.09	< 0.4 U	0.0734	< 0.005 U	< 8 U	< 0.6 U	< 0.1 U
8/13/2019	Assessment	< 0.02 U	2.41	58.3	0.196	0.02 J	0.206	6.55	1.378	0.19	0.417	0.108	< 0.005 U	< 0.4 U	0.1 J	< 0.1 U
3/11/2020	Assessment	< 0.02 U	0.81	62.4	0.312	0.02 J	0.1 J	2.62	1.504	0.04 J	0.396	0.0353	0.003 J	< 0.4 U	0.09 J	< 0.1 U
6/3/2020	Assessment	< 0.02 U	0.66	57.4	0.228	0.09	0.226	4.36	1.352	0.09	0.372	0.0561	0.003 J	< 0.4 U	0.06 J	< 0.1 U
11/3/2020	Assessment	< 0.02 U	1.22	64.8	0.257	0.02 J	0.220	5.27	1.594	0.08	0.364	0.0714	< 0.002 U	< 0.4 U	0.08 J	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-12
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.03	0.362	5	< 0.083 U	4.4	4	94
7/13/2016	Background	0.03	0.26	6	< 0.083 U	3.1	4	75
9/7/2016	Background	0.04	0.343	6	< 0.083 U	3.9	7	63
10/12/2016	Background	0.03	0.271	7	1	3.4	8	92
11/14/2016	Background	0.04	0.331	8	< 0.083 U	2.6	6	80
1/11/2017	Background	0.03	0.315	7	< 0.083 U	4.8	6	76
2/28/2017	Background	0.04	0.434	5	< 0.083 U	3.6	4	50
4/11/2017	Background	0.05	0.299	6	0.2565 J	4.7	7	72
8/23/2017	Detection	0.0495	0.245	6	0.213 J	4.8	6	52
3/21/2018	Assessment	0.01397	0.269	5	< 0.083 U	4.2	3	< 2 U
8/20/2018	Assessment	0.017	0.338	10	< 0.083 U	4.4	4	94
2/27/2019	Assessment	0.03 J	0.4 J	6.08	0.09	5.2	3.6	36
5/21/2019	Assessment	0.020	0.3 J	6.30	0.09	4.1	4.0	80
8/12/2019	Assessment	< 0.02 U	0.278	7.24	0.06 J	4.9	2.6	90
3/10/2020	Assessment	0.02 J	0.3 J	6.08	0.10	4.9	3.7	62
6/2/2020	Assessment	< 0.02 U	0.2 J	5.63	0.10	4.0	3.9	91
11/2/2020	Assessment	0.03 J	0.3 J	4.65	0.08	4.3	3.3	74

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-12
Pirkey - WBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	< 1.05 U	26	0.219521 J	< 0.07 U	0.710981 J	1.58207 J	0.2073	< 0.083 U	< 0.68 U	< 0.00013 U	< 0.005 U	< 0.29 U	1.73953 J	< 0.86 U
7/13/2016	Background	< 0.93 U	< 1.05 U	23	0.190337 J	< 0.07 U	0.68835 J	1.29444 J	2.909	< 0.083 U	< 0.68 U	0.008	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
9/7/2016	Background	< 0.93 U	< 1.05 U	30	0.232192 J	< 0.07 U	0.353544 J	1.66591 J	0.881	< 0.083 U	< 0.68 U	0.01	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
10/12/2016	Background	< 0.93 U	< 1.05 U	27	0.149553 J	< 0.07 U	0.529033 J	1.56632 J	0.257	1	< 0.68 U	0.012	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
11/14/2016	Background	< 0.93 U	< 1.05 U	28	0.152375 J	< 0.07 U	0.32826 J	1.47282 J	0.767	< 0.083 U	< 0.68 U	0.013	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
1/11/2017	Background	< 0.93 U	< 1.05 U	23	0.126621 J	< 0.07 U	0.650158 J	1.09495 J	1.536	< 0.083 U	< 0.68 U	0.01	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
2/28/2017	Background	< 0.93 U	< 1.05 U	26	0.149219 J	< 0.07 U	0.325811 J	1.29984 J	0.416	< 0.083 U	< 0.68 U	0.009	< 0.005 U	< 0.29 U	< 0.99 U	0.994913 J
4/11/2017	Background	< 0.93 U	< 1.05 U	24	0.159412 J	< 0.07 U	0.416007 J	1.33344 J	0.3895	0.2565 J	< 0.68 U	0.008	0.01364 J	< 0.29 U	< 0.99 U	< 0.86 U
3/21/2018	Assessment	< 0.93 U	< 1.05 U	25.82	0.16 J	< 0.07 U	1.05	1.49 J	0.784	< 0.083 U	< 0.68 U	0.00722	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
8/20/2018	Assessment	< 0.01 U	0.11	27.8	0.159	0.01 J	0.330	1.72	1.128	< 0.083 U	0.089	0.0143	< 0.005 U	0.04 J	0.1	0.04 J
2/27/2019	Assessment	< 0.4 U	< 0.6 U	22.5	< 0.4 U	< 0.2 U	< 0.8 U	1.37	0.225	0.09	< 0.4 U	0.00688	< 0.005 U	< 8 U	< 0.6 U	< 2 U
5/21/2019	Assessment	< 0.4 U	< 0.6 U	21.7	< 0.4 U	< 0.2 U	< 0.8 U	1.15	0.201	0.09	< 0.4 U	0.00576	< 0.005 U	< 8 U	< 0.6 U	< 0.1 U
8/12/2019	Assessment	< 0.02 U	0.07 J	23.8	0.154	< 0.01 U	0.204	1.30	0.237	0.06 J	0.08 J	0.00829	< 0.005 U	< 0.4 U	0.2 J	< 0.1 U
3/10/2020	Assessment	< 0.02 U	0.09 J	21.7	0.139	0.01 J	0.2 J	1.21	3.0706	0.10	0.09 J	0.00547	< 0.002 U	< 0.4 U	0.2	< 0.1 U
6/2/2020	Assessment	< 0.02 U	0.09 J	19.0	0.132	< 0.01 U	0.208	1.02	0.799	0.10	0.09 J	0.00505	< 0.002 U	< 0.4 U	0.3	< 0.1 U
11/2/2020	Assessment	0.05 J	0.09 J	18.9	0.122	< 0.01 U	0.204	1.04	0.929	0.08	0.09 J	0.00510	< 0.002 U	< 0.4 U	0.3	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-17
Pirkey - WBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.02	0.648	12	< 0.083 U	4.3	4	68
7/14/2016	Background	0.03	1.28	34	< 0.083 U	3.3	4	96
9/8/2016	Background	0.03	1.19	29	< 0.083 U	3.9	6	88
10/13/2016	Background	0.03	1.34	32	0.393 J	3.6	6	96
11/15/2016	Background	0.03	1.3	30	0.3446 J	3.7	6	88
1/12/2017	Background	0.03	1.08	26	< 0.083 U	4.4	6	90
3/1/2017	Background	0.04	0.57	19	< 0.083 U	4.0	5	80
4/10/2017	Background	0.03	0.395	20	< 0.083 U	4.2	9	88
8/24/2017	Detection	0.04495	1.06	25	0.245 J	4.6	6	98
12/21/2017	Detection	--	--	26	< 0.083 U	--	8	76
3/22/2018	Assessment	0.03113	0.0981	13	< 0.083 U	4.4	5	44
8/21/2018	Assessment	0.044	0.997	35	< 0.083 U	3.9	7	98
2/28/2019	Assessment	0.03 J	0.2 J	10.2	0.12	3.7	2.4	68
5/23/2019	Assessment	0.019	0.2 J	10.3	0.13	4.0	2.4	58
8/13/2019	Assessment	0.03 J	0.777	26.3	0.24	4.8	1.8	88
3/11/2020	Assessment	< 0.02 U	0.1 J	10.1	0.13	4.4	2.4	60 J
6/3/2020	Assessment	0.02 J	0.312	22.7	0.26	4.2	2.7	77
11/3/2020	Assessment	0.03 J	1.06	32.4	0.24	3.7	1.8	86

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-17
Pirkey - WBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	1.21333 J	143	0.507354 J	0.0868344 J	1	5	2.082	< 0.083 U	< 0.68 U	< 0.00013 U	0.06	< 0.29 U	2.55378 J	< 0.86 U
7/14/2016	Background	< 0.93 U	1.3096 J	334	0.85295 J	0.0833036 J	2	14	3.12	< 0.083 U	< 0.68 U	0.027	0.138	0.485824 J	< 0.99 U	< 0.86 U
9/8/2016	Background	< 0.93 U	1.76675 J	327	0.948023 J	< 0.07 U	5	14	4.473	< 0.083 U	< 0.68 U	0.028	0.142	< 0.29 U	< 0.99 U	1.0754 J
10/13/2016	Background	< 0.93 U	< 1.05 U	324	0.753919 J	< 0.07 U	0.542006 J	14	6.64	0.393 J	< 0.68 U	0.026	0.05	< 0.29 U	< 0.99 U	< 0.86 U
11/15/2016	Background	< 0.93 U	< 1.05 U	290	0.708598 J	< 0.07 U	0.448238 J	13	7.94	0.3446 J	< 0.68 U	0.026	0.078	< 0.29 U	< 0.99 U	< 0.86 U
1/12/2017	Background	< 0.93 U	< 1.05 U	234	0.541302 J	< 0.07 U	0.723126 J	10	9.6	< 0.083 U	< 0.68 U	0.023	0.055	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	< 1.05 U	176	0.499114 J	< 0.07 U	0.359001 J	8	2.31	< 0.083 U	< 0.68 U	0.019	0.084	< 0.29 U	< 0.99 U	< 0.86 U
4/10/2017	Background	< 0.93 U	< 1.05 U	140	0.511666 J	< 0.07 U	0.689417 J	7	3.67	< 0.083 U	< 0.68 U	0.016	0.069	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	94.77	0.38 J	< 0.07 U	1.21	4.57 J	1.669	< 0.083 U	< 0.68 U	0.01186	0.125	< 0.29 U	< 0.99 U	< 0.86 U
8/21/2018	Assessment	< 0.01 U	0.41	223	0.588	0.04	0.367	10.9	2.505	< 0.083 U	0.181	0.0234	0.216	< 0.02 U	0.5	0.051
2/28/2019	Assessment	< 0.4 U	< 0.6 U	71.4	< 0.4 U	< 0.2 U	< 0.8 U	2.93	0.772	0.12	< 0.4 U	0.00912	0.107	< 8 U	< 0.6 U	< 2 U
5/23/2019	Assessment	< 0.4 U	< 0.6 U	82.9	< 0.4 U	< 0.2 U	0.9 J	3.15	1.62	0.13	< 0.4 U	0.00911	0.103	< 8 U	< 0.6 U	< 0.1 U
8/13/2019	Assessment	< 0.02 U	0.40	216	0.554	0.04 J	0.732	9.03	6.4	0.24	0.2 J	0.0193	0.447	< 0.4 U	0.3	< 0.1 U
3/11/2020	Assessment	< 0.02 U	0.46	73.5	0.285	0.02 J	0.700	3.04	3.986	0.13	0.2 J	0.00822	0.175	< 0.4 U	0.2 J	< 0.1 U
6/3/2020	Assessment	< 0.02 U	0.17	176	0.553	0.03 J	0.208	7.02	2.44	0.26	0.09 J	0.0147	0.346	< 0.4 U	0.4	< 0.1 U
11/3/2020	Assessment	< 0.02 U	0.44	263	0.610	0.05	0.518	12.1	8.21	0.24	0.209	0.0237	0.476	< 0.4 U	0.4	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-18
Pirkey - WBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.01	0.548	8	< 0.083 U	4.5	7	108
7/14/2016	Background	0.01	0.409	8	< 0.083 U	4.7	7	116
9/8/2016	Background	0.01	0.343	8	< 0.083 U	4.7	8	110
10/13/2016	Background	0.02	0.56	7	< 0.083 U	4.1	10	124
11/15/2016	Background	0.02	0.59	7	< 0.083 U	4.4	7	134
1/12/2017	Background	0.01	0.415	7	< 0.083 U	4.7	10	128
3/1/2017	Background	0.01	0.224	6	< 0.083 U	4.1	7	108
4/10/2017	Background	0.01	0.304	7	< 0.083 U	4.1	8	102
8/24/2017	Detection	0.0278	0.435	8	< 0.083 U	4.9	8	68
3/22/2018	Assessment	0.01642	0.292	6	< 0.083 U	5.4	6	100
8/21/2018	Assessment	0.012	0.321	10	< 0.083 U	5.1	8	118
2/28/2019	Assessment	< 0.02 U	0.490	8.19	0.02 J	5.0	6.1	84
5/23/2019	Assessment	0.013	0.684	8.82	0.02 J	5.2	10.6	104
8/13/2019	Assessment	< 0.02 U	0.647	8.49	0.01 J	5.2	6.6	90
3/11/2020	Assessment	< 0.02 U	0.3 J	7.34	0.02 J	4.4	6.1	90 J
6/3/2020	Assessment	< 0.02 U	0.2 J	8.30	0.03 J	4.5	6.3	119
11/4/2020	Assessment	< 0.02 U	0.2 J	6.30	0.02 J	4.4	6.3	100

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-18
Pirkey - WBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	< 0.93 U	< 1.05 U	157	0.262755 J	0.109247 J	1	1.82932 J	0.847	< 0.083 U	< 0.68 U	0.004	0.01536 J	< 0.29 U	1.71074 J	< 0.86 U
7/14/2016	Background	< 0.93 U	3.77261 J	139	0.243326 J	< 0.07 U	3	2.16037 J	3.264	< 0.083 U	< 0.68 U	0.02	0.064	0.41347 J	2.45009 J	< 0.86 U
9/8/2016	Background	< 0.93 U	< 1.05 U	115	0.226343 J	< 0.07 U	0.779959 J	1.09947 J	1.105	< 0.083 U	< 0.68 U	0.019	0.03	< 0.29 U	< 0.99 U	< 0.86 U
10/13/2016	Background	< 0.93 U	< 1.05 U	112	0.192611 J	< 0.07 U	0.631027 J	2.24885 J	1.161	< 0.083 U	< 0.68 U	0.026	0.01416 J	< 0.29 U	< 0.99 U	< 0.86 U
11/15/2016	Background	< 0.93 U	< 1.05 U	94	0.107171 J	< 0.07 U	0.724569 J	1.66054 J	1.486	< 0.083 U	< 0.68 U	0.017	0.029	< 0.29 U	< 0.99 U	< 0.86 U
1/12/2017	Background	< 0.93 U	< 1.05 U	99	0.169196 J	< 0.07 U	0.411433 J	1.62881 J	0.976	< 0.083 U	< 0.68 U	0.026	0.01887 J	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	< 1.05 U	99	0.105337 J	< 0.07 U	0.572874 J	0.976724 J	0.468	< 0.083 U	< 0.68 U	0.017	0.01086 J	< 0.29 U	< 0.99 U	< 0.86 U
4/10/2017	Background	< 0.93 U	< 1.05 U	105	0.130316 J	< 0.07 U	0.967681 J	0.98157 J	0.648	< 0.083 U	< 0.68 U	0.019	0.0096 J	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	97.75	0.09 J	< 0.07 U	< 0.23 U	0.97 J	0.942	< 0.083 U	< 0.68 U	0.01647	0.006 J	< 0.29 U	1.53 J	< 0.86 U
8/21/2018	Assessment	0.02 J	1.01	99.8	0.129	0.02 J	0.809	1.18	1.108	< 0.083 U	0.280	0.0175	0.014 J	0.08 J	0.2	0.060
2/28/2019	Assessment	< 0.4 U	< 0.6 U	106	< 0.4 U	< 0.2 U	< 0.8 U	1.11	0.615	0.02 J	0.7 J	0.0177	0.009 J	< 8 U	< 0.6 U	< 2 U
5/23/2019	Assessment	< 0.4 U	< 0.6 U	131	< 0.4 U	< 0.2 U	< 0.8 U	1.47	0.492	0.02 J	< 0.4 U	0.0209	0.009 J	< 8 U	< 0.6 U	< 0.1 U
8/13/2019	Assessment	< 0.02 U	0.45	100	0.118	0.02 J	0.212	1.25	0.473	0.01 J	0.2 J	0.0183	0.023 J	< 0.4 U	0.09 J	< 0.1 U
3/11/2020	Assessment	< 0.02 U	0.09 J	97.1	0.09 J	0.01 J	0.1 J	0.948	4.813	0.02 J	< 0.05 U	0.0134	0.003 J	< 0.4 U	0.05 J	< 0.1 U
6/3/2020	Assessment	< 0.02 U	0.22	100	0.1 J	0.01 J	0.2 J	0.950	0.728	0.03 J	0.06 J	0.0132	0.007	< 0.4 U	0.09 J	< 0.1 U
11/4/2020	Assessment	< 0.02 U	0.29	89.3	0.08 J	0.01 J	0.1 J	0.917	1.169	0.02 J	0.06 J	0.0128	0.028	< 0.4 U	0.2 J	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-28
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.277	2.16	6	0.9005 J	4.7	18	106
7/14/2016	Background	0.301	1.69	6	0.4478 J	5.1	17	96
9/7/2016	Background	0.332	1.25	6	0.3966 J	4.1	19	94
10/13/2016	Background	0.23	3.21	6	0.532 J	5.3	19	124
11/15/2016	Background	0.32	1.64	8	0.9199 J	4.2	16	112
1/12/2017	Background	0.285	1.22	7	0.7158 J	4.1	17	84
3/1/2017	Background	0.293	1.25	5	< 0.083 U	3.4	18	96
4/10/2017	Background	0.293	1.2	7	0.6732 J	4.1	20	104
8/24/2017	Detection	0.281	1.22	6	0.557 J	5.1	18	96
12/21/2017	Detection	0.277	1.14	--	--	--	--	--
3/22/2018	Assessment	0.254	1.4	5	0.6327 J	5.2	23	100
8/21/2018	Assessment	0.330	1.39	9	0.4982 J	5.0	22	96
2/27/2019	Assessment	0.458	1.65	6.29	0.81	5.0	19.6	32
5/22/2019	Assessment	0.313	1.24	4.48	0.69	4.6	20.1	100
8/12/2019	Assessment	0.366	1.72	6.04	0.65	4.7	22.5	128
3/11/2020	Assessment	0.370	1.14	5.48	1.04	4.2	29.1	112
6/2/2020	Assessment	0.351	1.18	5.33	0.87	4.5	26.2	125
11/2/2020	Assessment	0.395	1.38	5.51	0.55	4.4	21.9	104

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-28
Pirkey - WBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	1.58838 J	2.49885 J	223	0.968775 J	< 0.07 U	1	18	1.212	0.9005 J	< 0.68 U	0.004	0.146	< 0.29 U	1.10335 J	< 0.86 U
7/14/2016	Background	< 0.93 U	1.52986 J	170	0.663081 J	< 0.07 U	0.982579 J	15	2.29	0.4478 J	< 0.68 U	0.034	0.162	< 0.29 U	< 0.99 U	< 0.86 U
9/7/2016	Background	< 0.93 U	< 1.05 U	168	0.728735 J	< 0.07 U	0.605543 J	14	1.44	0.3966 J	< 0.68 U	0.03	0.069	< 0.29 U	< 0.99 U	1.24745 J
10/13/2016	Background	< 0.93 U	6	152	0.42032 J	< 0.07 U	6	18	2.547	0.532 J	< 0.68 U	0.066	0.085	< 0.29 U	< 0.99 U	< 0.86 U
11/15/2016	Background	< 0.93 U	1.40867 J	148	0.520895 J	< 0.07 U	0.638766 J	13	3.35	0.9199 J	< 0.68 U	0.032	0.029	0.294156 J	< 0.99 U	< 0.86 U
1/12/2017	Background	< 0.93 U	< 1.05 U	154	0.475597 J	< 0.07 U	< 0.23 U	12	2.67	0.7158 J	< 0.68 U	0.031	0.025	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	< 1.05 U	163	0.576508 J	< 0.07 U	0.968975 J	14	2.082	< 0.083 U	< 0.68 U	0.031	0.025	< 0.29 U	< 0.99 U	< 0.86 U
4/10/2017	Background	< 0.93 U	< 1.05 U	162	0.654819 J	< 0.07 U	0.324151 J	15	2.331	0.6732 J	< 0.68 U	0.03	0.026	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	166	0.95 J	< 0.07 U	< 0.23 U	14.36	1.288	0.6327 J	< 0.68 U	0.02561	0.046	< 0.29 U	< 0.99 U	< 0.86 U
8/21/2018	Assessment	0.03 J	0.64	143	0.598	0.05	0.688	14.4	2.028	0.4982 J	0.266	0.0307	0.028	0.05 J	0.3	0.03 J
2/27/2019	Assessment	< 0.4 U	< 0.6 U	154	0.9 J	< 0.2 U	< 0.8 U	14.3	2.318	0.81	< 0.4 U	0.0266	0.061	< 8 U	< 0.6 U	< 2 U
5/22/2019	Assessment	< 0.4 U	< 0.6 U	148	0.5 J	< 0.2 U	< 0.8 U	13.8	1.948	0.69	< 0.4 U	0.0227	0.028	< 8 U	< 0.6 U	< 0.1 U
8/12/2019	Assessment	0.02 J	0.64	113	0.473	0.04 J	0.416	12.8	2.381	0.65	0.1 J	0.0380	0.092	< 0.4 U	0.2 J	< 0.1 U
3/11/2020	Assessment	< 0.02 U	0.21	172	0.959	0.07	0.235	17.1	2.265	1.04	0.1 J	0.0226	0.028	< 0.4 U	0.4	< 0.1 U
6/2/2020	Assessment	< 0.02 U	0.16	146	0.801	0.05	0.230	13.6	1.667	0.87	0.06 J	0.0223	0.026	< 0.4 U	0.3	< 0.1 U
11/2/2020	Assessment	< 0.02 U	0.18	131	0.466	0.04 J	0.2 J	13.4	2.33	0.55	0.06 J	0.0279	0.064	< 0.4 U	0.2	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-30
Pirkey - WBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.258	0.591	18	< 0.083 U	4.7	14	112
7/14/2016	Background	0.384	0.499	22	< 0.083 U	4.8	14	118
9/7/2016	Background	0.515	0.27	24	< 0.083 U	4.4	15	110
10/13/2016	Background	0.625	0.373	24	< 0.083 U	4.2	18	140
11/15/2016	Background	0.701	0.326	25	< 0.083 U	4.3	19	132
1/12/2017	Background	0.697	0.286	26	< 0.083 U	5.2	22	136
3/1/2017	Background	0.824	0.273	22	< 0.083 U	4.8	25	136
4/11/2017	Background	0.837	0.242	24	< 0.083 U	4.2	27	124
8/24/2017	Detection	1.39	0.294	25	< 0.083 U	5.2	46	176
12/21/2017	Detection	1.27	0.363	26	< 0.083 U	--	48	152
3/22/2018	Assessment	0.937	0.345	17	< 0.083 U	5.2	44	140
8/21/2018	Assessment	1.57	0.716	29	< 0.083 U	4.8	66	188
2/28/2019	Assessment	0.491	0.3 J	14.6	< 0.04 U	4.2	31.5	--
4/3/2019	Assessment	--	--	--	--	--	--	135
5/23/2019	Assessment	0.520	1.74	18.8	0.04 J	4.9	29.2	112
8/12/2019	Assessment	1.25	0.302	28.1	0.03 J	4.9	39.8	160
3/11/2020	Assessment	1.63	0.351	22.8	0.05 J	4.6	76.4	188
6/2/2020	Assessment	1.58	0.341	23.2	0.05 J	4.9	77.2	219
11/2/2020	Assessment	2.55	0.523	30.6	0.05 J	4.4	109	252

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-30
Pirkey - WBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	1.71137 J	1.92931 J	54	0.155441 J	< 0.07 U	3	2.21375 J	1.057	< 0.083 U	< 0.68 U	< 0.00013 U	0.278	< 0.29 U	< 0.99 U	< 0.86 U
7/14/2016	Background	< 0.93 U	< 1.05 U	54	0.126875 J	< 0.07 U	0.994219 J	2.13856 J	4.701	< 0.083 U	< 0.68 U	0.01	0.649	1.14165 J	< 0.99 U	< 0.86 U
9/7/2016	Background	< 0.93 U	< 1.05 U	52	0.153878 J	< 0.07 U	0.769517 J	1.83325 J	0.312	< 0.083 U	< 0.68 U	0.009	0.214	< 0.29 U	< 0.99 U	1.34697 J
10/13/2016	Background	< 0.93 U	< 1.05 U	56	0.0606961 J	< 0.07 U	0.543859 J	2.26228 J	2.27	< 0.083 U	< 0.68 U	0.01	0.709	< 0.29 U	< 0.99 U	< 0.86 U
11/15/2016	Background	< 0.93 U	< 1.05 U	52	0.0603858 J	< 0.07 U	< 0.23 U	1.91681 J	4.07	< 0.083 U	< 0.68 U	0.009	0.584	< 0.29 U	1.2068 J	0.959001 J
1/12/2017	Background	< 0.93 U	< 1.05 U	51	0.0580655 J	< 0.07 U	0.504125 J	1.76108 J	0.355	< 0.083 U	< 0.68 U	0.009	1.588	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	0.997045 J	< 1.05 U	55	0.0632093 J	< 0.07 U	0.740184 J	1.69598 J	0.354	< 0.083 U	< 0.68 U	0.008	2.59	< 0.29 U	< 0.99 U	< 0.86 U
4/11/2017	Background	< 0.93 U	< 1.05 U	55	0.0611 J	< 0.07 U	0.535696 J	1.80383 J	1.861	< 0.083 U	< 0.68 U	0.008	1.207	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	56.42	0.09 J	< 0.07 U	1.47	2.6 J	1.108	< 0.083 U	< 0.68 U	0.00837	0.104	< 0.29 U	< 0.99 U	< 0.86 U
8/21/2018	Assessment	< 100 U	0.77	62.9	0.07 J	< 0.05 U	1.22	2.93	0.987	< 0.083 U	0.2 J	0.0118	1.123	< 200 U	0.4 J	0.1 J
2/28/2019	Assessment	< 0.4 U	< 0.6 U	43.3	< 0.4 U	< 0.2 U	4 J	1.67	1.144	< 0.04 U	< 0.4 U	0.00707	0.461	< 8 U	< 0.6 U	< 2 U
5/23/2019	Assessment	< 0.4 U	0.6 J	59.2	< 0.4 U	< 0.2 U	1 J	3.26	1.089	0.04 J	< 0.4 U	0.00841	0.165	< 8 U	< 0.6 U	< 0.1 U
8/12/2019	Assessment	< 0.02 U	0.21	58.0	0.07 J	< 0.01 U	0.374	2.10	1.217	0.03 J	0.06 J	0.00804	0.345	< 0.4 U	0.2 J	< 0.1 U
3/11/2020	Assessment	< 0.02 U	0.23	82.6	0.08 J	< 0.01 U	0.300	2.82	3.41	0.05 J	0.09 J	0.00788	0.010	0.8 J	0.2 J	< 0.1 U
6/2/2020	Assessment	< 0.02 U	0.19	77.3	0.08 J	< 0.01 U	0.531	2.64	0.983	0.05 J	0.09 J	0.00779	0.021	< 0.4 U	0.2	< 0.1 U
11/2/2020	Assessment	< 0.02 U	0.15	104	0.09 J	0.01 J	0.328	4.10	1.311	0.05 J	< 0.05 U	0.0104	0.085	< 0.4 U	0.2 J	< 0.1 U

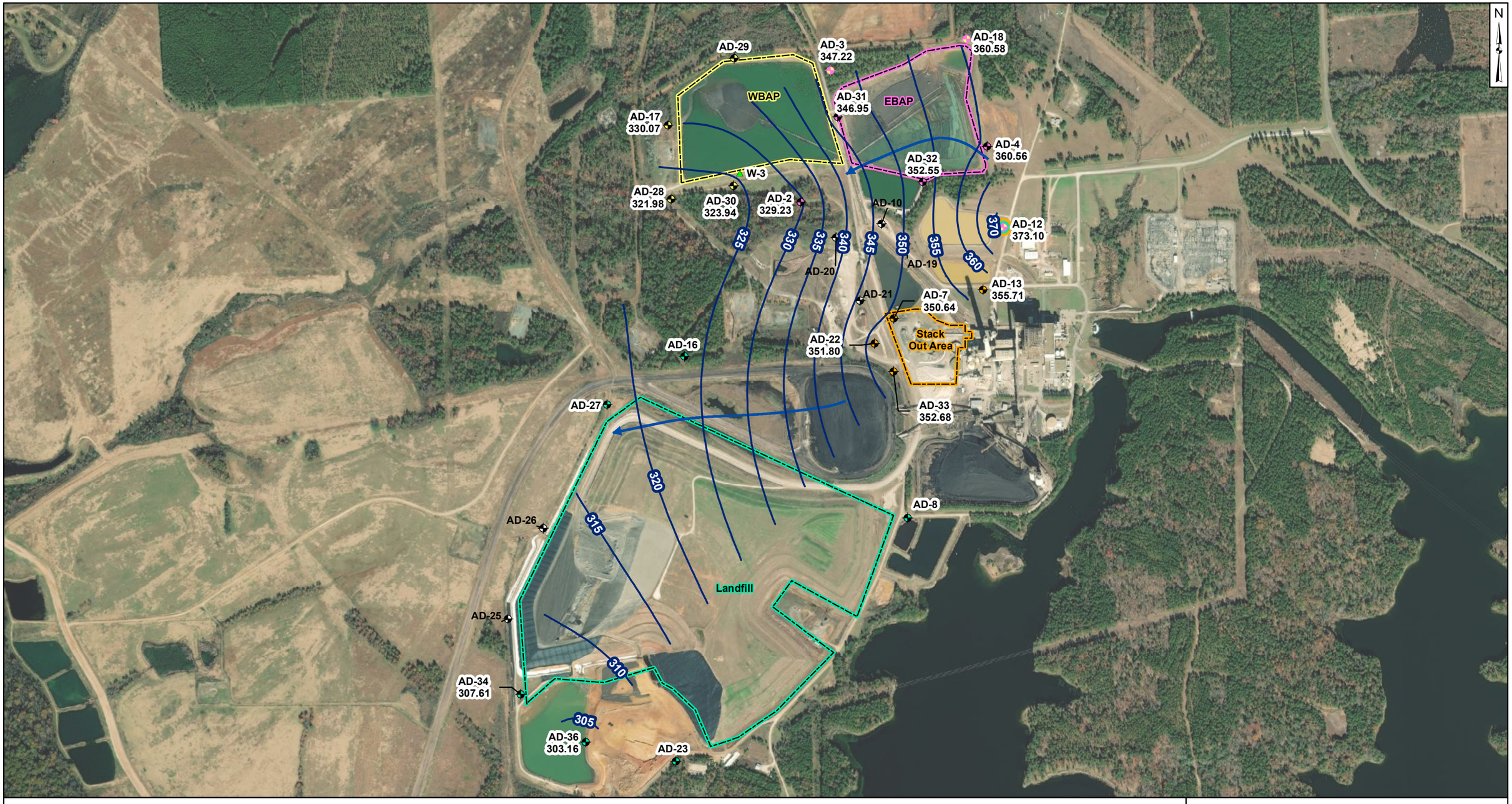
Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1: Residence Time Calculation Summary
Pirkey West Bottom Ash Pond

Geosyntec Consultants, Inc.

CCR Management Unit	Monitoring Well	Well Diameter (inches)	2020-03		2020-06		2020-11	
			Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
West Bottom Ash Pond	AD-3 [1]	4.0	16.5	7.4	16.3	7.5	26.3	4.6
	AD-12 [1]	4.0	35.1	3.5	20.1	6.0	26.9	4.5
	AD-17 [2]	2.0	13.1	4.6	12.0	5.1	7.9	7.7
	AD-18 [1]	2.0	9.2	6.6	10.1	6.0	10.8	5.6
	AD-28 [2]	2.0	10.7	5.7	15.4	3.9	11.6	5.2
	AD-30 [2]	2.0	14.9	4.1	13.1	4.6	13.4	4.5

Notes:
[1] - Background Well
[2] - Downgradient Well



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on March 10-11, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3, AD-16, AD-27, and AD-29 were not gauged in March 2020.
- AD-34 is an artesian well.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer March 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/06/12

Figure **1**

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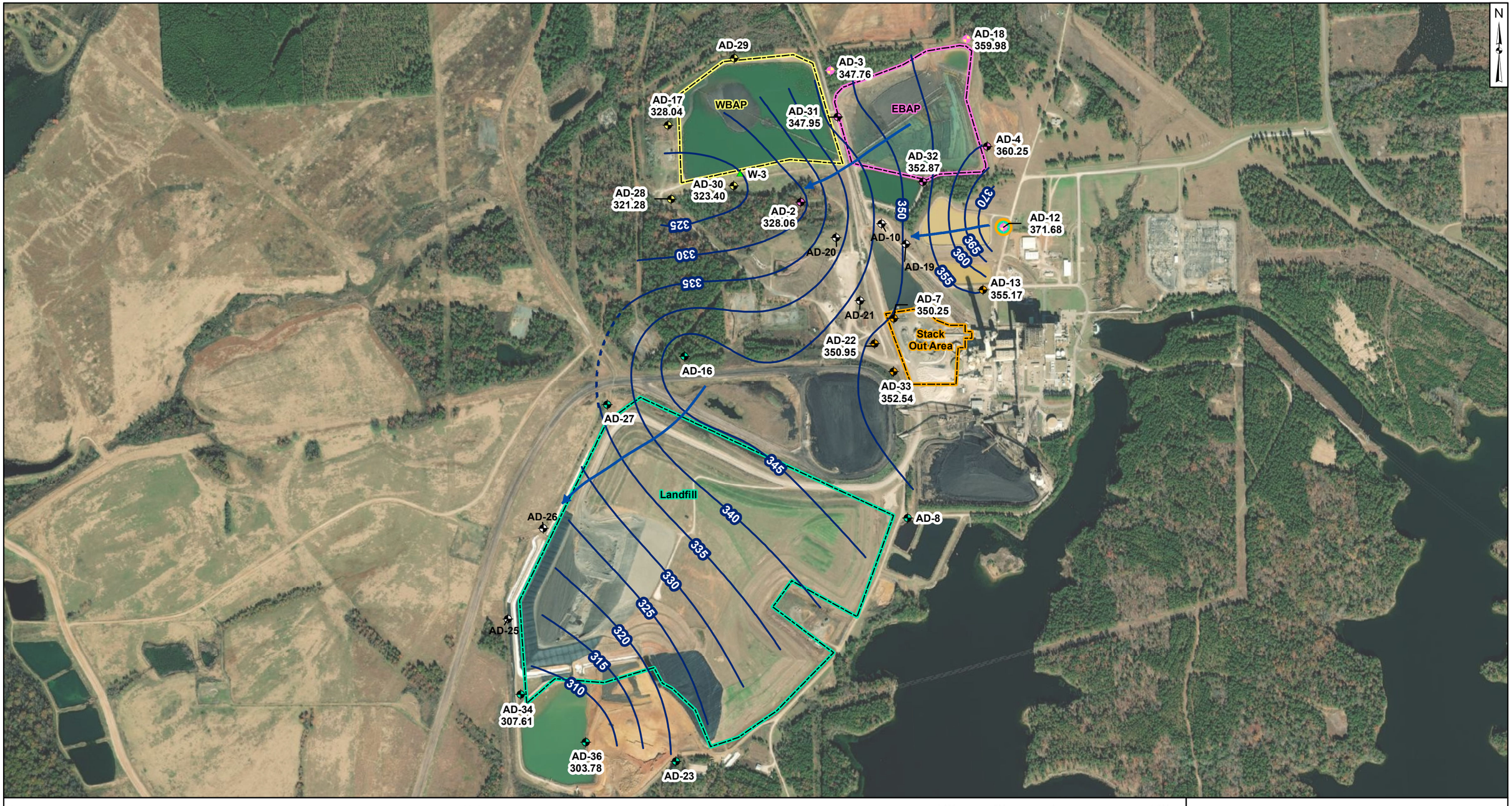


Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Grondwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on June 2 - 3, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3, AD-8, AD-16, AD-23, AD-27, and AD-29 were not gauged in June 2020.
- AD-34 is an artesian well.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer
June 2020

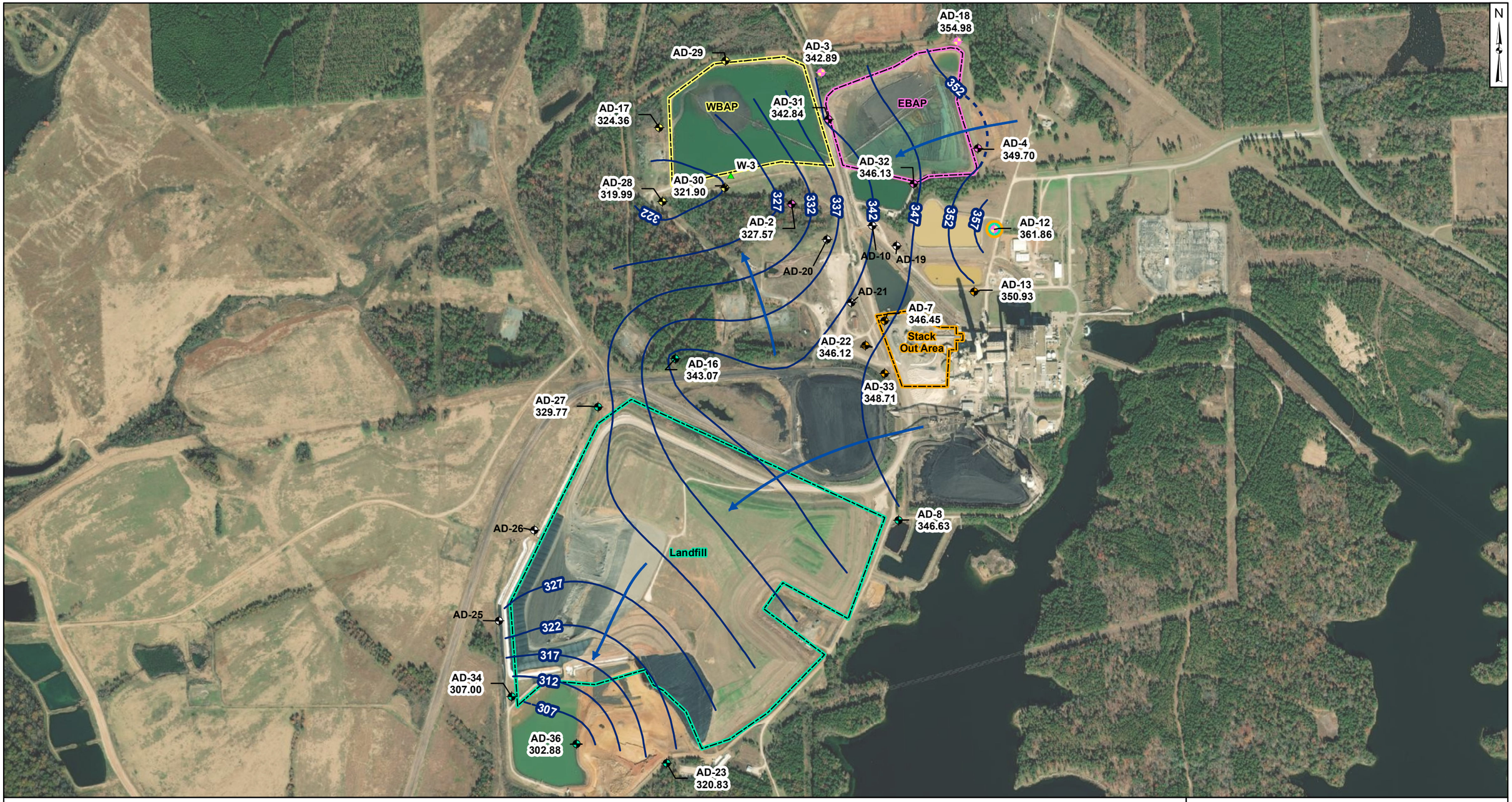
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/11/13

Figure **2**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2020\AEP-Pirkey_GW_2020-06June.mxd. HDuff. 11/13/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Grondwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on November 2-4, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 and AD-29 were not gauged in November 2020.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer
November 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2021/01/06

Figure **3**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2020\AEP-Pirkey_GW_2020-11November_new.mxd. HDuff. 1/6/2021. Project/Phase/Task.

APPENDIX II

Where applicable, show in this appendix the results from statistical analyses, and a description of the statistical analysis method chosen. These statistical analyses are to be conducted separately for each constituent in each monitoring well.

STATISTICAL ANALYSIS SUMMARY
WEST BOTTOM ASH POND
H.W. Pirkey Power Plant
Hallsville, Texas

Submitted to

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

October 2, 2020

CHA8500

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LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit
WBAP	West Bottom Ash Pond

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the West Bottom Ash Pond (WBAP), an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron at the WBAP. An alternative source was not identified at the time, so the WBAP has been in assessment monitoring since. Groundwater protection standards (GWPS) were set in accordance with 40 CFR 257.95(d)(2) and a statistical evaluation of the assessment monitoring data was conducted. During the most recent assessment monitoring event, completed in August 2019, an SSL was identified for cobalt at well AD-28 (Geosyntec, 2019). A successful alternative source demonstration (ASD) was completed per 40 CFR 257.95(g)(3); therefore, the WBAP remained in assessment monitoring. Two assessment monitoring events were conducted at the WBAP in March and June 2020 in accordance with 40 CFR 257.95. The results of these assessment events are documented in this report.

Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact data usability.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. An SSL was identified for cobalt. Thus, either the unit will move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

WEST BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, two sets of samples were collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(b) (March 2020) and 257.95(d)(1) (June 2020). Samples from both sampling events were analyzed for the Appendix III and Appendix IV parameters. A summary of data collected during these assessment monitoring events are presented in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.26 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the WBAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained in March and June 2020 were screened for potential outliers. No outliers were identified for these events.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. 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. Tolerance limits were calculated parametrically with 95% coverage and 95% confidence for chromium, combined radium, and lithium. Non-parametric tolerance limits were calculated

for barium, beryllium, cobalt, and mercury due to apparent non-normal distributions and for antimony, arsenic, cadmium, fluoride, lead, molybdenum, selenium, and thallium due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSL was identified at the Pirkey WBAP:

- The LCL for cobalt exceeded the GWPS of 0.0090 mg/L at AD-28 (0.0134 mg/L).

As a result, the Pirkey WBAP will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring.

2.2.3 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results was also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations.

Data collected during the June 2020 assessment monitoring event from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 3. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0768 mg/L at AD-28 (0.351 mg/L) and AD-30 (1.58 mg/L).

- Chloride concentrations exceeded the interwell UPL of 9.50 mg/L at AD-17 (22.7 mg/L) and AD-30 (23.2 mg/L).

- Sulfate concentrations exceeded the intrawell UPL of 23.2 mg/L at AD-28 (26.2 mg/L) and the intrawell UPL of 31.6 mg/L at AD-30 (77.2 mg/L).

- Total dissolved solids (TDS) concentrations exceeded the intrawell UPL of 189 mg/L at AD-30 (219 mg/L).

While the prediction limits were calculated for a one-of-two retesting procedure, SSIs were conservatively assumed if the June 2020 sample was above the UPL or below the LPL. Based on

these results, concentrations of Appendix III constituents appear to be above background concentrations.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified no potential outliers in the March and June 2020 data. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. An SSL was identified for cobalt. Appendix III parameters were compared to calculated prediction limits, with exceedances identified for boron, chloride, sulfate, and TDS.

Based on this evaluation, the Pirkey WBAP CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – H.W. Pirkey Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2019. Statistical Analysis Summary – West Bottom Ash Pond, H.W. Pirkey Plant. December.

TABLES

Table 1 - Groundwater Data Summary
Pirkey Plant - West Bottom Ash Pond

Parameter	Unit	AD-3		AD-12		AD-17		AD-18		AD-28		AD-30	
		3/11/2020	6/3/2020	3/10/2020	6/2/2020	3/11/2020	6/3/2020	3/11/2020	6/3/2020	3/11/2020	6/2/2020	3/11/2020	6/2/2020
Antimony	µg/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Arsenic	µg/L	0.81	0.66	0.09 J	0.09 J	0.46	0.17	0.09 J	0.22	0.21	0.16	0.23	0.19
Barium	µg/L	62.4	57.4	21.7	19.0	73.5	176	97.1	100	172	146	82.6	77.3
Beryllium	µg/L	0.312	0.228	0.139	0.132	0.285	0.553	0.09 J	0.1 J	0.959	0.801	0.08 J	0.08 J
Boron	mg/L	0.04 J	0.04 J	0.02 J	0.05 U	0.05 U	0.02 J	0.05 U	0.05 U	0.370	0.351	1.63	1.58
Cadmium	µg/L	0.02 J	0.09	0.01 J	0.05 U	0.02 J	0.03 J	0.01 J	0.01 J	0.07	0.05	0.05 U	0.05 U
Calcium	mg/L	2.84	4.56	0.3 J	0.2 J	0.1 J	0.312	0.3 J	0.2 J	1.14	1.18	0.351	0.341
Chloride	mg/L	5.76	6.44	6.08	5.63	10.1	22.7	7.34	8.30	5.48	5.33	22.8	23.2
Chromium	µg/L	0.1 J	0.226	0.2 J	0.208	0.700	0.208	0.1 J	0.2 J	0.235	0.230	0.300	0.531
Cobalt	µg/L	2.62	4.36	1.21	1.02	3.04	7.02	0.948	0.950	17.1	13.6	2.82	2.64
Combined Radium	pCi/L	1.504	1.352	3.0706	0.799	3.986	2.44	4.813	0.728	2.265	1.667	3.41	0.983
Fluoride	mg/L	0.04 J	0.09	0.10	0.10	0.13	0.26	0.02 J	0.03 J	1.04	0.87	0.05 J	0.05 J
Lead	µg/L	0.396	0.372	0.09 J	0.09 J	0.2 J	0.09 J	0.2 U	0.06 J	0.1 J	0.06 J	0.09 J	0.09 J
Lithium	mg/L	0.0353	0.0561	0.00547	0.00505	0.00822	0.0147	0.0134	0.0132	0.0226	0.0223	0.00788	0.00779
Mercury	µg/L	0.003 J	0.003 J	0.005 U	0.005 U	0.175	0.346	0.003 J	0.007	0.028	0.026	0.010	0.021
Molybdenum	µg/L	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	0.8 J	2 U
Selenium	µg/L	0.09 J	0.06 J	0.2	0.3	0.2 J	0.4	0.05 J	0.09 J	0.4	0.3	0.2 J	0.2
Sulfate	mg/L	19.5	29.2	3.7	3.9	2.4	2.7	6.1	6.3	29.1	26.2	76.4	77.2
Thallium	µg/L	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Total Dissolved Solids	mg/L	124	171	62	91	60 J	77	90 J	119	112	125	188	219
pH	SU	4.8	5.3	4.9	4.0	4.4	4.2	4.4	4.5	4.2	4.5	4.6	4.9

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. For statistical analysis, parameters which were not detected were replaced with the reporting limit.
J: Estimated value. Parameter was detected in concentrations below the reporting limit.

Table 2: Groundwater Protection Standards
Pirkey Plant - West Bottom Ash Pond

Constituent Name	MCL	CCR Rule-Specified	Background Limit
Antimony, Total (mg/L)	0.006		0.005
Arsenic, Total (mg/L)	0.01		0.0050
Barium, Total (mg/L)	2		0.16
Beryllium, Total (mg/L)	0.004		0.0020
Cadmium, Total (mg/L)	0.005		0.001
Chromium, Total (mg/L)	0.1		0.0036
Cobalt, Total (mg/L)	n/a	0.006	0.009
Combined Radium, Total (pCi/L)	5		3.80
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.005
Lithium, Total (mg/L)	n/a	0.04	0.13
Mercury, Total (mg/L)	0.002		0.000064
Molybdenum, Total (mg/L)	n/a	0.1	0.01
Selenium, Total (mg/L)	0.05		0.005
Thallium, Total (mg/L)	0.002		0.002

Notes:
Grey cell indicates calculated UTL is higher than MCL.
MCL = Maximum Contaminant Level
RSL = Regional Screening Level
Calculated UTL (Upper Tolerance Limit) represents site-specific background values.
The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3 - Appendix III Data Summary
Pirkey Plant - West Bottom Ash Pond

Geosyntec Consultants, Inc.

Analyte	Unit	Description	AD-17	AD-28	AD-30
			6/3/2020	6/2/2020	6/2/2020
Boron	mg/L	Interwell Background Value (UPL)	0.0768		
		Analytical Result	0.02	**0.351**	**1.58**
Calcium	mg/L	Intrawell Background Value (UPL)	1.79		
		Analytical Result	0.312	1.18	0.341
Chloride	mg/L	Interwell Background Value (UPL)	9.50		
		Analytical Result	**22.7**	5.33	**23.2**
Fluoride	mg/L	Interwell Background Value (UPL)	1.00		
		Analytical Result	0.26	0.87	0.05
pH	SU	Intrawell Background Value (UPL)	4.8	5.9	5.5
		Intrawell Background Value (LPL)	3.2	3.3	3.8
		Analytical Result	4.2	4.5	4.9
Sulfate	mg/L	Intrawell Background Value (UPL)	9.32	23.2	31.6
		Analytical Result	2.7	**26.2**	**77.2**
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	115	129	189
		Analytical Result	77	125	**219**

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey West Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature

112498

License Number

TEXAS

Licensing State

10.02.2020

Date

ATTACHMENT B

Statistical Analysis Output

September 1, 2020

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey West Bottom Ash Pond
Assessment Monitoring Event – June 2020

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the Assessment Monitoring Event statistical analysis of groundwater data through June 2020 for American Electric Power Inc.'s Pirkey West Bottom Ash Pond. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-3, AD-12, and AD-18
- **Downgradient wells:** AD-17, AD-28, and AD-30

Data were sent electronically to Groundwater Stats Consulting, and the statistical analysis report was prepared according to the background screening conducted in December 2017 that was approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to Groundwater Stats Consulting. The analysis was reviewed by Dr. Jim Loftis, Civil & Environmental Engineering professor emeritus at Colorado State University and Senior Advisor to Groundwater Stats Consulting.

The CCR Assessment Monitoring program consists of the following constituents:

- **Appendix IV** (Assessment Monitoring) **–** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium

Time series plots and box plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B).

Background Screening:

Prior to constructing statistical limits, background data are screened through time series plots for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Values identified as outliers are flagged with (o) and displayed in a lighter font and disconnected symbol on the time series graphs. A summary of flagged outliers is included as Figure C.

For the current analysis, all data through June 2020 were screened, including data from downgradient wells. For the downgradient well data that are used to construct confidence intervals, a regulatory conservative approach is taken in that values that are marginally high relative to the rest of the data are retained unless there is particular justification for excluding them. Several outliers were flagged as a result of changes in reporting limits as follows.

The reporting limit for thallium for the February 2019 event was <0.01 mg/L, which is higher than both the historical reporting limit of <0.002 mg/L and the GWPS. Since the <0.01 mg/L values cannot help distinguish whether other observations exceed the GWPS, they are flagged as outliers. Similarly, the high nondetects for molybdenum of <0.04 mg/L for February and May of 2019 are flagged since they are censored at a much higher level than are the other nondetects. However, they are still lower than the GWPS of 0.1 mg/L.

Summary of Statistical Methods:

Assessment monitoring for Appendix IV parameters involves the comparison of a confidence interval for each parameter at each downgradient well against the corresponding Ground Water Protection Standard (GWPS). If, and only if, the entire confidence interval exceeds the GWPS, the well/constituent is considered to exceed its

standard. The GWPS is determined for each parameter as the largest of the Maximum Contaminant Levels (MCLs), CCR Rule-Specified levels, or background limits determined from tolerance limits on pooled upgradient well data.

Prior to computing tolerance limits on upgradient well data or confidence intervals on downgradient well data, the distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric tolerance limits and confidence intervals as appropriate, based on the following criteria.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, the reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory. There is no replacement of historical reporting limits with the most recent reporting limit. For several constituents, the most recent reporting limits are significantly lower than those reported historically. This is the most conservative approach for tolerance limits and confidence intervals at this site.
- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.
- Nonparametric tolerance limits are used on data containing greater than 50% nondetects.

Evaluation of Appendix IV Parameters – June 2020:

When data followed a normal or transformed-normal distribution, parametric tolerance limits were used to calculate background limits for Appendix IV parameters using pooled upgradient well data through June 2020 with a target of 95% confidence and 95% coverage (Figure D). Nonparametric tolerance limits are constructed when data do not follow a normal or transformed-normal distribution or when there are greater than 50% nondetects. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These background limits were then compared to the Maximum Contaminant Levels (MCLs) and CCR Rule-Specified levels to determine the highest limit for use as the GWPS in the confidence interval comparisons (Figure E).

Confidence intervals were then constructed on downgradient wells with data through June 2020 for each of the Appendix IV parameters using either parametric or nonparametric intervals depending on the data distribution and percentage of nondetects, similar to the logic used to construct tolerance limits as discussed above (Figure F). Each confidence interval was compared with the corresponding GWPS from Figure E. Only when the entire confidence interval is above the GWPS is the well/constituent pair considered to exceed its respective standard. Both a tabular summary and graphical presentation of the confidence interval results follow this letter. An exceedance was noted for the following well/constituent pair:

- Cobalt: AD-28

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey West Bottom Ash Pond. If you have any questions or comments, please feel free to contact us.

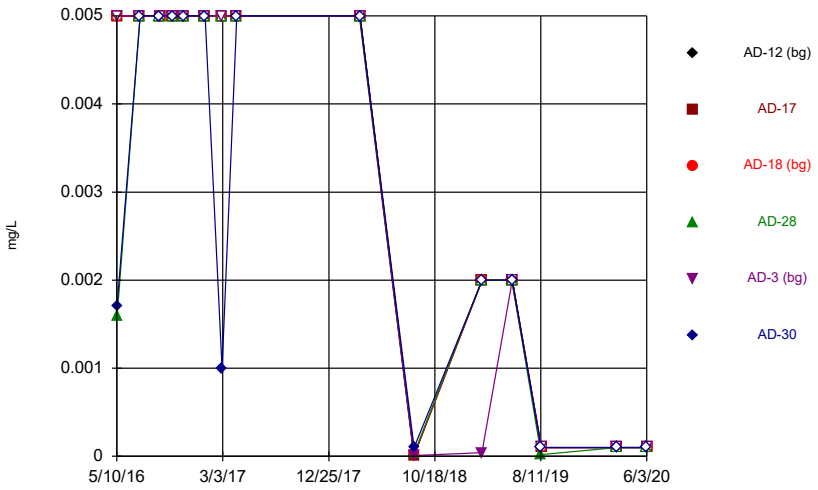
For Groundwater Stats Consulting,

Andrew T. Collins
Project Manager

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Antimony, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
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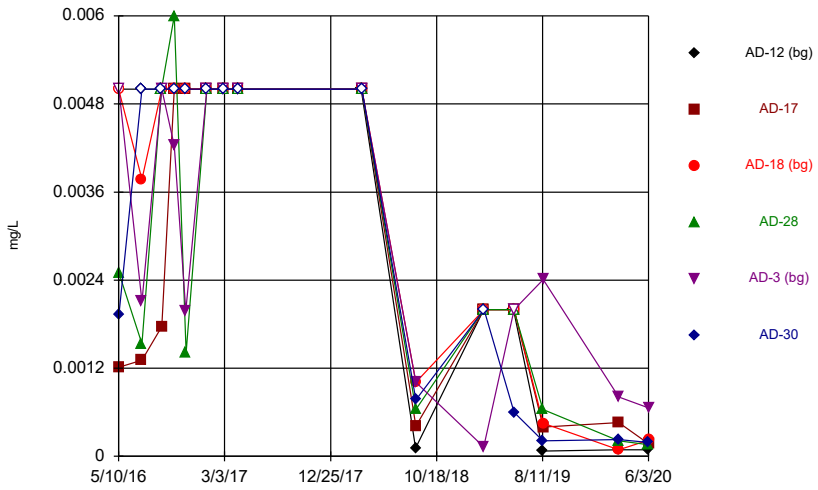
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



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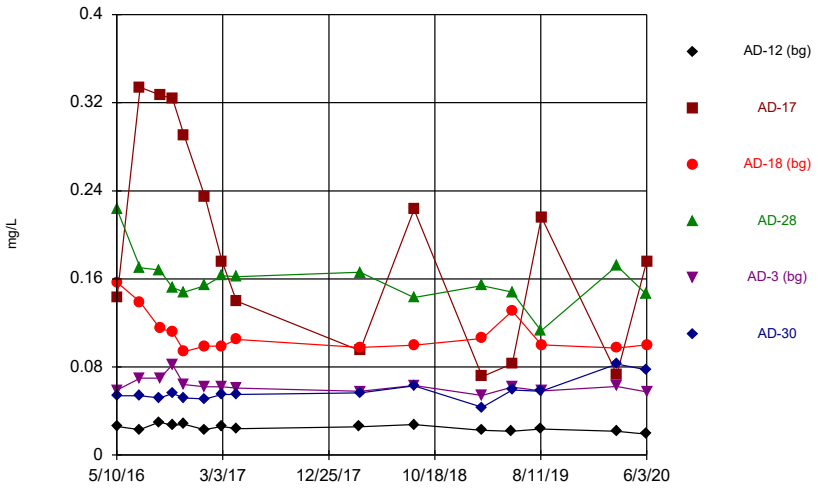
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Time Series



Constituent: Barium, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
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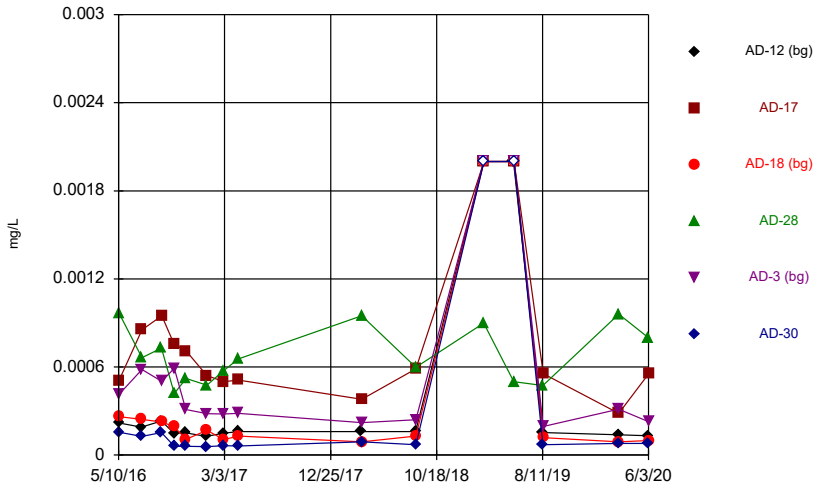
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Beryllium, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
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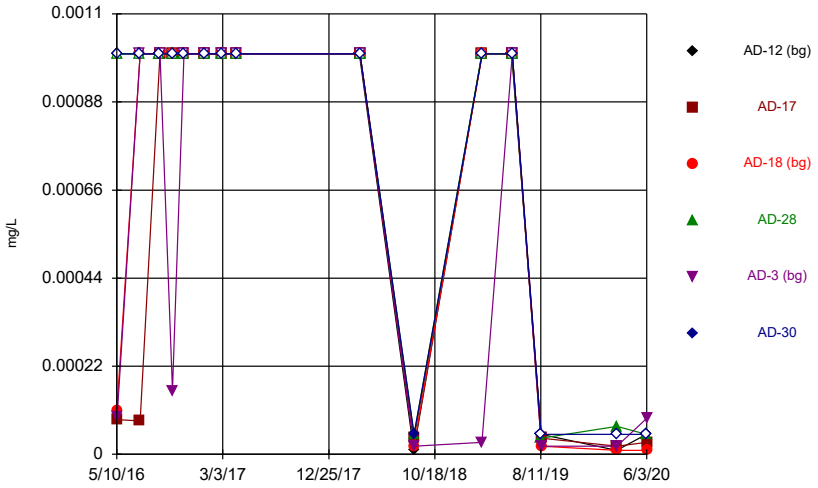
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



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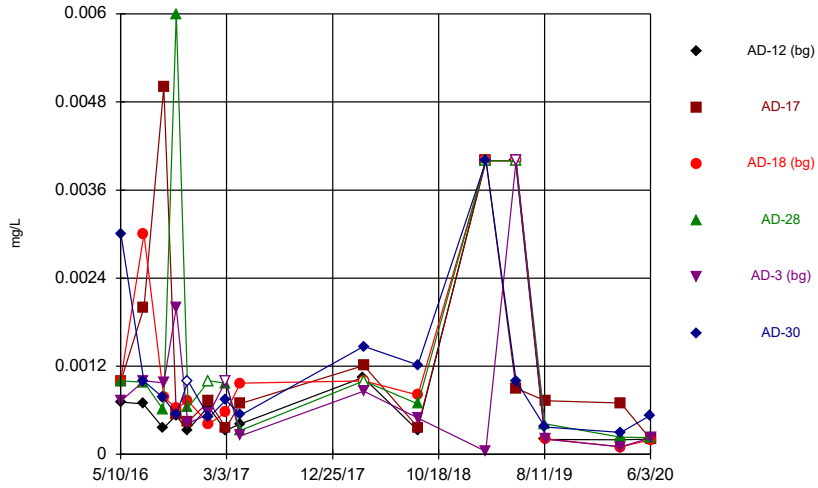
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



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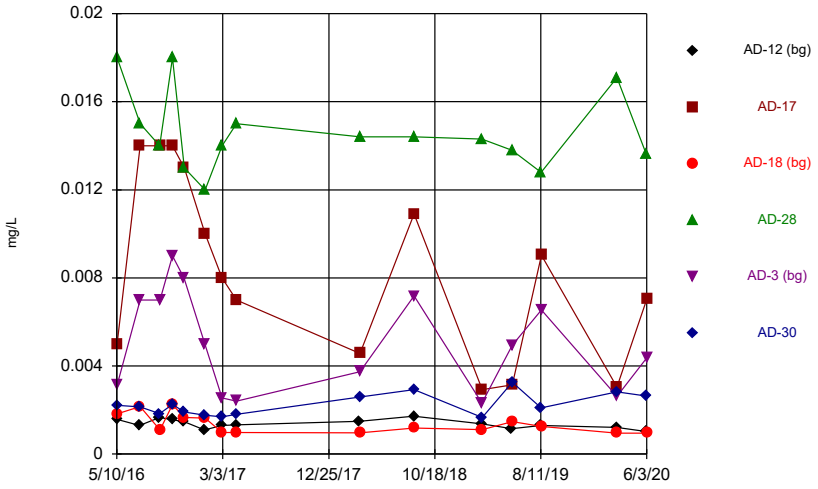
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Time Series



Constituent: Cobalt, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
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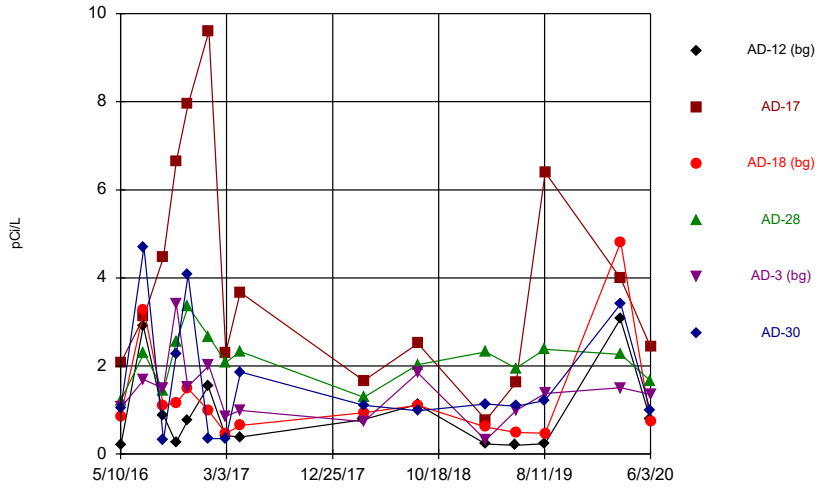
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 9/1/2020 1:39 PM View: Appendix IV
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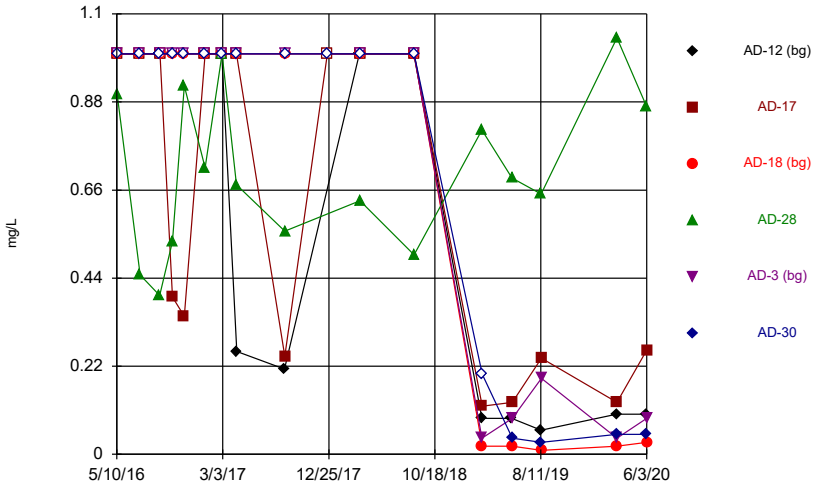
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Fluoride, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
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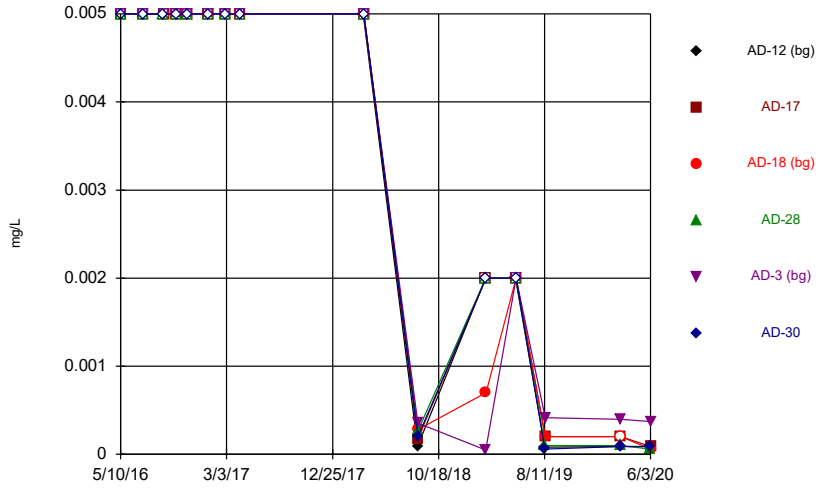
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Lead, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
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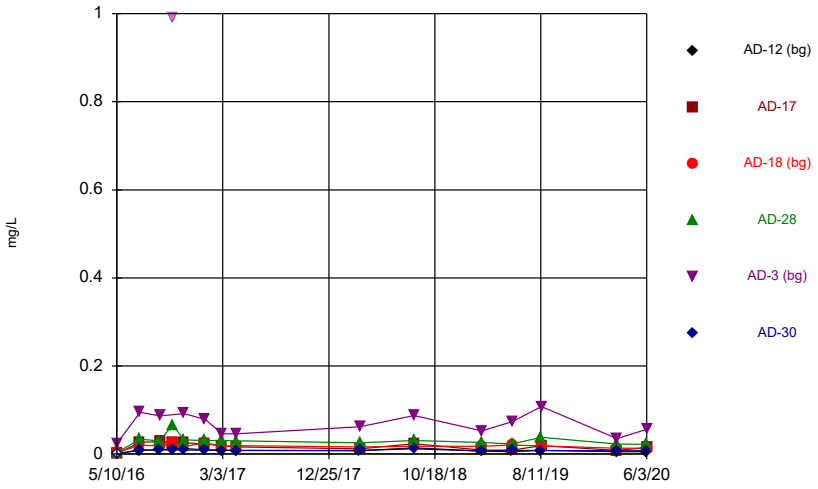
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Lithium, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
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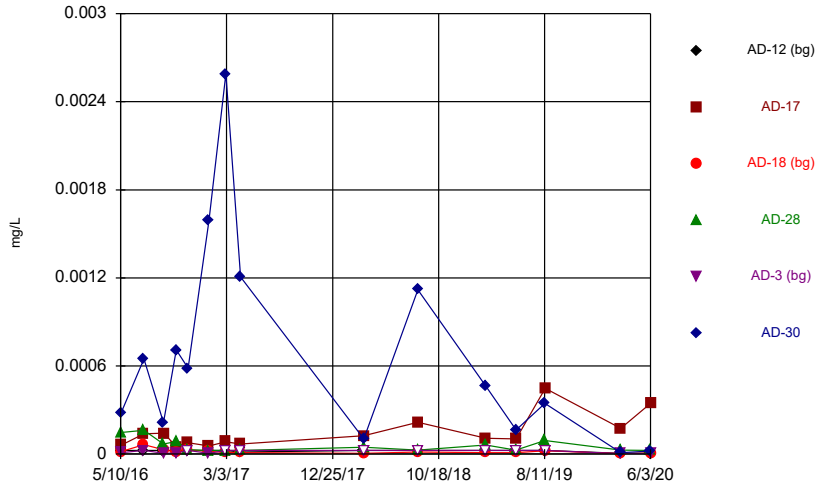
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Mercury, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
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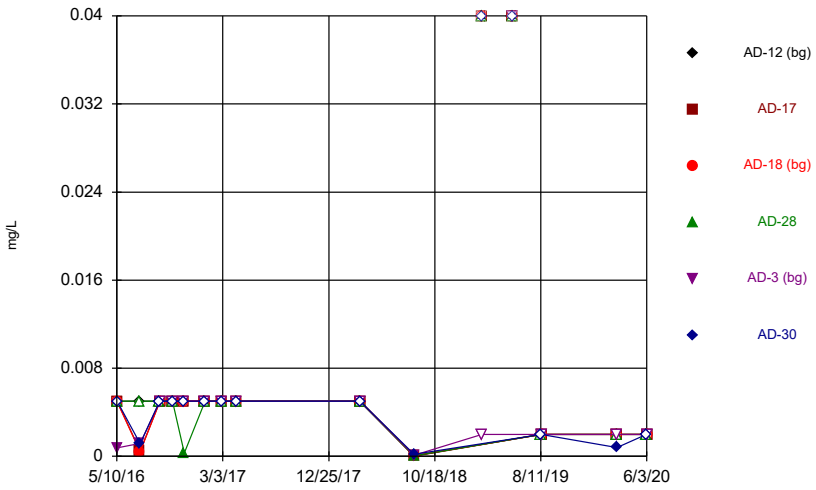
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

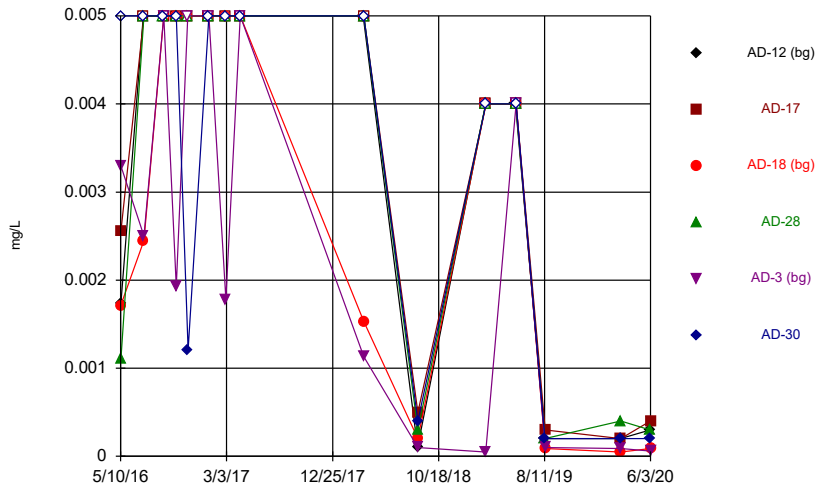
Time Series



Constituent: Molybdenum, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



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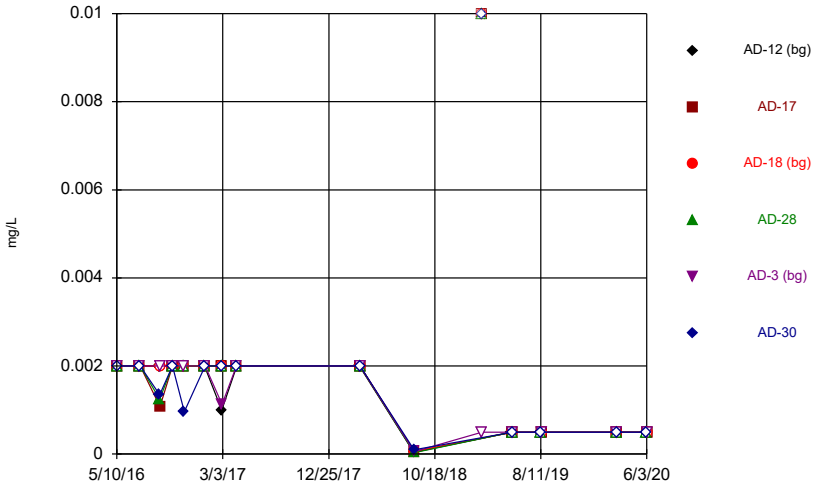
Hollow symbols indicate censored values.

Time Series



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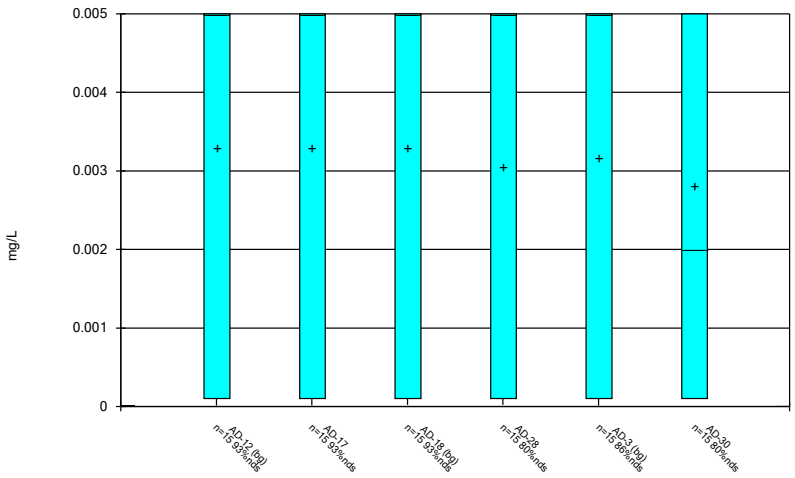
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



Constituent: Antimony, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
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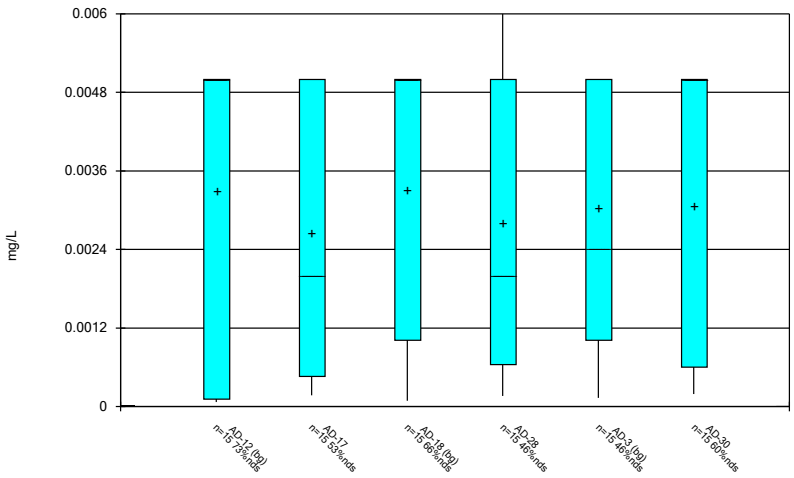
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Box & Whiskers Plot



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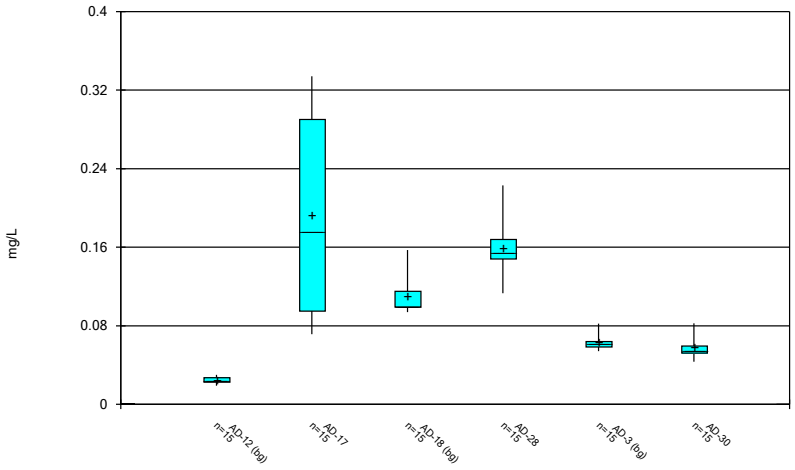
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Barium, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
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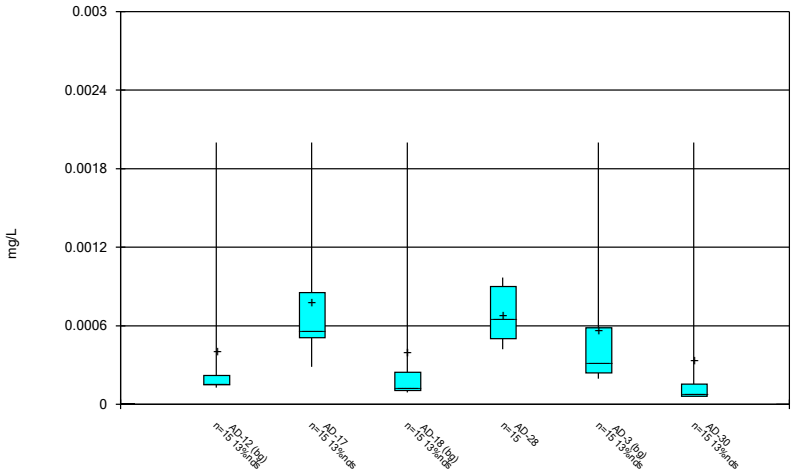
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Beryllium, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
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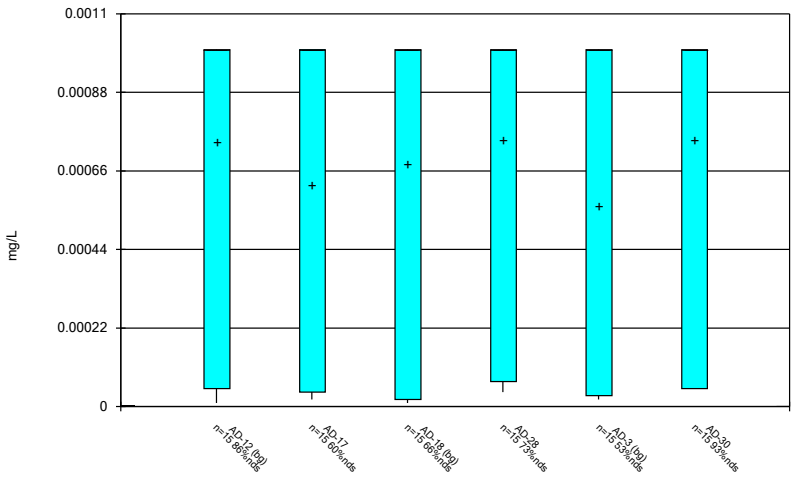
Box & Whiskers Plot



Constituent: Cadmium, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
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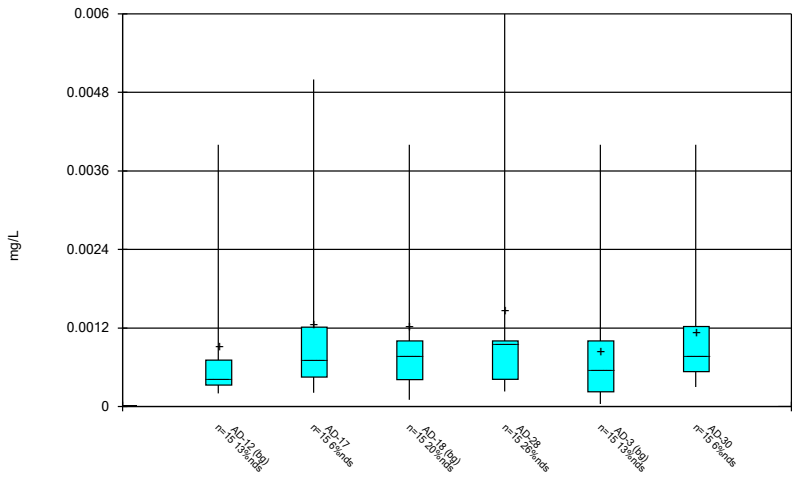
Box & Whiskers Plot



Constituent: Chromium, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
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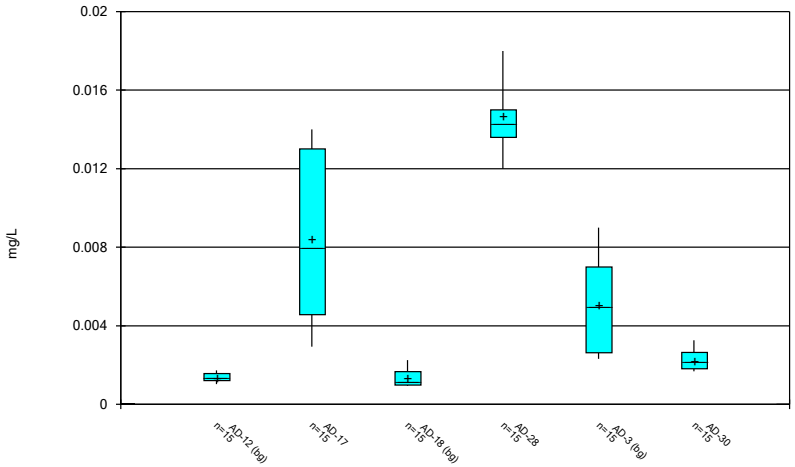
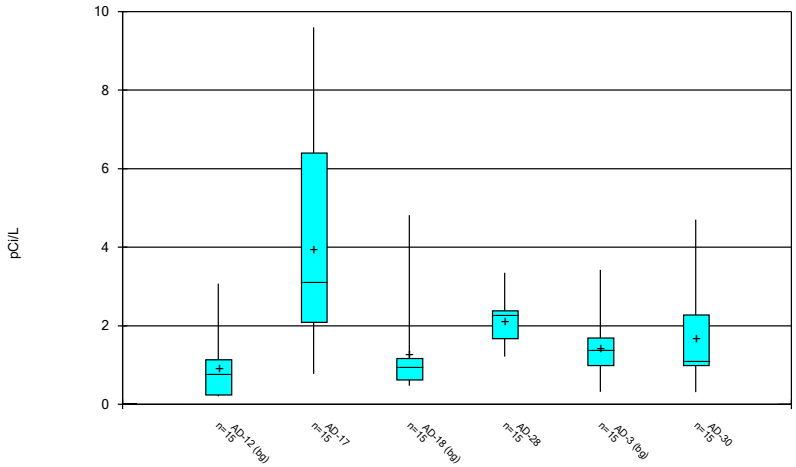
Box & Whiskers Plot



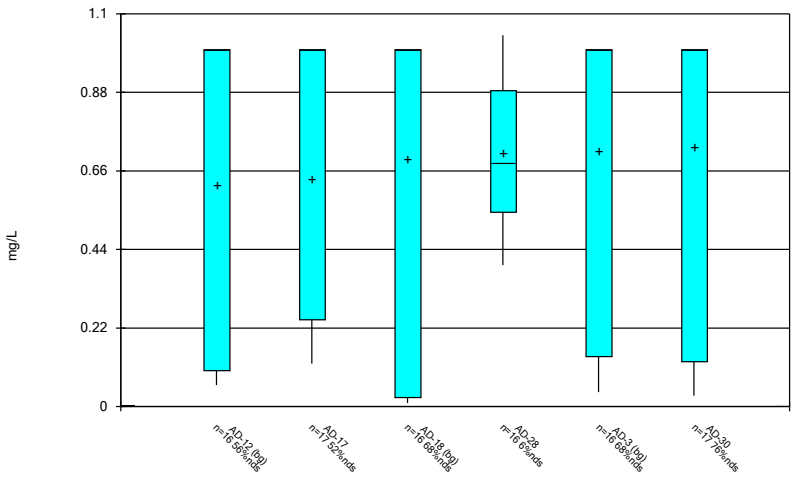
Constituent: Cobalt, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



Constituent: Combined Radium 226 + 228 Analysis Run 9/1/2020 1:42 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

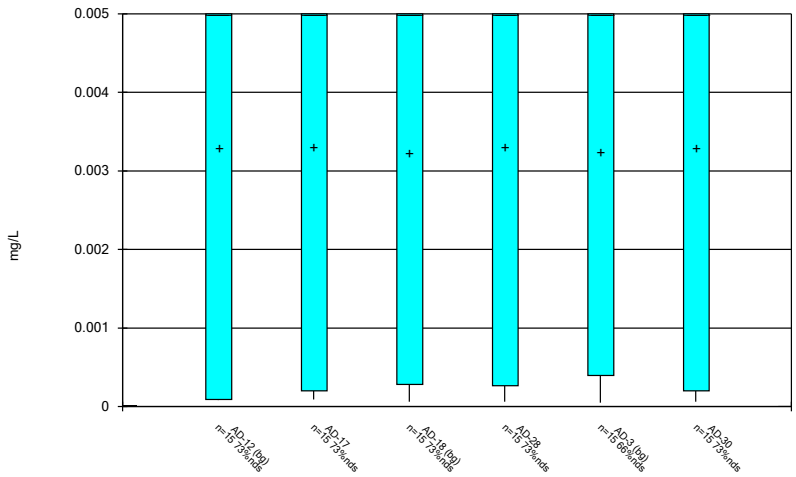
Box & Whiskers Plot



Constituent: Fluoride, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

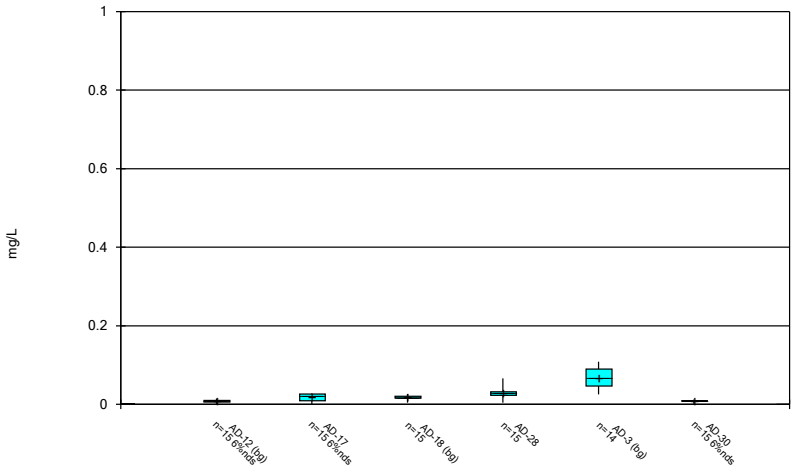
Box & Whiskers Plot



Constituent: Lead, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

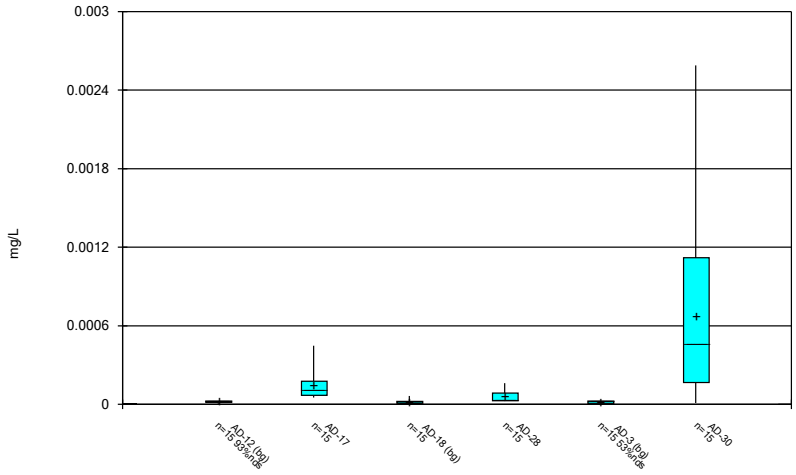
Box & Whiskers Plot



Constituent: Lithium, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Mercury, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
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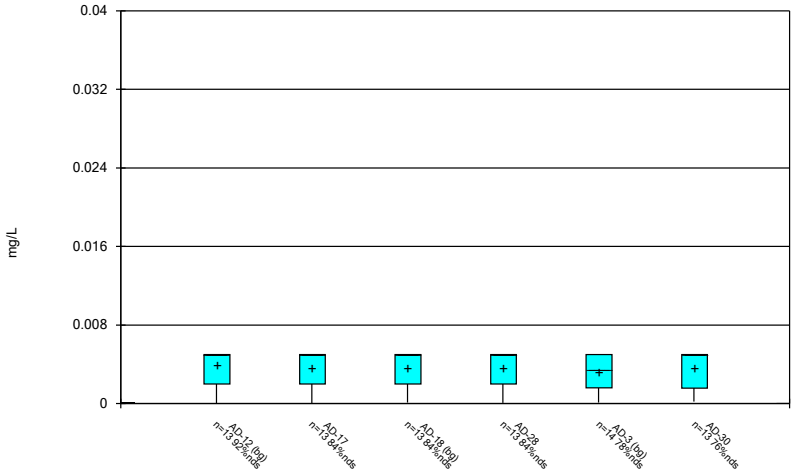
Box & Whiskers Plot



Constituent: Molybdenum, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
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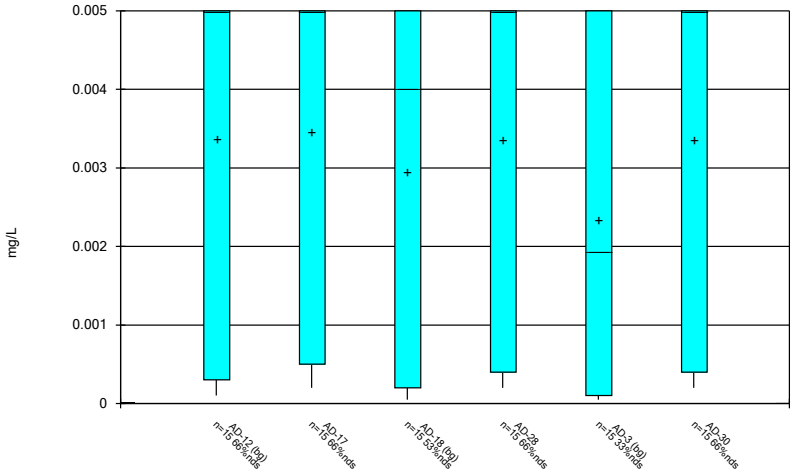
Box & Whiskers Plot



Constituent: Selenium, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
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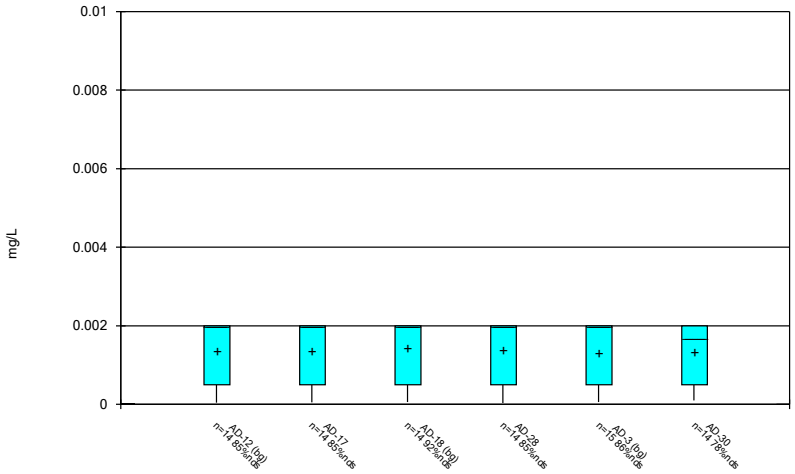
Box & Whiskers Plot



Constituent: Thallium, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Outlier Summary

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 9/1/2020, 1:43 PM

	AD-3 Lithium, total (mg/L)	AD-12 Molybdenum, total (mg/L)	AD-17 Molybdenum, total (mg/L)	AD-18 Molybdenum, total (mg/L)	AD-28 Molybdenum, total (mg/L)	AD-3 Molybdenum, total (mg/L)	AD-30 Molybdenum, total (mg/L)	AD-12 Thallium, total (mg/L)	AD-17 Thallium, total (mg/L)	AD-18 Thallium, total (mg/L)
10/13/2016	0.991 (o)									
2/27/2019		<0.04 (o)			<0.04 (o)			<0.01 (o)		
2/28/2019			<0.04 (o)	<0.04 (o)			<0.04 (o)		<0.01 (o)	<0.01 (o)
5/21/2019		<0.04 (o)								
5/22/2019					<0.04 (o)					
5/23/2019			<0.04 (o)	<0.04 (o)		<0.04 (o)	<0.04 (o)			

	AD-28 Thallium, total (mg/L)	AD-30 Thallium, total (mg/L)
10/13/2016		
2/27/2019	<0.01 (o)	
2/28/2019		<0.01 (o)
5/21/2019		
5/22/2019		
5/23/2019		

Tolerance Limit Summary Table

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 9/1/2020, 1:46 PM

Constituent	Upper Lim.	Lower Lim.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	0.005	n/a	n/a	45	n/a	n/a	91.11	n/a	n/a	0.09944	NP Inter(NDs)
Arsenic, total (mg/L)	0.005	n/a	n/a	45	n/a	n/a	62.22	n/a	n/a	0.09944	NP Inter(NDs)
Barium, total (mg/L)	0.157	n/a	n/a	45	n/a	n/a	0	n/a	n/a	0.09944	NP Inter(normality)
Beryllium, total (mg/L)	0.002	n/a	n/a	45	n/a	n/a	13.33	n/a	n/a	0.09944	NP Inter(normality)
Cadmium, total (mg/L)	0.001	n/a	n/a	45	n/a	n/a	68.89	n/a	n/a	0.09944	NP Inter(NDs)
Chromium, total (mg/L)	0.003583	n/a	n/a	45	-7.811	0.942	15.56	Kaplan-Meier	ln(x)	0.01	Inter
Cobalt, total (mg/L)	0.009	n/a	n/a	45	n/a	n/a	0	n/a	n/a	0.09944	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	3.759	n/a	n/a	45	1.025	0.3952	0	None	sqrt(x)	0.01	Inter
Fluoride, total (mg/L)	1	n/a	n/a	48	n/a	n/a	64.58	n/a	n/a	0.08526	NP Inter(NDs)
Lead, total (mg/L)	0.005	n/a	n/a	45	n/a	n/a	71.11	n/a	n/a	0.09944	NP Inter(NDs)
Lithium, total (mg/L)	0.1261	n/a	n/a	44	0.2824	0.09431	2.273	None	x^(1/3)	0.01	Inter
Mercury, total (mg/L)	0.000064	n/a	n/a	45	n/a	n/a	48.89	n/a	n/a	0.09944	NP Inter(normality)
Molybdenum, total (mg/L)	0.005	n/a	n/a	40	n/a	n/a	85	n/a	n/a	0.1285	NP Inter(NDs)
Selenium, total (mg/L)	0.005	n/a	n/a	45	n/a	n/a	51.11	n/a	n/a	0.09944	NP Inter(NDs)
Thallium, total (mg/L)	0.002	n/a	n/a	43	n/a	n/a	88.37	n/a	n/a	0.1102	NP Inter(NDs)

PIRKEY WBAP GWPS				
Constituent Name	**MCL**	**CCR Rule-Specified**	**Background Limit**	**GWPS**
Antimony, Total (mg/L)	0.006		0.005	0.006
Arsenic, Total (mg/L)	0.01		0.005	0.01
Barium, Total (mg/L)	2		0.16	2
Beryllium, Total (mg/L)	0.004		0.002	0.004
Cadmium, Total (mg/L)	0.005		0.001	0.005
Chromium, Total (mg/L)	0.1		0.0036	0.1
Cobalt, Total (mg/L)	n/a	0.006	0.009	0.009
Combined Radium, Total (pCi/L)	5		3.8	5
Fluoride, Total (mg/L)	4		1	4
Lead, Total (mg/L)	0.015		0.005	0.015
Lithium, Total (mg/L)	n/a	0.04	0.13	0.13
Mercury, Total (mg/L)	0.002		0.000064	0.002
Molybdenum, Total (mg/L)	n/a	0.1	0.005	0.1
Selenium, Total (mg/L)	0.05		0.005	0.05
Thallium, Total (mg/L)	0.002		0.002	0.002

**Grey cell indicates Background Limit is higher than MCL or CCR Rule-Specified Level*

**MCL = Maximum Contaminant Level*

**GWPS = Groundwater Protection Standard*

**CCR = Coal Combustion Resdiual*

Confidence Intervals Summary Table - Significant Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 9/1/2020, 1:47 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Cobalt, total (mg/L)	**AD-28**	**0.01584**	**0.01341**	**0.009**	**Yes**	**15**	**0.01463**	**0.001788**	**0**	**None**	**No**	**0.01**	**Param.**

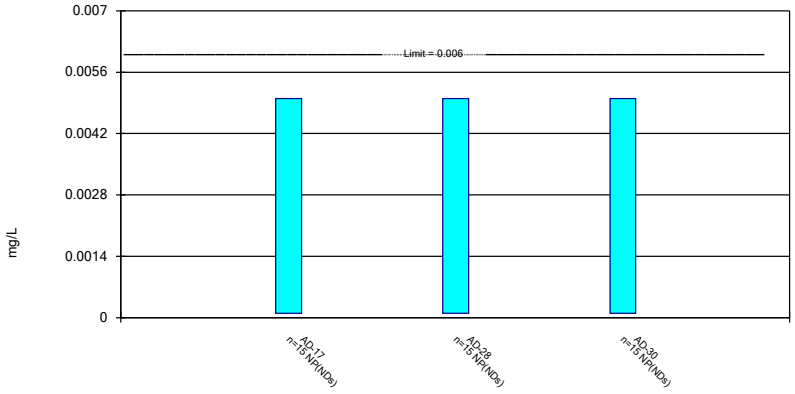
Confidence Intervals Summary Table - All Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 9/1/2020, 1:47 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	AD-17	0.005	0.0001	0.006	No	15	0.003287	0.002251	93.33	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-28	0.005	0.0001	0.006	No	15	0.003056	0.002244	80	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-30	0.005	0.0001	0.006	No	15	0.002807	0.002216	80	None	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-17	0.005	0.00041	0.01	No	15	0.002649	0.002064	53.33	None	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-28	0.00179	0.000318	0.01	No	15	0.002806	0.002111	46.67	Kaplan-Meier	sqrt(x)	0.01	Param.
Arsenic, total (mg/L)	AD-30	0.005	0.00023	0.01	No	15	0.003062	0.002207	60	Kaplan-Meier	No	0.01	NP (NDs)
Barium, total (mg/L)	AD-17	0.2575	0.1299	2	No	15	0.1937	0.0942	0	None	No	0.01	Param.
Barium, total (mg/L)	AD-28	0.1731	0.143	2	No	15	0.1588	0.02303	0	None	ln(x)	0.01	Param.
Barium, total (mg/L)	AD-30	0.0629	0.052	2	No	15	0.05791	0.009988	0	None	No	0.01	NP (normality)
Beryllium, total (mg/L)	AD-17	0.0009604	0.0004649	0.004	No	15	0.0007789	0.0005239	13.33	None	ln(x)	0.01	Param.
Beryllium, total (mg/L)	AD-28	0.0008109	0.0005478	0.004	No	15	0.0006793	0.0001941	0	None	No	0.01	Param.
Beryllium, total (mg/L)	AD-30	0.0001554	0.0000607	0.004	No	15	0.000342	0.0006739	13.33	None	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-17	0.001	0.00004	0.005	No	15	0.00062	0.000482	60	None	No	0.01	NP (NDs)
Cadmium, total (mg/L)	AD-28	0.001	0.00005	0.005	No	15	0.0007473	0.0004337	73.33	None	No	0.01	NP (NDs)
Cadmium, total (mg/L)	AD-30	0.001	0.00005	0.005	No	15	0.0007467	0.0004349	93.33	None	No	0.01	NP (NDs)
Chromium, total (mg/L)	AD-17	0.001516	0.0004663	0.1	No	15	0.001259	0.001397	6.667	None	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-28	0.001076	0.0003645	0.1	No	15	0.001473	0.001732	26.67	Kaplan-Meier	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-30	0.0014	0.00053	0.1	No	15	0.001132	0.001032	6.667	None	ln(x)	0.01	Param.
Cobalt, total (mg/L)	AD-17	0.01119	0.005565	0.009	No	15	0.008376	0.004148	0	None	No	0.01	Param.
Cobalt, total (mg/L)	**AD-28**	**0.01584**	**0.01341**	**0.009**	**Yes**	**15**	**0.01463**	**0.001788**	**0**	**None**	**No**	**0.01**	**Param.**
Cobalt, total (mg/L)	AD-30	0.002581	0.001905	0.009	No	15	0.002243	0.0004988	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-17	5.699	2.199	5	No	15	3.949	2.583	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-28	2.502	1.741	5	No	15	2.122	0.5619	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-30	2.351	0.7361	5	No	15	1.661	1.366	0	None	sqrt(x)	0.01	Param.
Fluoride, total (mg/L)	AD-17	1	0.24	4	No	17	0.639	0.4004	52.94	None	No	0.01	NP (NDs)
Fluoride, total (mg/L)	AD-28	0.8371	0.5796	4	No	16	0.7084	0.1979	6.25	None	No	0.01	Param.
Fluoride, total (mg/L)	AD-30	1	0.05	4	No	17	0.7276	0.4364	76.47	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-17	0.005	0.0002	0.015	No	15	0.003311	0.002214	73.33	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-28	0.005	0.0001	0.015	No	15	0.003302	0.002229	73.33	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-30	0.005	0.00009	0.015	No	15	0.003296	0.002238	73.33	None	No	0.01	NP (NDs)
Lithium, total (mg/L)	AD-17	0.02305	0.01185	0.13	No	15	0.01745	0.008263	6.667	None	No	0.01	Param.
Lithium, total (mg/L)	AD-28	0.034	0.0226	0.13	No	15	0.02977	0.01269	0	None	No	0.01	NP (normality)
Lithium, total (mg/L)	AD-30	0.009627	0.007251	0.13	No	15	0.008224	0.002313	6.667	None	x^2	0.01	Param.
Mercury, total (mg/L)	AD-17	0.0001951	0.00007579	0.002	No	15	0.0001463	0.0001132	0	None	x^(1/3)	0.01	Param.
Mercury, total (mg/L)	AD-28	0.000092	0.000026	0.002	No	15	0.0000584	0.00004511	0	None	No	0.01	NP (normality)
Mercury, total (mg/L)	AD-30	0.0009903	0.0001826	0.002	No	15	0.0006697	0.0007057	0	None	sqrt(x)	0.01	Param.
Molybdenum, total (mg/L)	AD-17	0.005	0.0004858	0.1	No	13	0.003577	0.001955	84.62	None	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-28	0.005	0.0002942	0.1	No	13	0.003565	0.001976	84.62	None	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-30	0.005	0.0008	0.1	No	13	0.003549	0.001962	76.92	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-17	0.005	0.0004	0.05	No	15	0.003464	0.002055	66.67	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-28	0.005	0.0003	0.05	No	15	0.003354	0.002153	66.67	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-30	0.005	0.0002	0.05	No	15	0.003347	0.002166	66.67	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-17	0.002	0.0005	0.002	No	14	0.001366	0.0007859	85.71	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-28	0.002	0.0005	0.002	No	14	0.001377	0.0007851	85.71	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-30	0.002	0.0005	0.002	No	14	0.001315	0.0007619	78.57	None	No	0.01	NP (NDs)

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

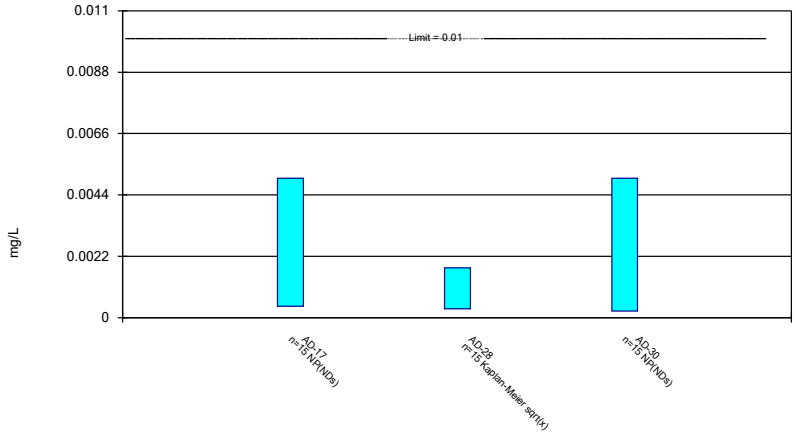


Constituent: Antimony, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Arsenic, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV
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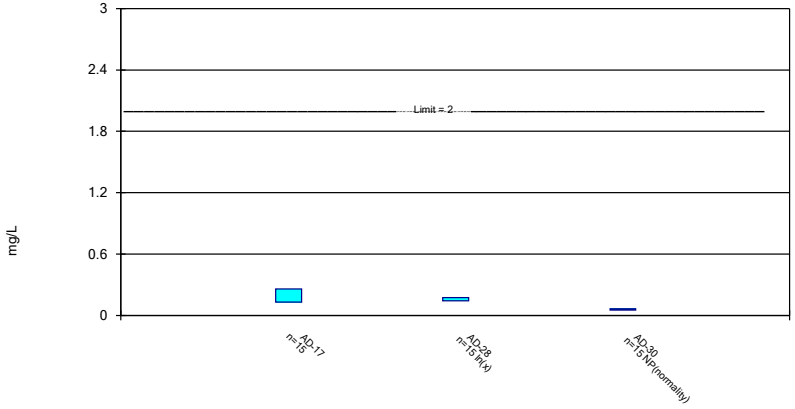
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

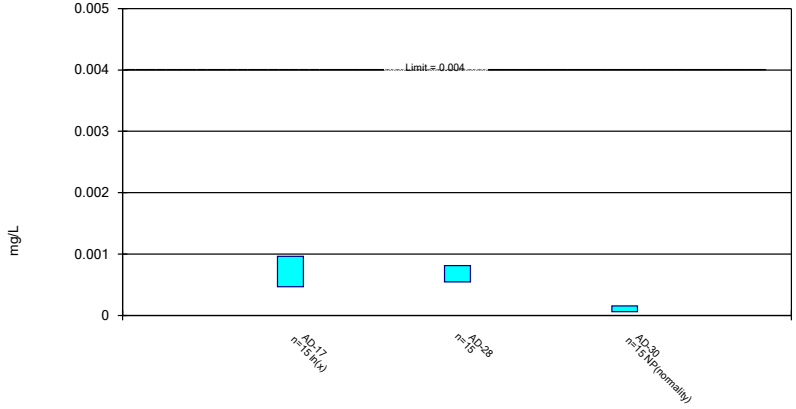


Constituent: Barium, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

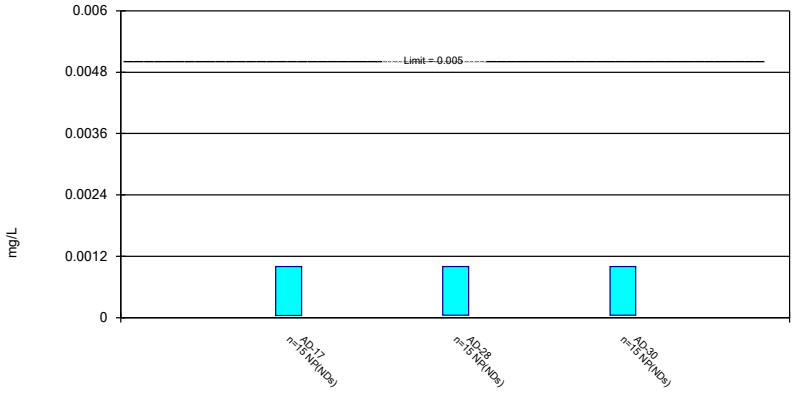
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Beryllium, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

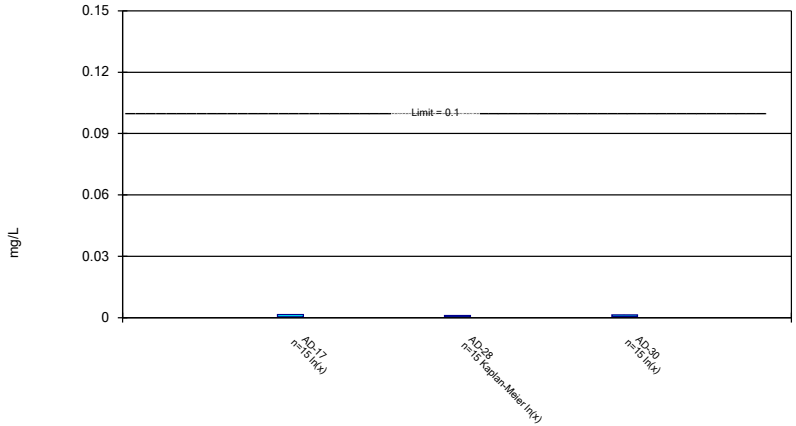
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Cadmium, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

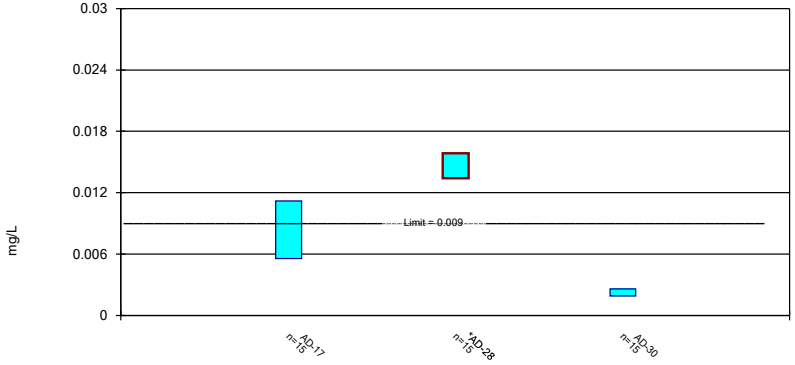
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Chromium, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

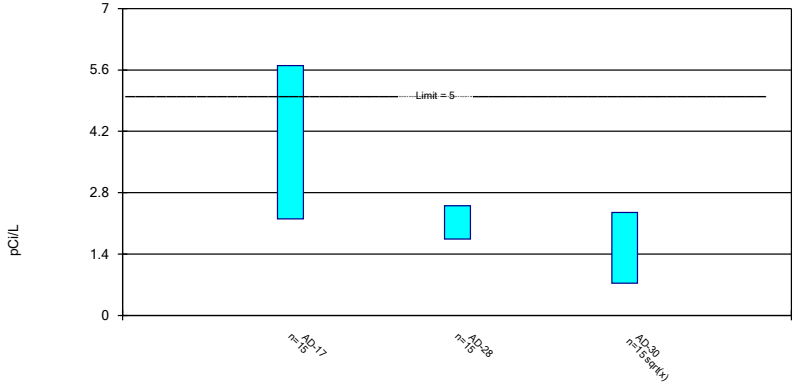
Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cobalt, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

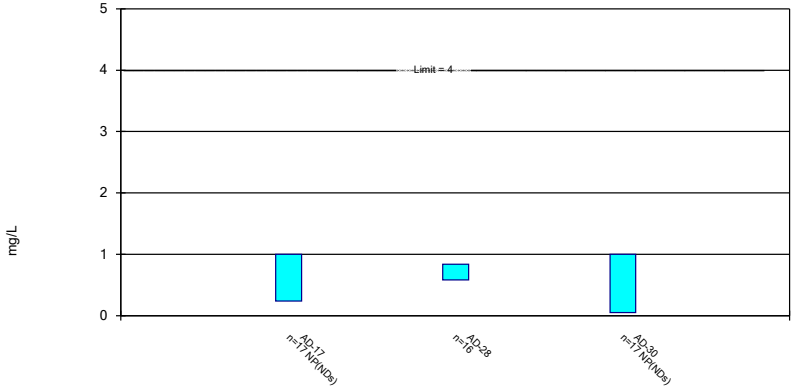
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228 Analysis Run 9/1/2020 1:47 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Fluoride, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

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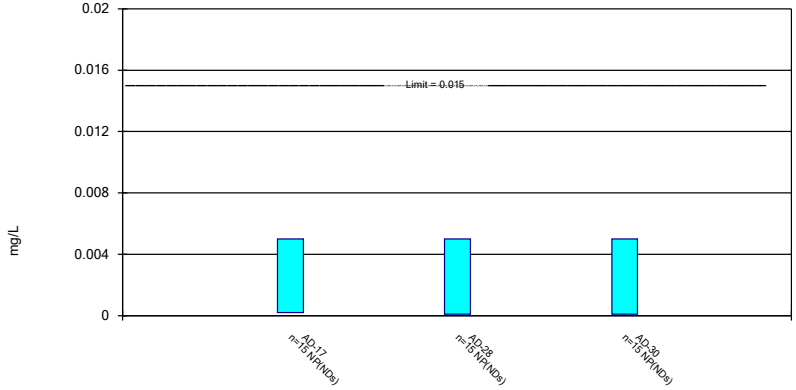
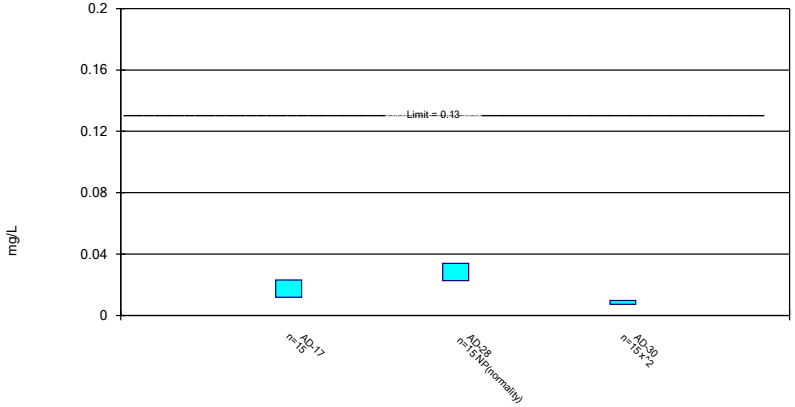


Constituent: Lead, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

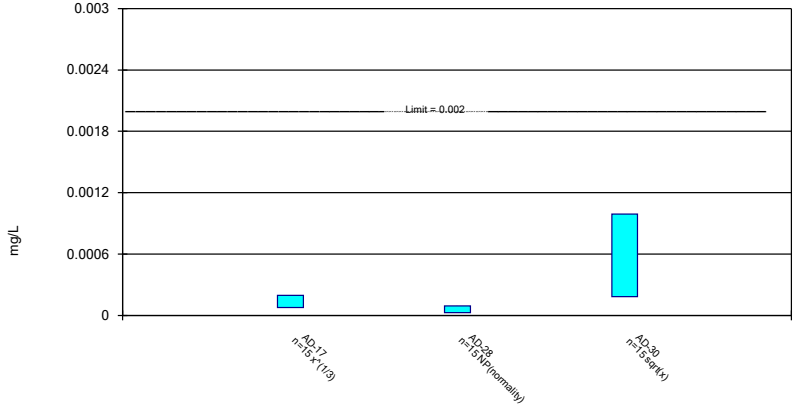
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Lithium, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Mercury, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

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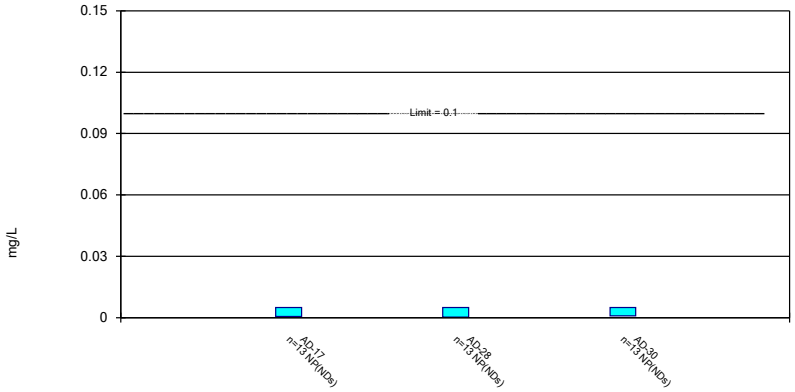
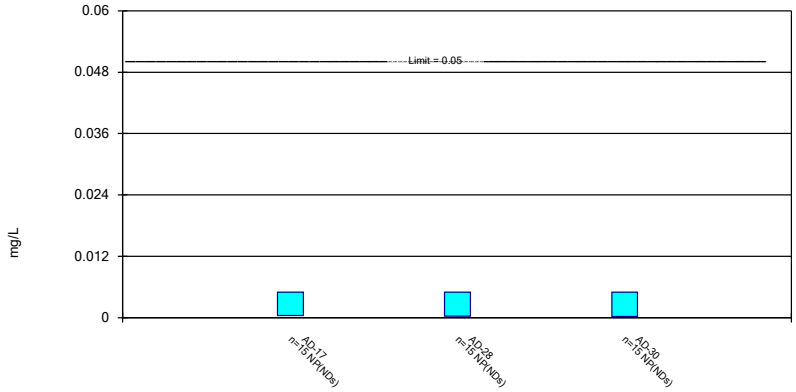


Constituent: Molybdenum, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

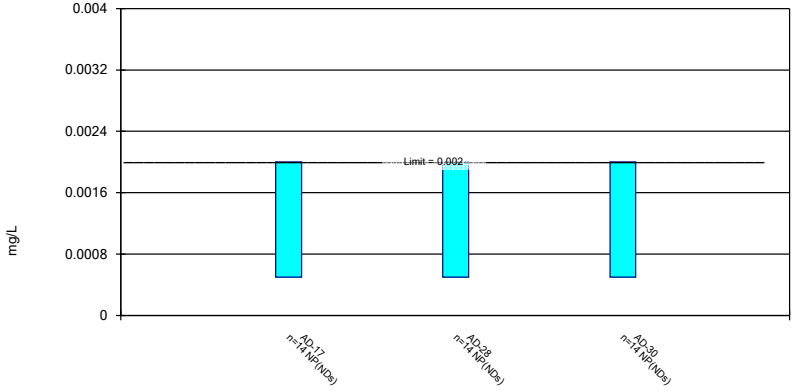


Constituent: Selenium, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Thallium, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

APPENDIX III

Alternate source demonstrations are included in this appendix. Alternate sources are sources or reasons that explain that statistically significant increases over background or statistically significant levels above the groundwater protection standard are not attributable to the CCR unit.

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

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

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

April 2, 2020

CHA8495

TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopy
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 Procedure
SSL	Statistically Significant Level
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

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the West Bottom Ash Pond (WBAP, Figure 1). In August 2019, a semi-annual assessment monitoring event was conducted at the WBAP in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were re-established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) 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 the background concentration and the maximum contaminant level (MCL) or, for constituents without an MCL, the risk-based level specified in 40 CFR 257.95(h)(2). 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 Appendix IV 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). At the WBAP, an SSL was identified for cobalt at AD-28, where the LCL of 0.0132 milligrams per liter (mg/L) exceeded the calculated GWPS of 0.009 mg/L (Geosyntec, 2020). No other SSLs were identified.

1.1 CCR Rule Requirements

USEPA regulations regarding assessment monitoring programs for coal combustion residuals CCR landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSL identified for cobalt at AD-28 is from a source other than the WBAP.

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 SSL identified for cobalt at AD-28 was based on a Type IV cause and not by a release from the Pirkey WBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal 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 SSL identified for 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 ASDs due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSL has been attributed to natural variation associated with the underlying geology, which is a Type IV (natural variation) issue.

Monitoring well AD-28 is located near the southwest corner of the WBAP, as shown in Figure 1. Two previous ASDs for cobalt at the WBAP provided evidence to show 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). The previous ASDs discussed how the WBAP itself 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-864 Test Method 1312, [USEPA, 1994]) of the ash material. Cobalt was not detected in the SPLP leachate above the reporting limit of 0.01 mg/L. Because cobalt mobility is affected by pH, the SPLP test results are likely even more conservative than actual pond conditions. SPLP is run at a pH of 5 SU, whereas the operational pH of the pond varies between approximately 5.8 and 7.0 SU. Cobalt mobility increases under more acidic conditions, although even at a pH of approximately 5, only 2% of cobalt in fly ash is mobile (Izquierdo and Querol, 2012).

Cobalt was also not detected above the reporting limit of 0.005 mg/L in a grab sample of the pond water. As shown in Table 1, the reporting limits for the SPLP ash leachate test and pond water analysis are both below the average concentration of cobalt for samples collected at AD-28 for compliance under the Federal CCR Rule (0.0145 mg/L). Since the previous ASD was prepared, there have been no notable changes in coal handling or sourcing at the plant that would have affected the composition of the ash or pond water.

Four additional permanent wells (B-2, B-3, AD-40, and AD-41) were installed upgradient of the WBAP in 2019. These upgradient locations were selected to represent conditions at the facility which are unimpacted by site operations. The most recent data available for select wells in the vicinity of the WBAP, as well as the upgradient locations, are shown in Figure 2. Groundwater cobalt concentrations at upgradient locations vary from 0.000799 mg/L to 0.0345 mg/L at AD-40 and B-3, respectively. This wide range in cobalt concentrations provides further evidence for the natural variation of cobalt at the Site, particularly as the concentrations at upgradient well B-3

exceed both the GWPS for the WBAP and the LCL calculated for cobalt at AD-28 (the well of interest).

As noted in the previous two ASDs, soil samples collected across the site, including from locations near the WBAP, identified cobalt in the aquifer solids at varying concentrations. While no additional soil samples were collected in support of this ASD, soil sampling data from select upgradient and downgradient locations from the previous investigations are summarized in Table 2 and Figure 3. Cobalt was identified in the aquifer solids at varying concentrations, with the highest value of 23.5 milligrams per kilogram (mg/kg) reported at AD-41, which is upgradient of the WBAP (Figure 3). Other testing included collection of aquifer solids to evaluate for the presence of cobalt-containing minerals. X-ray diffraction evidence identified pyrite and marcasite (both iron sulfides) at select locations at concentrations up to 3% by weight (Table 2). Cobalt is known to substitute for iron in crystalline iron minerals such as pyrite and marcasite due to their similar ionic radii (Krupka and Serne, 2002; Hitzman et al., 2017).

Groundwater samples were collected from upgradient location B-3 via vertical aquifer profiling (VAP), as described in an ASD previously generated for the Pirkey Plant's East Bottom Ash Pond (EBAP; Geosyntec, 2019c). The VAP groundwater samples were centrifuged to separate solid and liquid phases, and the solid material was submitted for analysis of total metals and mineralogy by X-ray diffraction (XRD). The samples were also submitted for analysis of chemical composition and mineralogy by scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS). Following installation of permanent monitoring wells at B-2 and B-3, groundwater samples were collected by purging groundwater through the filter pack using a submersible pump. An additional groundwater sample was collected at AD-30. These permanent well groundwater samples were filtered through a 1.5-micron filter, and the solid material retained on the filter was submitted for analysis of total metals and by SEM/EDS.

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). Cobalt was detected in the solid material filtered out of groundwater at AD-30 at an estimated value of 9.3 mg/kg, which is comparable to the concentration observed in bulk soil collected at the same location at the screened interval (15 mg/kg). These results provide further evidence that cobalt concentrations reported during groundwater sampling are naturally occurring and associated with the solid phase in the aquifer.

According to XRD results of the centrifuged solid sample [VAP-B3-(40-45)], pyrite was present as approximately 3% of the solid phase (Table 3). Logging completed while the VAP boring was advanced identified coal at several intervals, including 45 and 48 ft 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 framboid pattern (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 A). While cobalt was not identified in the EDS spectrum, it is likely present at concentrations below the detection limit.

Pyrite was also identified during SEM/EDS analysis of lignite which is mined immediately adjacent to the site.

In addition to pyrite, hematite (an iron(III) oxide) was present at 2% of the centrifuged solid sample (Table 3). Weathering of pyrite to hematite is a known phenomenon in east Texas soils (Dixon, et al., 1982); the adsorption of cobalt to hematite is a documented mechanism which provides an additional pathway for cobalt to enter groundwater from the soil system (McLaren et al., 1986; Borggaard, 1987).

While soil analytical and mineralogical data are not available for AD-28, the wide distribution of iron minerals across the site suggests that naturally occurring cobalt, which is known to substitute for iron in pyrite or adsorb to hematite, may also be present in the aquifer solids near AD-28. The presence of lignite in the area is well-documented, including at upgradient and downgradient locations relative to the WBAP (Broom and Myers, 1966; ETTL, 2010). Additionally, the pond was not identified as the source of cobalt at AD-28 in the previous two ASDs based on the documented low mobility of cobalt under the pond conditions and lack of detectable cobalt in the pond itself.

2.2 Sampling Requirements

As the ASD presented above supports the position that the identified SSL is not due to a release from the Pirkey WBAP, 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 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL of cobalt for AD-28 identified during assessment monitoring in August 2019 was not due to a release from the WBAP. The identified SSL was, instead, attributed to natural variation in the underlying geology, including the presence of pyrite or marcasite and hematite in the solid aquifer material. Therefore, no further action is warranted, and the Pirkey WBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment B.

SECTION 4

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TABLES

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

Sample	Unit	Cobalt Concentration
Bottom Ash	mg/kg	5.8
SPLP Leachate	mg/L	<0.01
WBAP Pond Water	mg/L	<0.005
AD-28 - Average	mg/L	0.0145

Notes:
mg/kg - milligram per kilogram
mg/L - milligram per liter
AD-28 - Average value was calculated using all cobalt data collected under 40 CFR 257 Subpart D.

Table 2: Soil Cobalt and Mineralogy Data
West Bottom Ash Pond - H.W. Pirkey Plant

Geosyntec Consultants, Inc.

Location ID	Sample Depth (ft bgs)	Cobalt (mg/kg)	Pyrite/Marcasite (%)
Bulk Soil Samples			
AD-17	7	3.10	2
	15	1.50	0
AD-18	8	3.60	1
	22	2.90	0
AD-30	7	1.00	3
	23	15.0	1
AD-31	12	1.90	2
	26	0.83	0
AD-32	11	1.70	--
	20-25	9.10	--
AD-41	15	< 1.0	--
	35	23.5	---
	95	1.90	---
B-2	10	2.36	---
	16	3.62	---
	71	10.30	---
	82	7.21	---
	87	3.11	---
B-3	10	1.30	---
	20	0.59	---
	97	1.11	---
Solid Material Retained After Filtration			
AD-30	15-25	9.3 J	--
B-2	38-48	4.3 J	--
B-3	29-34	12.0	--
	VAP 40-45	18.0	3

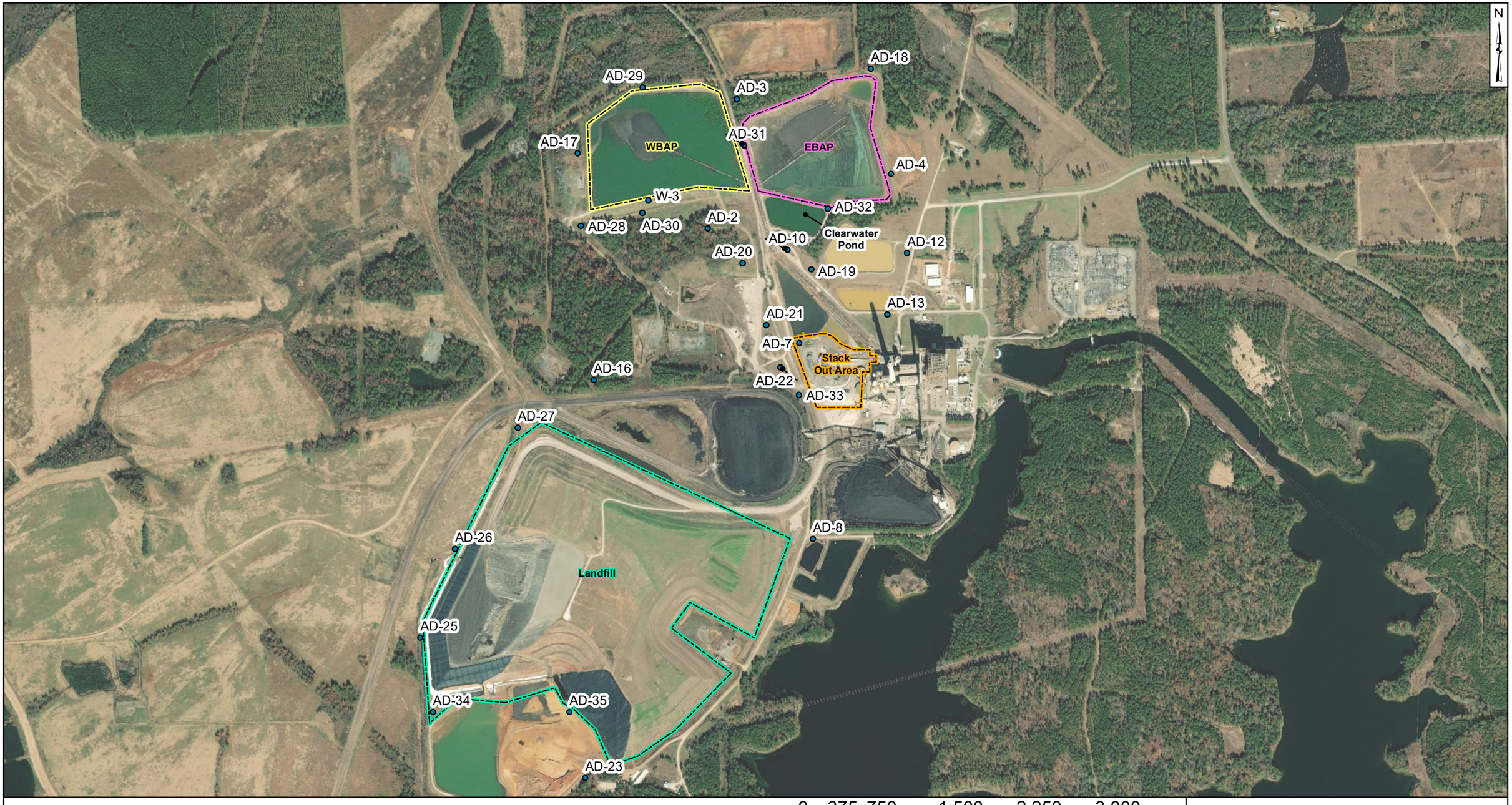
Notes:
'--' - analysis not completed
mg/kg- milligram per kilogram
ft bgs - feet below ground surface
J = estimated value
For AD-XX locations, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation. Samples for B-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.

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

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
Kaolinte	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.

FIGURES



Legend

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

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

0 375 750 1,500 2,250 3,000 Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/03/24

Figure **1**

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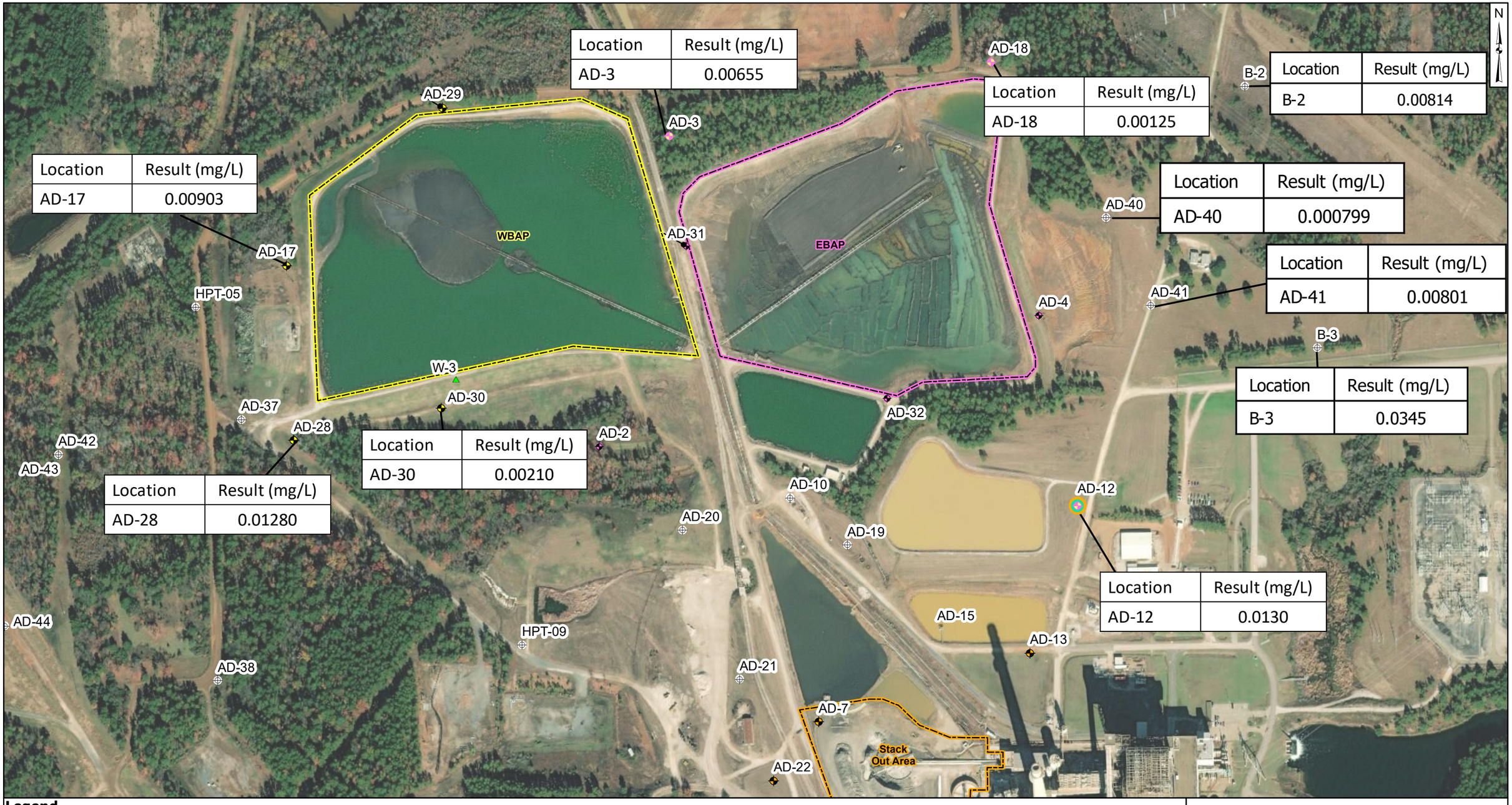

Legend

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- EBAP
- Stack Out Area
- WBAP

Notes
- Monitoring well coordinates, site features, and data provided by AEP
-AD-15 location is approximated
- Samples collected in August 2019
- AD-29 included in the well network for water level measurements only

400 200 0 400 Feet

Cobalt Distribution in Groundwater
August 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/03/30

Figure **2**

C:\Users\BAres\Documents\AEP_Pirkey_Cobalt_20200319.mxd. BAres. 3/30/2020. Project/Phase/Task.

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-17	
Depth (ft bgs)	7	15
Cobalt (mg/kg)	3.1	1.5
Pyrite/Marcasite (%)	2	0

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-30	
Depth (ft bgs)	7	23
Cobalt (mg/kg)	1	15
Pyrite/Marcasite (%)	3	1

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

AD-29
AD-31
AD-18
B-2
AD-40
AD-17
HPT-05
AD-4
AD-41
WBAP
EBAP
B-3
W-3
AD-30
AD-37
AD-28
AD-2
AD-32
Clearwater Pond
AD-10
AD-12
AD-20
AD-19

N

Legend

- Monitoring Wells
- EBAP
- WBAP

Notes
- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019.
- ft bgs: feet below ground surface.
- mg/kg: milligrams per kilogram.
- -- not analyzed.

300 150 0 300 Feet

Soil Chemical and Mineralogical Analysis Results

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/03/19

Figure 3

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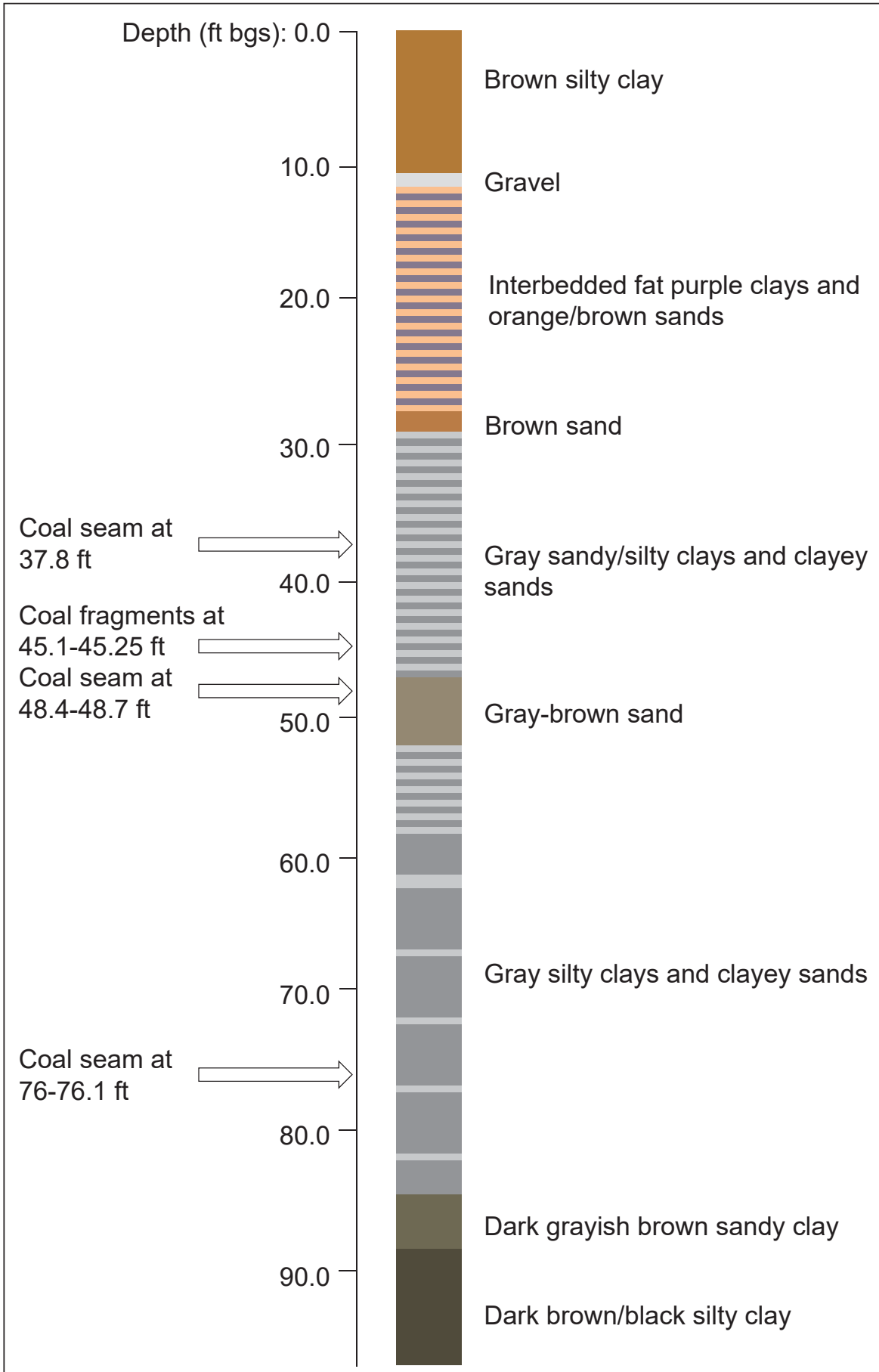


Notes:
- Ft = feet
- Bgs = below ground surface
- Boring completed May 2019
- Total depth of 97.5 ft bgs
- Well installed in offset boring screened at 29-34 ft bgs

B-3 Visual Boring Log

AEP Pirkey Powerplant
Hallsville, TX

Geosyntec consultants

CHA8495	March 2020

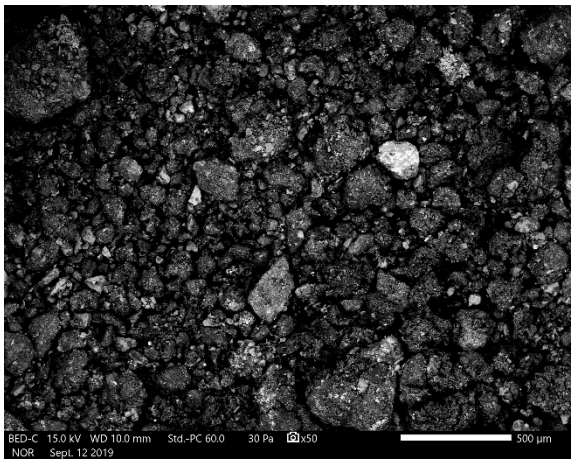
Figure 4

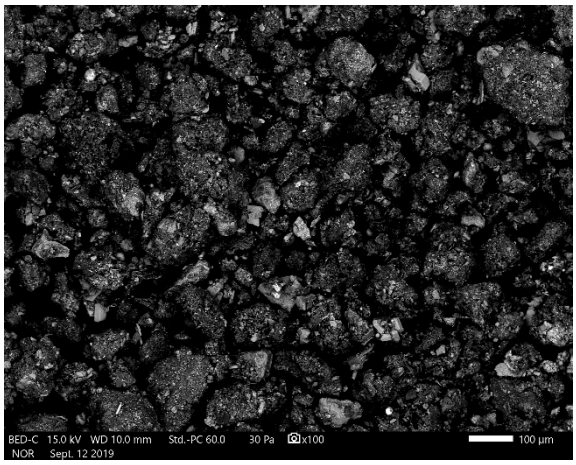
\\annarbor-01\data\Projects\AEP\Legal Department - ASD Review\Pirkey\2019-05 Field Investigation\Field Forms\Compiled Boring Logs\Visual boring logs

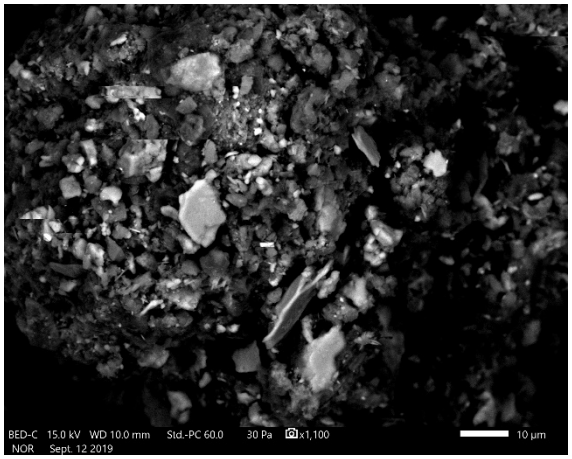
ATTACHMENT A
SEM/EDS Analysis

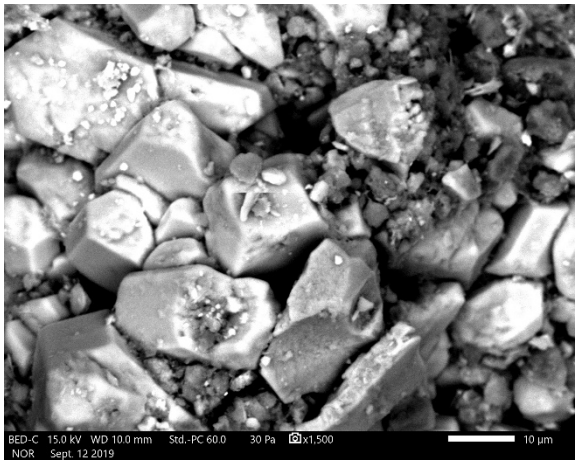
September 16, 2019

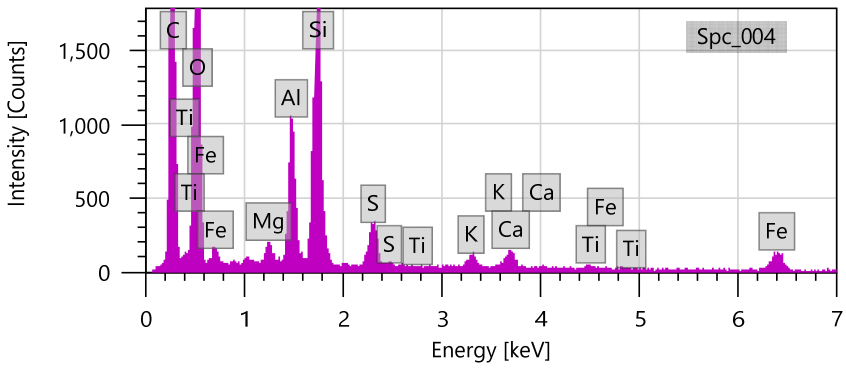
Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221
via Email: BSass@geosyntec.com





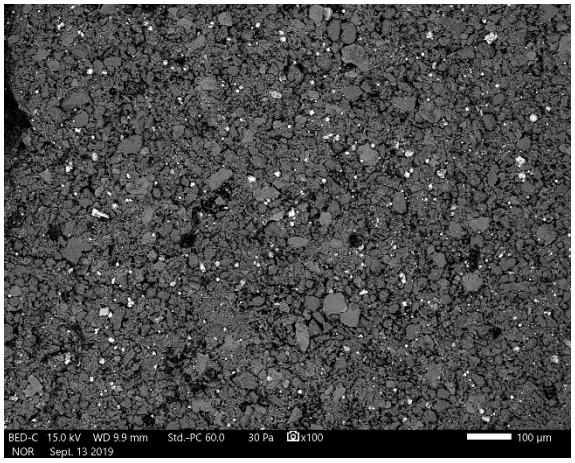


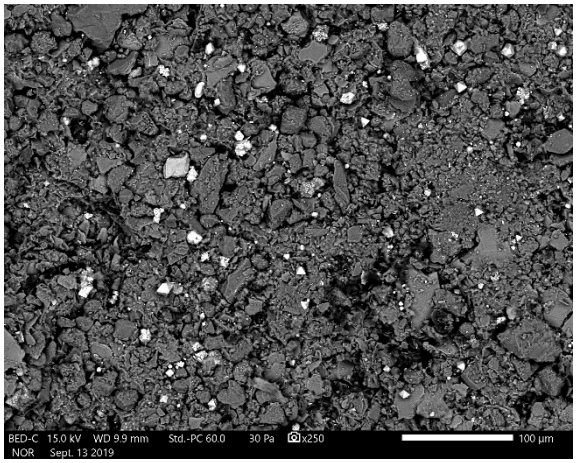


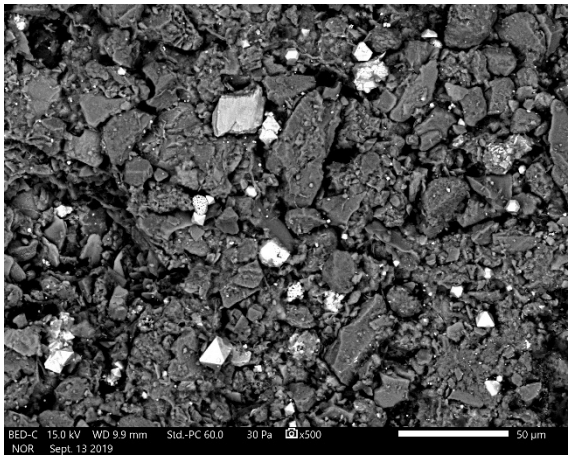


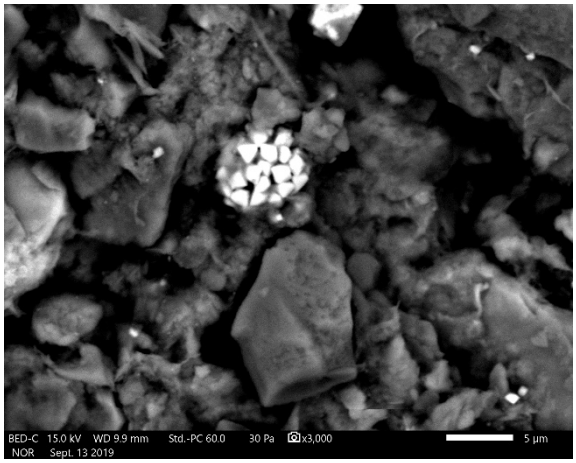
Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.

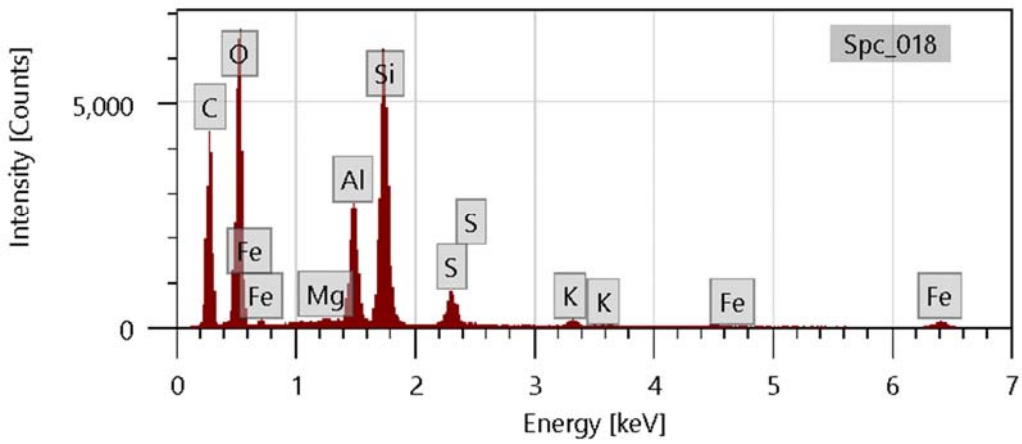
Geosyntec
CTLGroup 150350



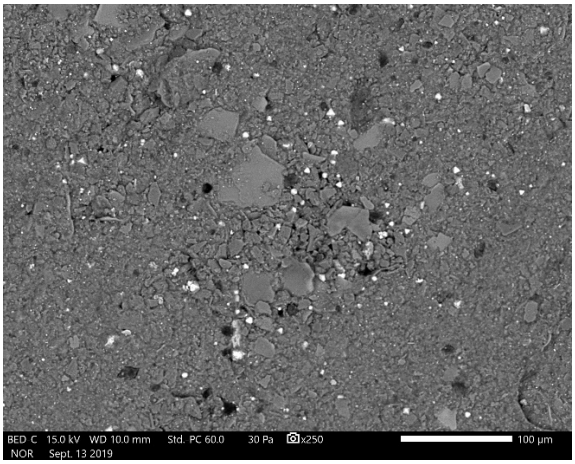


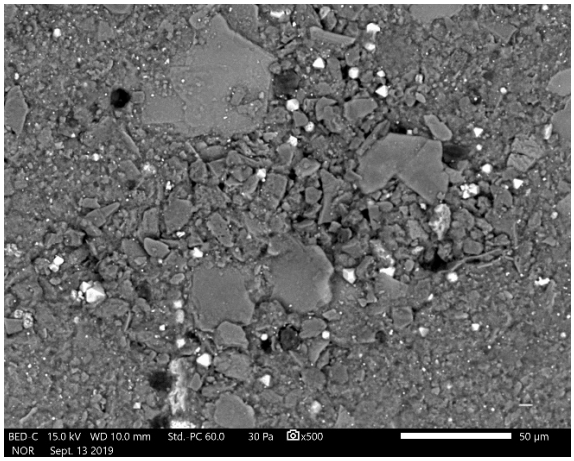


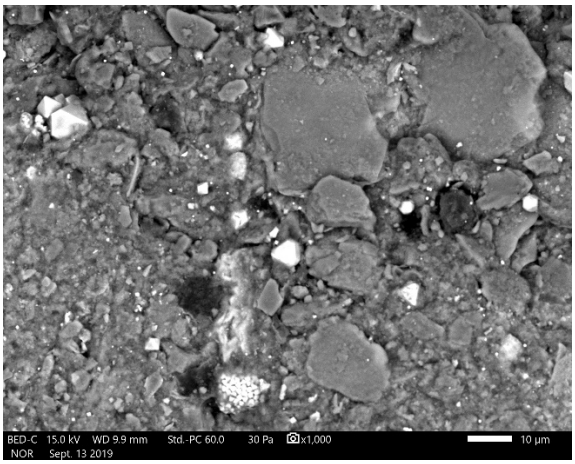


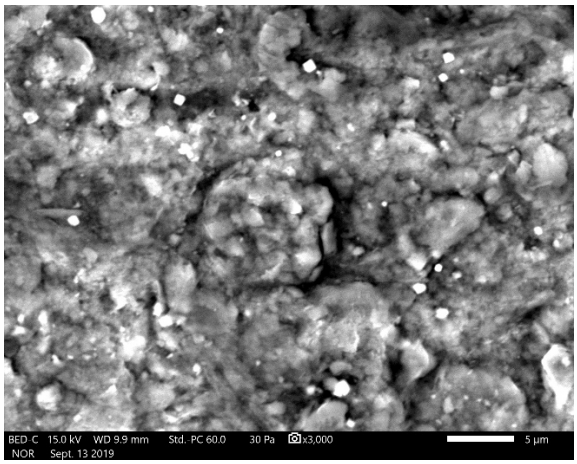


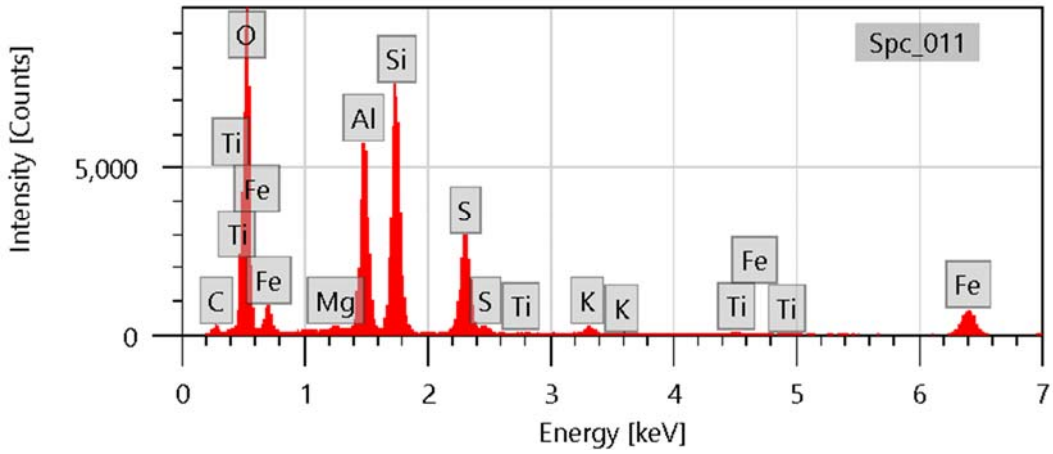
Sample VAP B3 40-45. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 500X. Bright particles are pyrite (framboid in bottom right micrograph). Major peaks for carbon, oxygen, silicon, and aluminum suggest 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 B
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 West Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) 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	Texas	4/2/2020
License Number	Licensing State	Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

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

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

December 2020

CHA8495

TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopy
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 Procedure
SSL	Statistically Significant Level
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 a statistically significant level (SSL) for cobalt in the groundwater monitoring network at the H.W. Pirkey Plant Western Bottom Ash Pond (WBAP) following the first semiannual detection monitoring event of 2020. The WBAP 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, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the West Bottom Ash Pond (**Figure 1**). In June 2020, a semi-annual assessment monitoring event was conducted at the WBAP in accordance with 40 CFR 257.95(d)(1). 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 facility (AEP, 2017) 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 the background concentration and the maximum contaminant level (MCL) or, for constituents without an MCL, the risk-based level specified in 40 CFR 257.95(h)(2). 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. 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). An SSL was identified for cobalt at AD-28 at the WBAP, where the LCL of 0.0134 milligrams per liter (mg/L) exceeded the calculated GWPS of 0.009 mg/L (Geosyntec, 2020a). No other SSLs were identified.

1.1 CCR Rule Requirements

USEPA regulations regarding assessment monitoring programs for CCR landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a*

> *qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section.*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this ASD report to document that the SSL identified for cobalt at AD-28 is from a source other than the WBAP.

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 SSL identified for cobalt at AD-28 was based on a Type IV cause and not by a release from the Pirkey WBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal 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 SSL identified for 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 ASDs 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 the Federal CCR Rule and draft TCEQ guidance for groundwater monitoring (TCEQ, 2020). As described below, the SSL has been attributed to natural variation associated with the underlying geology, which is a Type IV (natural variation) issue.

Monitoring well AD-28 is located near the southwest corner of the WBAP, as shown in **Figure 1**. Previous ASDs for cobalt at the WBAP provided evidence to show 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). The previous ASDs discussed how the WBAP itself 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-864 Test Method 1312, [USEPA, 1994]) of the ash material. Cobalt was not detected in the SPLP leachate above the reporting limit of 0.01 mg/L (**Table 1**).

To support this ASD determination, a grab sample of the pond water was collected from the WBAP on November 4, 2020. Cobalt was detected at a concentration of 0.000501 mg/L in the WBAP sample (**Table 1**). This concentration is 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 observed at AD-28 (**Figure 2; Table 1**). Thus, the WBAP is not the likely source of cobalt at AD-28.

Groundwater cobalt concentrations at the Site vary considerably, even within upgradient monitoring wells. The most recent cobalt concentrations from upgradient wells vary from 0.000799 mg/L at AD-40 to 0.0108 mg/L at B-3 (**Figure 2**). The reported cobalt concentration at downgradient well AD-28, which was identified as an exceedance, was only slightly above the value reported at B-3. The range of cobalt concentrations provides evidence for natural variation of cobalt at the Site, particularly as the concentration at upgradient well B-3 exceeds the GWPS for the WBAP.

As noted in the previous ASDs, soil samples collected across the site, including from locations near the WBAP, identified cobalt in the aquifer solids at varying concentrations. SB-28 was advanced in the vicinity of AD-28 in April 2020 to re-log the geology at AD-28 and collect samples for laboratory analysis of total metals and mineralogy. The SB-28 field boring log, generated by Auckland Consulting LLC, is provided as **Attachment A**. Cobalt was identified at SB-28 at concentrations of 4.53 milligrams per kilogram (mg/kg) at 15.5-16 feet below ground surface (bgs) and 8.70 mg/kg at 40-41 feet bgs (**Table 2**). The 15.5-16 feet bgs interval at SB-28 correlates to the depth of the monitoring well screen of AD-28 (15-35 feet bgs), indicating that cobalt is present in aquifer solids within the AD-28 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 WBAP (**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-28 identified pyrite (an iron sulfide) in samples collected at 25-30 feet bgs and 40-41 feet bgs at concentrations up to 3% by weight (**Table 2, Table 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 angstrom (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-28 are distinctly red in color at shallow depths, as illustrated in the photolog of soil cores provided in **Attachment B.** Red color in soils is often associated with the presence of oxidized iron-bearing minerals such as hematite and goethite. Goethite, an iron oxide mineral (FeOOH), was present at depths up to 16 ft bgs at SB-28 at up to 37% of the total aquifer solids (**Table 3**). 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 an ASD previously generated for the Pirkey Plant's East Bottom Ash Pond, vertical aquifer profiling was used to collect groundwater samples from upgradient locations B-2 and B-3 during the soil boring and sample collection process (EBAP; Geosyntec, 2019c). A groundwater sample was also collected from AD-30, an existing well within the WBAP groundwater monitoring network. Solid phases within these groundwater samples were separated and submitted for analysis of chemical composition and mineralogy. For the VAP samples, separation was completed using a centrifuge. For the groundwater sample at AD-30, 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 4**). 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 ft 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, which is then known to weather to iron oxides. The presence of pyrite and iron oxides has been confirmed at AD-28 and across the Site. The presence of these aquifer minerals suggests that pyrite may be providing a source for aqueous cobalt in groundwater. Additionally, the pond was not identified as the source of cobalt at AD-28 based on the low concentrations of cobalt in the pond itself.

2.2 Sampling Requirements

As the ASD presented above supports the position that the identified SSL is not due to a release from the Pirkey WBAP, 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 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL for cobalt identified at AD-28 during assessment monitoring in June 2020 was not due to a release from the WBAP. The identified SSL was, instead, attributed to natural variation in the underlying geology, including the presence of pyrite and goethite in the solid aquifer material. Therefore, no further action is warranted, and the Pirkey WBAP 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 Analytical Data
West Bottom Ash Pond - H.W. Pirkey Plant

Sample	Sample Date	Unit	Cobalt Concentration
Bottom Ash	2/11/2019	mg/kg	5.8
SPLP Leachate	2/11/2019	mg/L	<0.01
WBAP Pond Water	11/4/2020	mg/L	0.000501
AD-28 - Average	May 2016 - June 2020	mg/L	0.0146

Notes:
mg/kg - milligram per kilogram
mg/L - milligram per liter
AD-28 - Average value was calculated using all cobalt data collected under 40 CFR 257 Subpart D.

Table 2: Soil Cobalt and Mineralogy Data
West Bottom Ash Pond - H.W. Pirkey Plant

Geosyntec Consultants, Inc.

Location ID	Location	Sample Depth (ft bgs)	Cobalt (mg/kg)
Bulk Soil Samples			
AD-28	WBAP Network	6-6.5	< 2.38
		15.5-16	4.53
		25-30	< 2.50
		40-41	8.70
AD-30	WBAP Network	7	1.00
		23	15.0
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-30	WBAP Network	15-25	9.3 J
B-2	Upgradient	38-48	4.3 J
B-3	Upgradient	29-34	12.0
		VAP 40-45	18.0

Notes:

mg/kg- milligram per kilogram

ft bgs - feet below ground surface

J = estimated value

For AD-28 and AD_30, 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 at B-2 and B-3 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 - AD-28 Mineralogy Results
West Bottom Ash Pond - H. W. Pirkey Plant

Boring ID	**SB-28 (AD-28)**			
Sample Depth Interval	6-6.5	15.5-16	25-30	40-41
Sample Location	Above Screened Interval	Within Screened Interval		Below Screened Interval
Color	Red-brown to yellow-brown	Light gray, light red-brown	Brown, light red-brown	Gray to dark gray
Mineralogy				
Quartz	58%	46%	73%	34%
Pyrite	--	--	3%	3%
K-Feldspar	--	1%	1%	1%
Siderite	--	--	2%	52%
Goethite	37%	15%	--	--
Anhydrite	--	--	--	2%
Clay/Mica	5%	38%	21%	8%

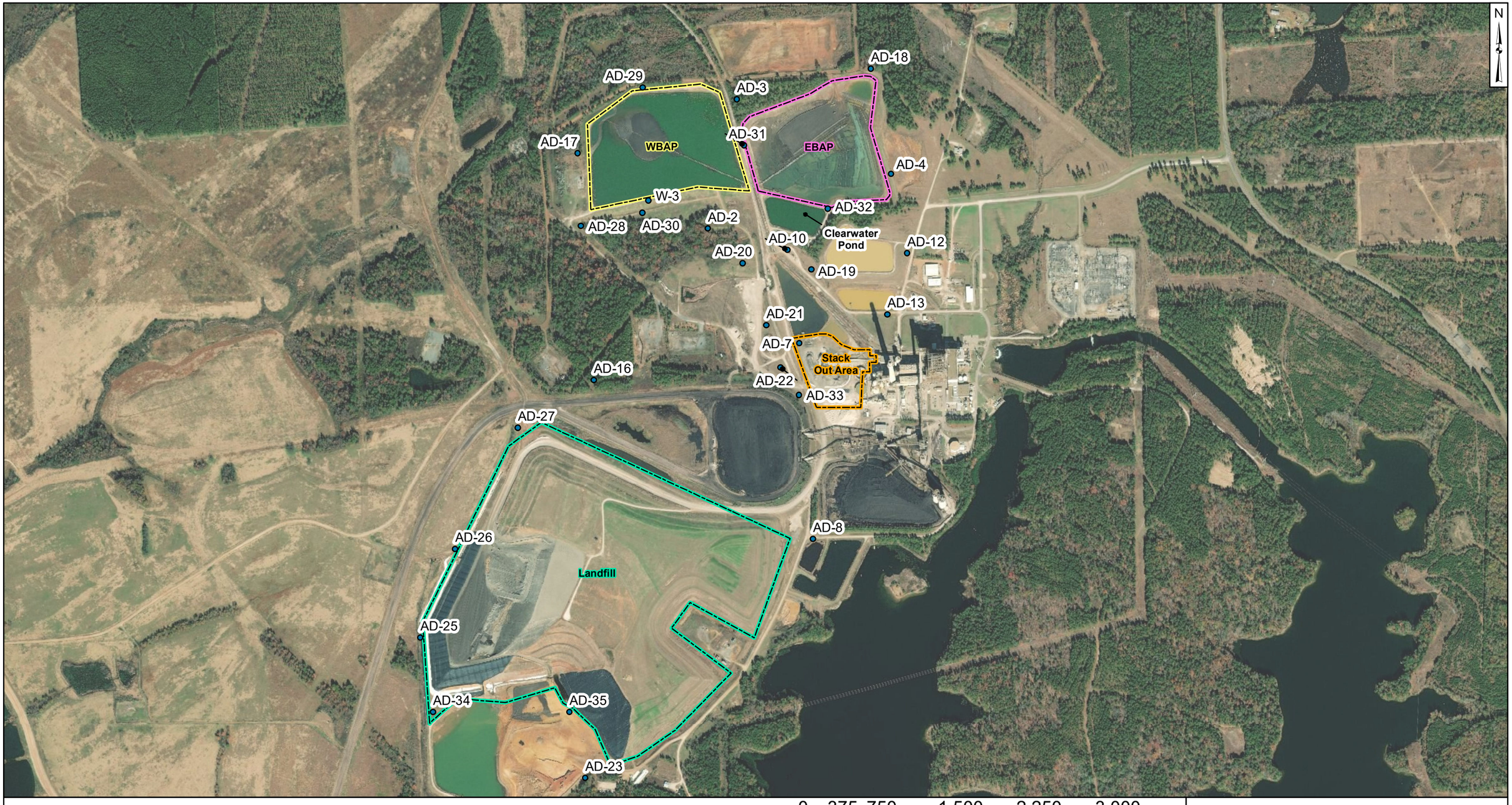
Notes:
Sample depths are shown in feet below ground surface (bgs)
Well AD-28 is screened from 15-35 ft. below ground surface.
Mineralogical components are shown in relative abundance.

Table 4: B-3 X-Ray Diffraction Results
West Bottom Ash Pond - H. W. Pirkey Plant

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
Kaolinte	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.

FIGURES



Legend

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

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

0 375 750 1,500 2,250 3,000 Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/11/18

Figure **1**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Site_Layout_2020324.mxd. hduff. 3/24/2020. Project/Phase/Task.

AD-3	Result (mg/L)
	0.00436

AD-18	Result (mg/L)
	0.00095

B-2**	Result (mg/L)
	0.00716

AD-17	Result (mg/L)
	0.00702

AD-40*	Result (mg/L)
	0.000799

AD-41*	Result (mg/L)
	0.00801

B-3**	Result (mg/L)
	0.0108

AD-28	Result (mg/L)
	0.0136

AD-30	Result (mg/L)
	0.00264

AD-12	Result (mg/L)
	0.0010

AD-29
AD-31
AD-32
AD-4
AD-2
AD-10
AD-12
AD-20
AD-19
AD-15
AD-13
AD-21
AD-7
AD-30
AD-37
AD-28
AD-43
AD-42
AD-44
AD-45
AD-38
HPT-09
HPT-05
AD-17
AD-18
AD-40
AD-41
B-2
B-3
W-3
WBAP
EBAP
Clearwater Pond
Stack Out Area
N

Legend

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- EBAP
- Stack Out Area
- WBAP

Notes
- Monitoring well coordinates, site features, and data provided by AEP.
- AD-15 location is approximated
- Samples collected in June 2020
- * - Well most recently sampled August 2019
- ** - Well most recently sampled November 2020
- AD-29 included in the well network for water level measurements only

400 200 0 400
Feet

Cobalt Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/12/22

Figure **2**

\\annarbor-01\data\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_Pirkey_Cobalt_20201222.mxd. CChristenson. 12/22/2020. Project/Phase/Task.

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-17	
Depth (ft bgs)	7	15
Cobalt (mg/kg)	3.1	1.5
Pyrite/Marcasite (%)	2	0

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

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

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

Location	AD-28			
Depth (ft bgs)	6 – 6.5	15.5 - 16	25 - 30	40 - 41
Cobalt (mg/kg)	< 2.38	4.53	< 2.50	8.7
Pyrite/Marcasite (%)	0	0	3	3

Location	AD-30	
Depth (ft bgs)	7	23
Cobalt (mg/kg)	1	15
Pyrite/Marcasite (%)	3	1

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

AD-29
AD-31
AD-18
B-2
AD-40
AD-17
HPT-05
WBAP
EBAP
AD-4
AD-41
B-3
W-3
AD-30
AD-2
AD-37
AD-28
Clearwater Pond
AD-32
AD-10
AD-12
AD-20
AD-19

N

Legend

- Monitoring Wells
- EBAP
- WBAP

Notes
- Monitoring well coordinates provided by AEP.
- AD-2 and AD-28 samples 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.

300 150 0 300
Feet

Cobalt Distribution in Soil

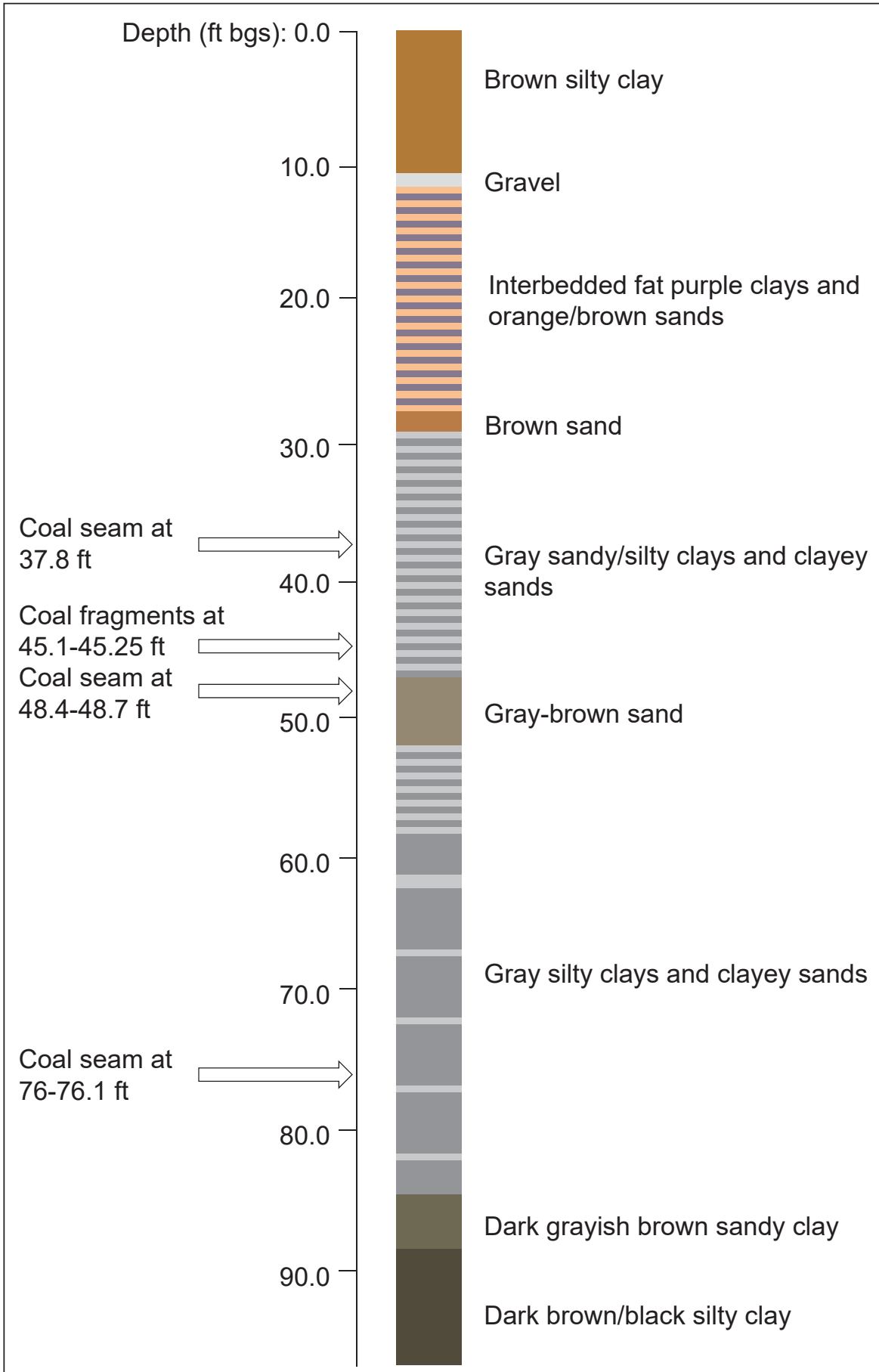
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/12/22

Figure 3

\\annarbor-01\data\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\20201218 Pirkey_SoilChem_minerals_March2019_new.mxd. CChristenson. 12/22/2020. Project/Phase/Task.



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

CHA8495	November 2020

Figure 4

\\annarbor-01\data\Projects\AEP\Legal Department - ASD Review\Pirkey\2019-05 Field Investigation\Field Forms\Compiled Boring Logs\Visual boring logs

ATTACHMENT A
SB-28 Boring Log

PROJECT NO. _____ PROJ. _____ BOR. NO. SB-28

LOCATION AD-28/MW-28 - Pirkey Power Plant ELEV. _____ DATE 4/20/20

SILTS & SANDS		COHESIVE SOILS - CLAYS			COLORS	MATERIALS	SAND ADJ.	CHARACTERTICS
CONDITION		CONSISTENCY	PENETROMETER	N - VALUE	Li .... Light .....Br ....Brown	Cl ..... Clay, Clayer	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 ....Grenn	Ls .... Limestone	Si.....Silty	Lam ..... Laminate
De ..... Dense	30-50	St..... Stiff	1.0 - 2.0	8 - 15	R ..... Red .....Y .....Yellow	Gr .... Gravel		Sls ..... Slickensided
VDe ..... Very Dense	>50	VSt.. Very Stiff	2.0 - 4.0	15 - 30	Rdish.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 - TEST ASSIGNMENT	SAMPLE NO. Recovery	DEPTH FT.	SAMPLES	STRATUM DESCRIPTION: CONDITION OR CONSISTENCY	COLOR	MINOR MATERIALS OR ADJECTIVES	PREDOMINATE MATERIAL	CHARACTERISTICS OR MODIFICATIONS	STANDARD PENETROMETER: SEAT - 6"	1st - 6"	2nd - 6"	UNIFIED SOIL CLASSIFICATION	N - VALUE OR HAND PENETROMETER
0													
0-5	4'			0-2	Br, Lt.Br, Lt.Rd Br	Si	Sa	Silty sand, trace clay & roots, trace fine rnd ore gravel,				moist	(0-2)
SM 2'		2		2-10'	Rd Br, Yllw Br	Si, Gr	Cl	Clay - some silt, trace vf. sand, trace coarse iron ore concretions,				moist	(2-5)
CL													
5-10	1.5'											moist	(5-10)
								- some vf. sand, ironstone layer @ 6-6.5					
10'													
		10						clayey vf to f					
10-15	1'			10'-16'	Rd Br, Lt. Br	Si Cl	Sa	Silty Sand with clay in thin lenses, trace cemented clayey sand				V. Moist	(10-15)
SC-SM													
15-20	1.5'				Lt. Gr & Lt. Rd Br			- clay lense @ 15' (6")				v. moist	(15-16)
16'								- ironstone layer @ 15.5' & cemented sand to 16'					
SM													
20-25	3"			16-40	Br, Lt. Rd Br	Si	Sa	Silty Sand - some ironstone				Saturated @ 16' to 40'	
					Gray			- gray @ 20'					
25-30	3"							+ some cemented clayey sand (only recovery @ 25-30')					
30-35	NR												
35-40	NR												
								B.T. @ 40'					
40'													
SC								* Split Spoon Driven from 40-41'					
40-41	1'			40-41	Gray, Dk Gray	Cl	Sa	clayey sand w/ lenses of cemented sand @ 41.5-41.75				V. Moist	40-41
								trace gypsum crystals @ 40-41'					
								* 6-6.5' collected @ 1140					
								* 15.5-16' collected @ 1215					
								* 25-30' collected @ 1230					
								* 40-41' collected @ 1300					

Type Boring HSA Dry Auger ☒ Rotary Wash ☐

SEEPAGE @ 16 FT. WHILE DRILLING, W.L. @ ___ FT. ON COMPL.
(OR) BAILED TO ___ FT. UPON COMPLETION.
W.L. @ ___ FT AND CAVED TO ___ FT. ON _____.

* GPS: 32.46544°, -94.49432 (18' W-NW of AD-28/MW-28)

ATTACHMENT B

SB-28 Boring Photographic Log

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Client: American Electric Power	**Project Number: CHA8495/12A/02**
Site Name: H.W. Pirkey Plant WBAP	**Site Location: Hallsville, Texas**

Photograph 1

Date: 4/21/2020

Direction: N/A

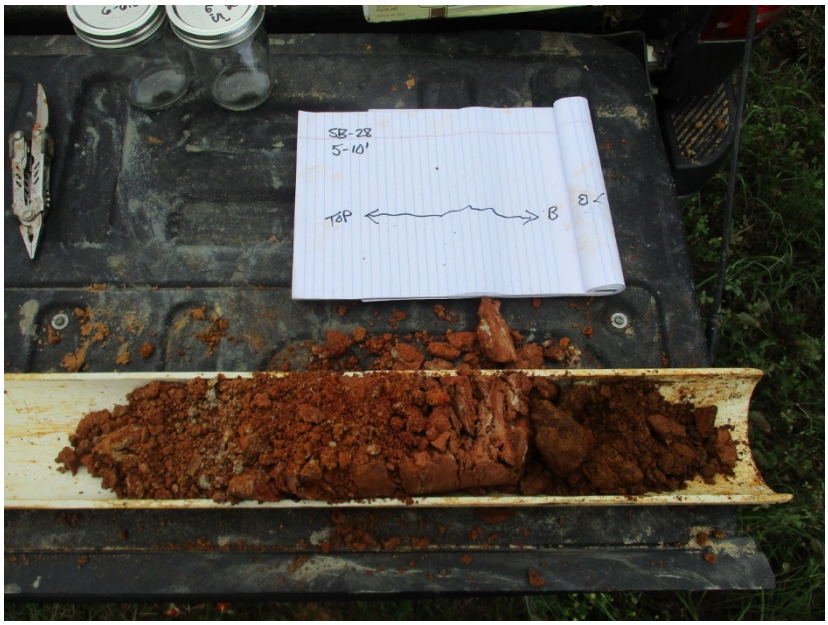
Comments:
Multiple sections of core from soil boring SB-28 advanced near downgradient monitoring well AD-28 within the Western Bottom Ash Pond (WBAP) CCR unit. 5-foot pushes were used. Note the reddish color indicating the presence of oxidized iron-bearing minerals.

Photograph 2

Date: 4/21/2020

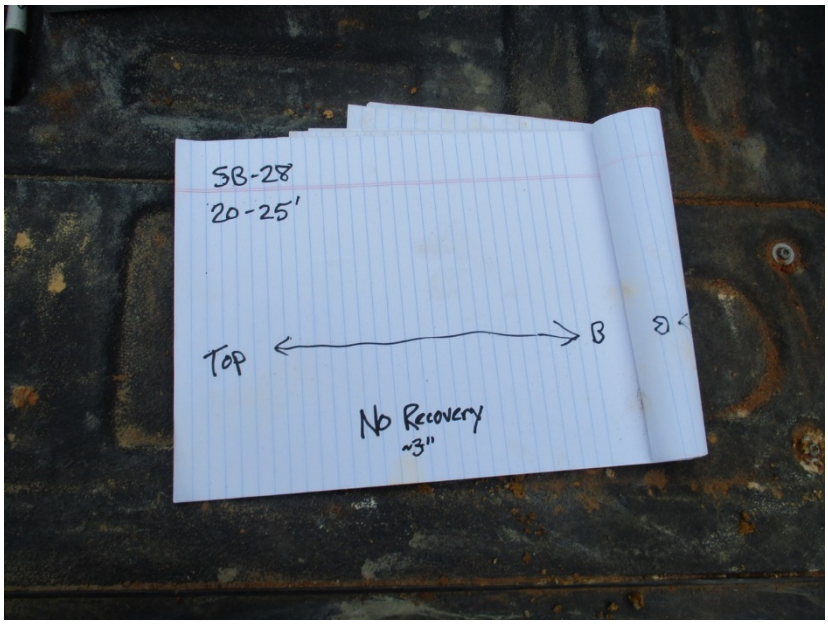
Direction: N/A

Comments:
0-5 foot interval of SB-28.

Photograph 3	
Date: 4/21/2020	
Direction: N/A	
Comments: 5-10 foot interval of SB-28. Recovery of this interval was limited. A sample was collected from this interval from 6-6.5 ft. below ground surface (bgs).	

Photograph 4	
Date: 4/21/2020	
Direction: N/A	
Comments: 10-15 foot interval of SB-28. Recovery of this interval was limited.	

Photograph 5	
Date: 4/21/2020	
Direction: N/A	
Comments: 15-20 foot interval of SB-28. Recovery of this interval was limited. A sample was collected from this interval from 15.5-16 ft. bgs.	

Photograph 6	
Date: 4/21/2020	
Direction: N/A	
Comments: Field geologist's note indicating that very little of the 20-25 foot interval of SB-28 was recovered.	

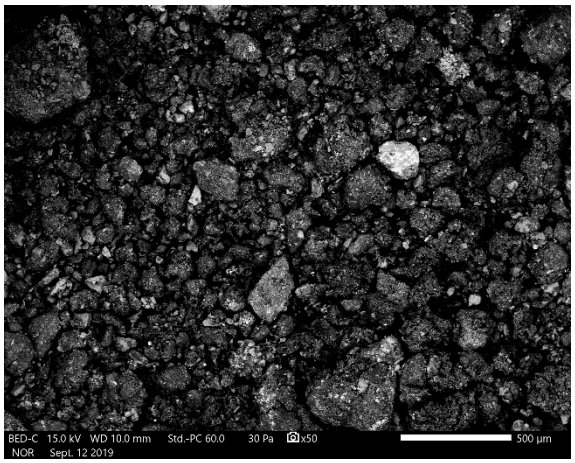
Photograph 7	
Date: 4/21/2020	
Direction: N/A	
Comments: 25-30 foot interval of SB-28. Very little of this interval was recovered. Note the color change of the soil from red to dark brown/black. A sample was collected from this interval.	

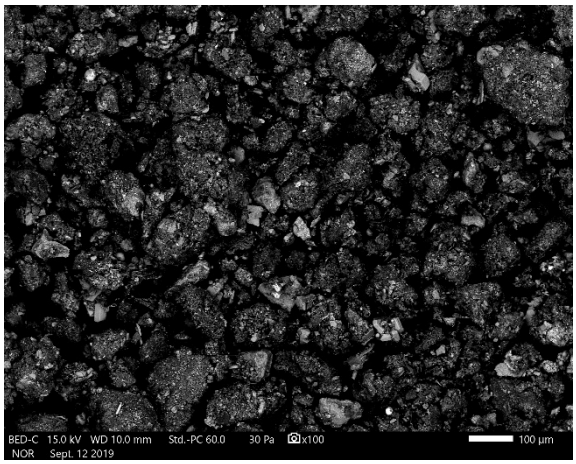
Photograph 8	
Date: 4/21/2020	
Direction: N/A	
Comments: Bottom of SB-28. The boring log indicates no recovery of soil from the 30-40 foot interval. A sample was collected from this interval.	

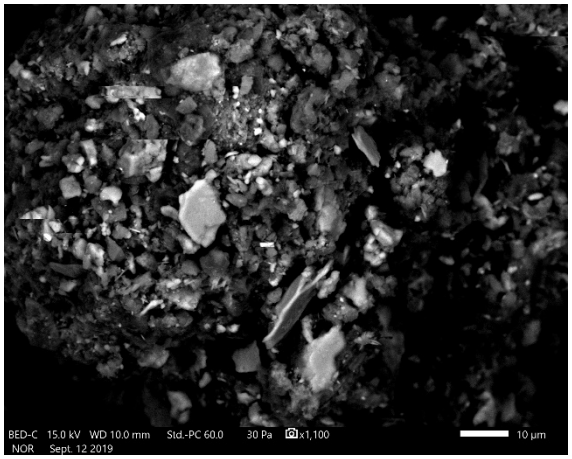
ATTACHMENT C
SEM/EDS Analysis

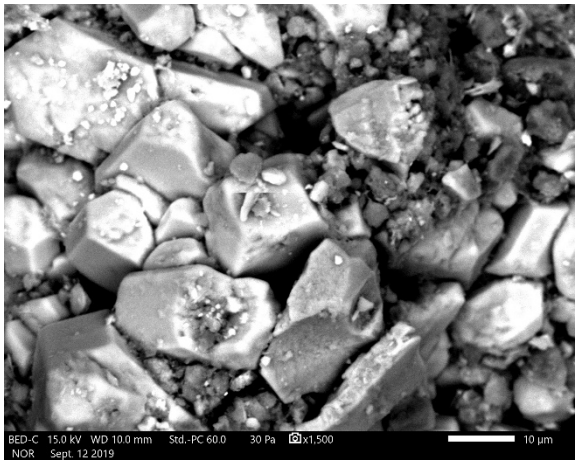
September 16, 2019

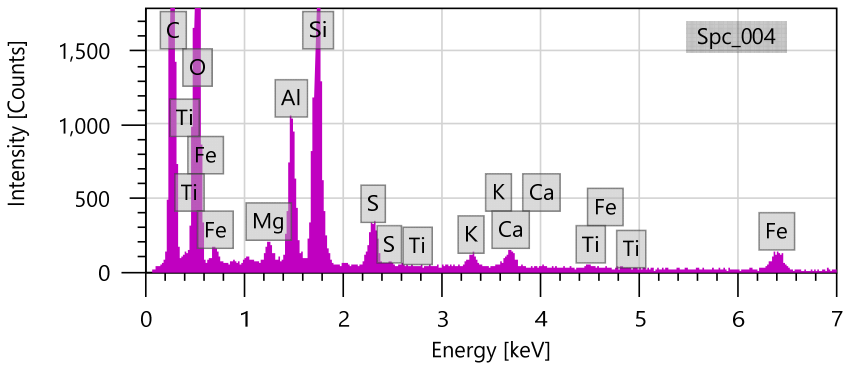
Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221
via Email: BSass@geosyntec.com





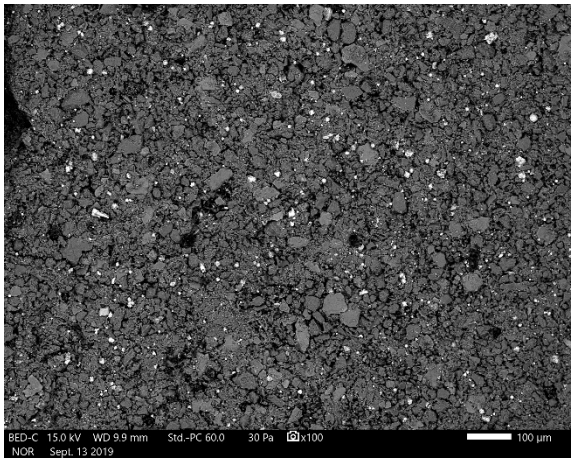


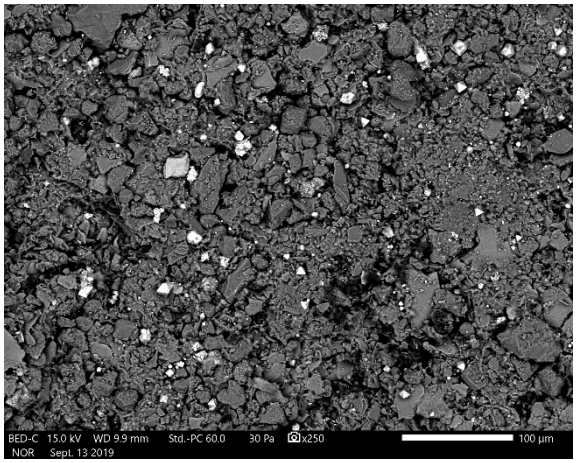


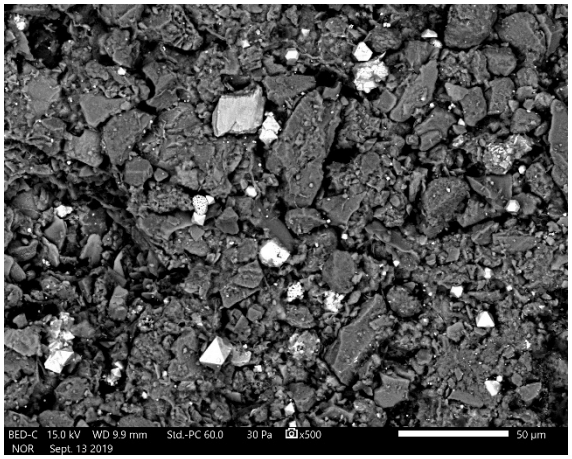


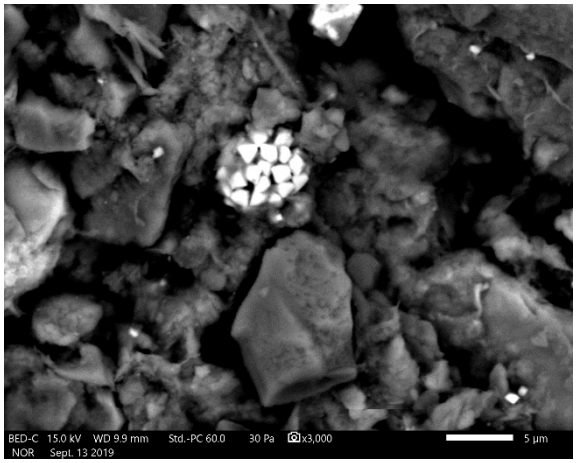
Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.

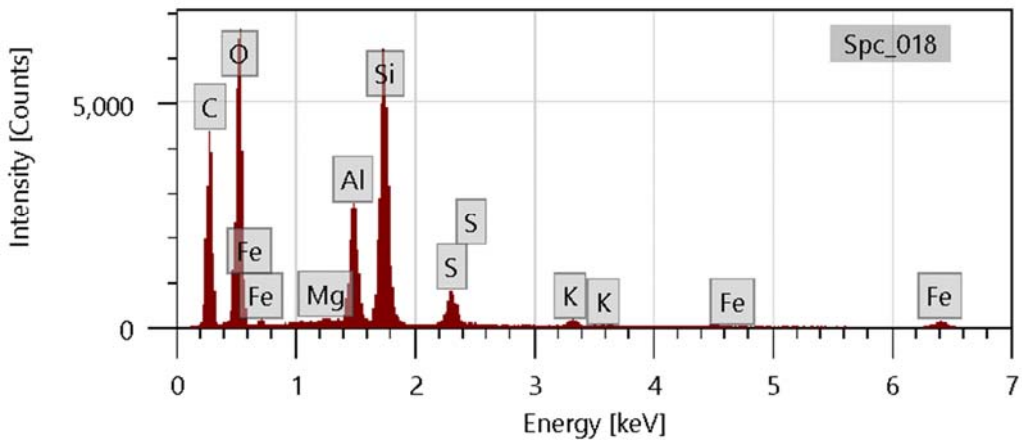
Geosyntec
CTLGroup 150350



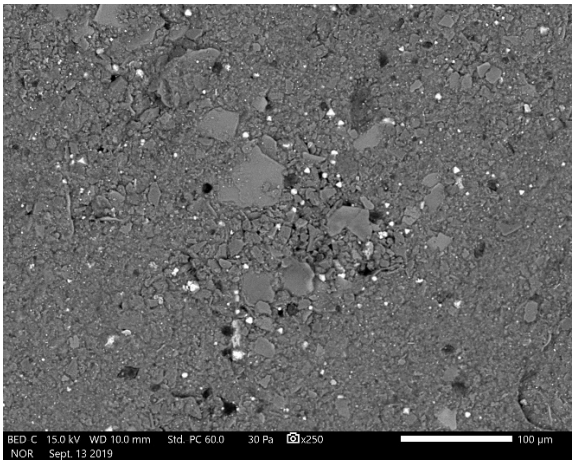


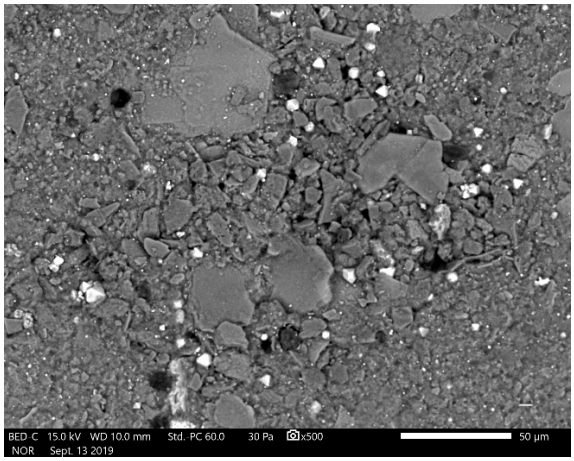


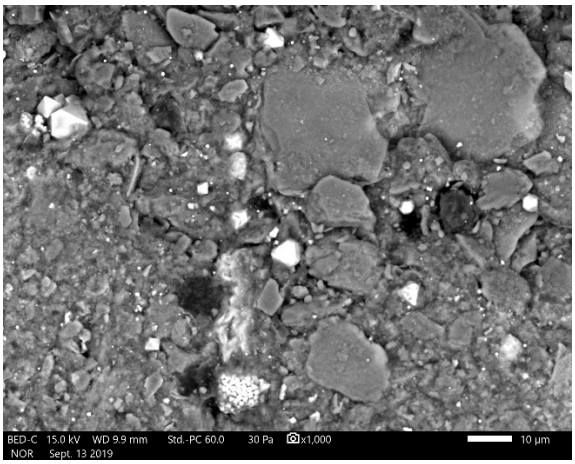


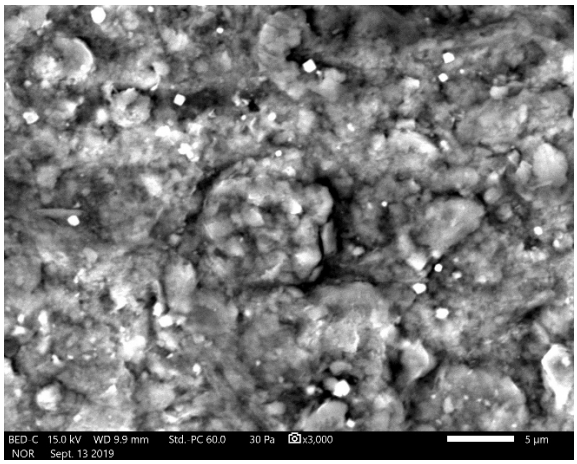


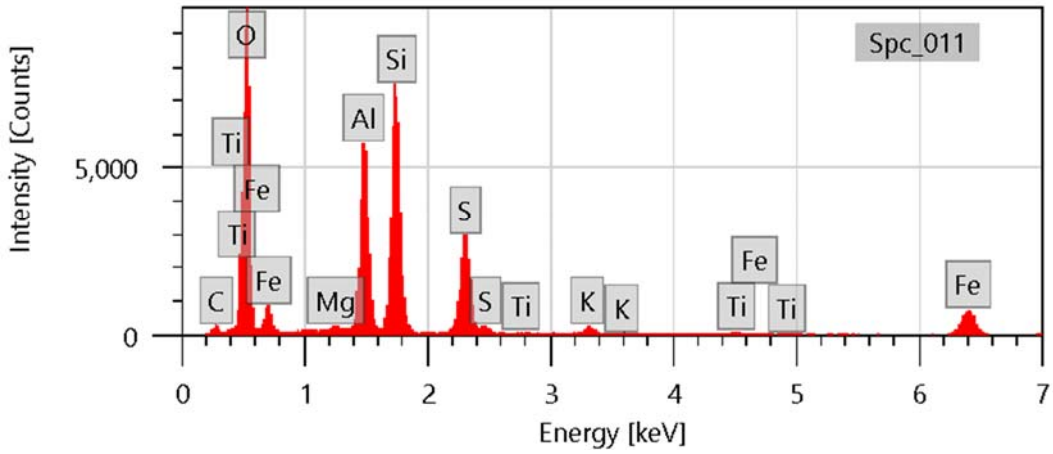
Sample VAP B3 40-45. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 500X. Bright particles are pyrite (framboid in bottom right micrograph). Major peaks for carbon, oxygen, silicon, and aluminum suggest 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 West Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Gross
Signature

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

Texas Registered Engineering Firm
No. F-1182

79864	Texas	12/31/2020
License Number	Licensing State	Date

APPENDIX IV

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

STATE OF TEXAS WELL REPORT for Tracking #540556

Owner:	**American Electric Power Company**	Owner Well #:	**AD-7R**
Address:	**502 N. Allen Street Shreveport, LA 71101**	Grid #:	**35-37-1**
		Latitude:	**32° 27' 43.7" N**
Well Location:	**2400 Farm Road 3251 Hallsville, TX 75650**	Longitude:	**094° 29' 18.3" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/3/2020** Drilling End Date: **3/3/2020**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**31.5**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
Filter Pack Intervals:	**18**	**31.5**	**Sand**	**20/40**

Annular Seal Data: **No Data**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **David Diduch** Apprentice Number: **60297**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1.5**	**Top soil, vegetation, black silt, gravel, light gray/red/brown clayey silt**
1.5	**10**	**Red/light gray clay, low plasticity, high stiffness, iron ore present, trace silt,**
10	**15**	**Maroon/light gray clay, high stiffness, low plasticity, iron ore, wet**
15	**20**	**Black silty clay, low-moderate plasticity, wet, Maroon/orange clayey silt, wet, good cohesion, iron ore, gray/orange clayey silt, iron ore present, wet, good cohesion**
20	**24.6**	**Black clayey silt, Dark gray fine grained sand, trace clay, wet, black silty clay, low-moderate plasticity, moderate to low stiffness**
24.6	**31.5**	**Dark gray fine grained sand, wet, well sorted, orange fine grained sand, wet, well sorted, tan fine grained sand, wet, well sorted, iron present**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**20**	**30**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540