Pirkey Power Plant
Landfill
Alternate Source Demonstration

The Pirkey Landfill initiated an assessment monitoring program in accordance with 40 CFR 257.95 on April 3, 2018. Groundwater protection standards (GWPS) were set in accordance with 257.95(d)(2) and a statistical evaluation of the assessment monitoring data was conducted. The statistical evaluation revealed an exceedance of the cadmium and cobalt GWPSs on December 26, 2018. A successful alternate source demonstration (ASD) was completed per 257.95(g)(3), therefore, the Pirkey Landfill will remain in assessment monitoring. An alternate source demonstration is documentation that shows a source other than the CCR unit was responsible for causing the statistics to exceed the GWPS. The ASD document will explain the alternate cause of the GWPS exceedance. The successful ASD is attached.

Alternate Source Demonstration Evaluation Report

American Electric Power

Henry W. Pirkey Power Plant
Landfill CCR Management Unit
Project No. 112112

Revision 0
4/22/2019

Alternate Source Demonstration Evaluation Report

prepared for

American Electric Power
Henry W. Pirkey Power Plant
Landfill CCR Management Unit
Hallsville, Texas

Project No. 112112

Revision 0
4/22/2019

prepared by

Burns & McDonnell Engineering Company, Inc.
St. Louis, Missouri

INDEX AND CERTIFICATION

American Electric Power
Alternate Source Demonstration Evaluation Report
Project No. 112112

Report Index

Certification

I hereby certify, as a Professional Engineer in the state of Texas, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the American Electric Power or others without specific verification or adaptation by the Engineer.

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4-22-19

Eric Dulle, P.E. (Texas 128008)

Date: 4/22/2019

TABLE OF CONTENTS

LIST OF TABLES

Page No.

LIST OF FIGURES

Page No.

LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
AEP	American Electric Power
amsl	Above Mean Sea Level
ASD	Alternate Source Demonstration
Burns & McDonnell	Burns & McDonnell Engineering Company, Inc.
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EPA	U. S. Environmental Protection Agency
ft	Feet
GWPS	Groundwater Protection Standard
LCL	Lower confidence limit
MCL	Maximum contaminant level
MDL	Method detection limit
mg/L	Milligram per Liter
MS	Matrix spike
MSD	Matrix spike duplicate
SWEPCO	Southwestern Electric Power Company
SSL	Statistically Significant Level
UTL	Upper tolerance limit

1.0 INTRODUCTION

Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) has prepared on behalf of AEP this Alternate Source Demonstration (ASD) Evaluation Report (ASD Evaluation Report) for the existing coal combustion residuals (CCR) landfill (Landfill) located at the American Electric Power (AEP) Southwestern Electric Power Company (SWEPCO) Henry W. Pirkey Power Plant (Pirkey Plant or Site) in Hallsville, Texas.

In 2018, two assessment monitoring events were conducted at the Pirkey Plant Landfill in accordance with 40 Code of Federal Regulations (CFR) 257.95. The monitoring data were submitted to Groundwater Stats Consulting, LLC 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 U. S. Environmental Protection Agency's (EPA) Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance (Unified Guidance; EPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or GWPSs established under 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 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). An SSL was identified for cadmium and cobalt at AD-34 at the Landfill (Geosyntec, 2018).

This ASD is produced in conformance with requirements in the "Standards for the Disposal of Coal Combustion Residuals (CCR) in Landfills and Surface Impoundments" in 40 CFR 257.95(g)(3)(ii).

1.1 Purpose and Scope of Evaluation

The purpose of this evaluation is to determine if concentrations of certain CCR constituents measured in groundwater samples collected from Site groundwater monitoring wells at SSLs above GWPSs established for the Landfill in accordance with 40 CFR 257.95(h) resulted from a source other than the Landfill or from natural variation in groundwater quality. Specifically, the LCL for cadmium (0.00511 milligram per liter [mg/L]) at AD-34 was above the Landfill GWPS of 0.005 mg/L and the LCL for cobalt (0.277 mg/L) at AD-34 was above the Landfill GWPS of 0.026 mg/L. The scope of the evaluation included reviews of historical site records, existing groundwater monitoring system well data, and supplemental data collected from December 2018 through March 2019 to support this evaluation.

1.2 Site Setting

As shown on Figure 1-1, the Landfill is bound by an access road followed by Brandy Branch Reservoir to the east, the Stormwater Runoff Pond followed by former lignite mining areas to the south, former lignite mining areas to the west, and a coal pile and coal pile runoff pond to the north. Western portions of the Landfill are underlain by former lignite mining (reclaimed) land. The local surface topography slopes downward to the southwest towards Hatley Creek, located approximately 0.7 miles west of the Landfill. An unnamed tributary of Hatley Creek originates south of the Stormwater Runoff Pond and flows to the southwest towards Hatley Creek.

The Landfill, including closed, active, and under construction areas, occupies approximately 137 acres. The landfill consists of 10 cells identified by their date of construction (1984, 1987, 1993, 1995, 1997, 1999, 2005E, 2005W, 2012 and 2015) and there are three (3) leachate collection outlets along the southern edge of the active cell and the areas under construction. According to the Arcadis 2018 Landfill Lateral Expansion – CCR Location Restriction Evaluation (Arcadis 2018), AEP initiated an evaluation for the lateral expansion of the landfill. The expansion will cover approximately 15 acres and will be located directly southeast of the current landfill.

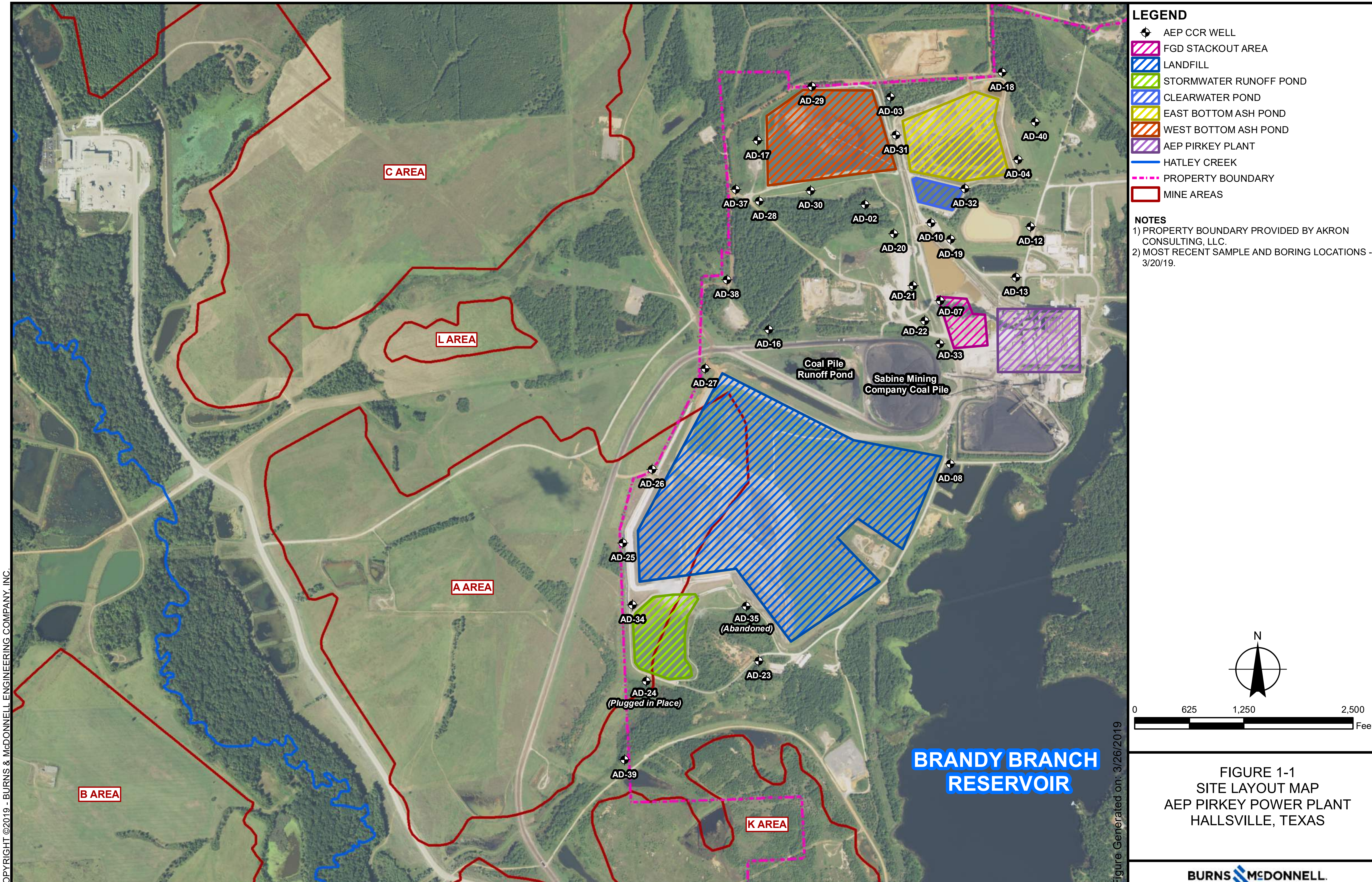

FIGURE 1-1
SITE LAYOUT MAP
AEP PIRKEY POWER PLANT
HALLSVILLE, TEXAS

BURNS & McDONNELL

2.0 SUPPLEMENTAL DATA COLLECTION

This section of the ASD Evaluation Report describes sampling and analysis conducted during supplemental data collection activities to support the Landfill ASD evaluation at the Site in February and March 2019.

2.1 Overview

Supplemental data collection activities included the collection and analysis of groundwater samples from existing Landfill sentinel wells AD-25 and AD-26 and newly installed sentinel well (SB-10/AD-39) and nature and extent wells located west and southwest of the Landfill (SB-07, SB-08, SB-09, SB-10, and SB-11). In addition, these activities included the collection and analysis of a Landfill leachate sample and surface water sample of the water impounded in the Landfill Stormwater Runoff Pond located southwest of the Landfill. A summary of sample locations is provided in Table 2-1 below and sample locations are shown on Figure 2-1.

Table 2-1: Supplemental Data Collection Summary

Sample Media	Location (Designation)	Purpose/Notes
Landfill Leachate	Landfill	Characterize leachate from Landfill
Surface Water	Landfill Stormwater Runoff Pond	Characterize water quality for runoff collected in Landfill Stormwater Runoff Pond
Groundwater	AD-25 (sentinel well), AD-26 (sentinel well), SB-07 (nature and extent well), SB-08 (nature and extent well), SB-09 (nature and extent well), SB-10 (nature and extent well), SB-11 (nature and extent well), and AD-39 (sentinel well)	Characterize groundwater quality in former lignite mining (reclaimed) areas and areas to the southwest of the Landfill
Soil	SB-6, SB-7, SB-8, SB-9, SB-10 and SB-11	Characterize soil conditions in former lignite mining (reclaimed) areas and background (SB-6)

A summary of the Landfill leachate and stormwater runoff pond results is provided in Appendix A, Table A-1, a summary of groundwater sampling results is provided in Appendix A, Table A-2, and a summary of soil sampling results are summarized in Appendix A, Table A-3. A synoptic round of water level measurements was collected on March 13, 2019 at existing monitoring and sentinel wells and at newly installed nature and extent and sentinel monitoring wells. These measurements are summarized in

Appendix A, Table A-4. Figure 2-2 presents the potentiometric surface map prepared using the March 13, 2019 synoptic round of water level measurements.

LEGEND

- AEP CCR WELL
- LEACHATE SAMPLE
- SOIL BORING
- SURFACE WATER
- HATLEY CREEK
- PROPERTY BOUNDARY
- MINE AREAS

NOTES
1) PROPERTY BOUNDARY PROVIDED BY AKRON CONSULTING, LLC.
2) MOST RECENT SAMPLE AND BORING LOCATIONS - 3/20/19.

Figure Generated on: 3/26/2019

FIGURE 2-1
SAMPLE LOCATION MAP
AEP PIRKEY POWER PLANT
HALLSVILLE, TEXAS

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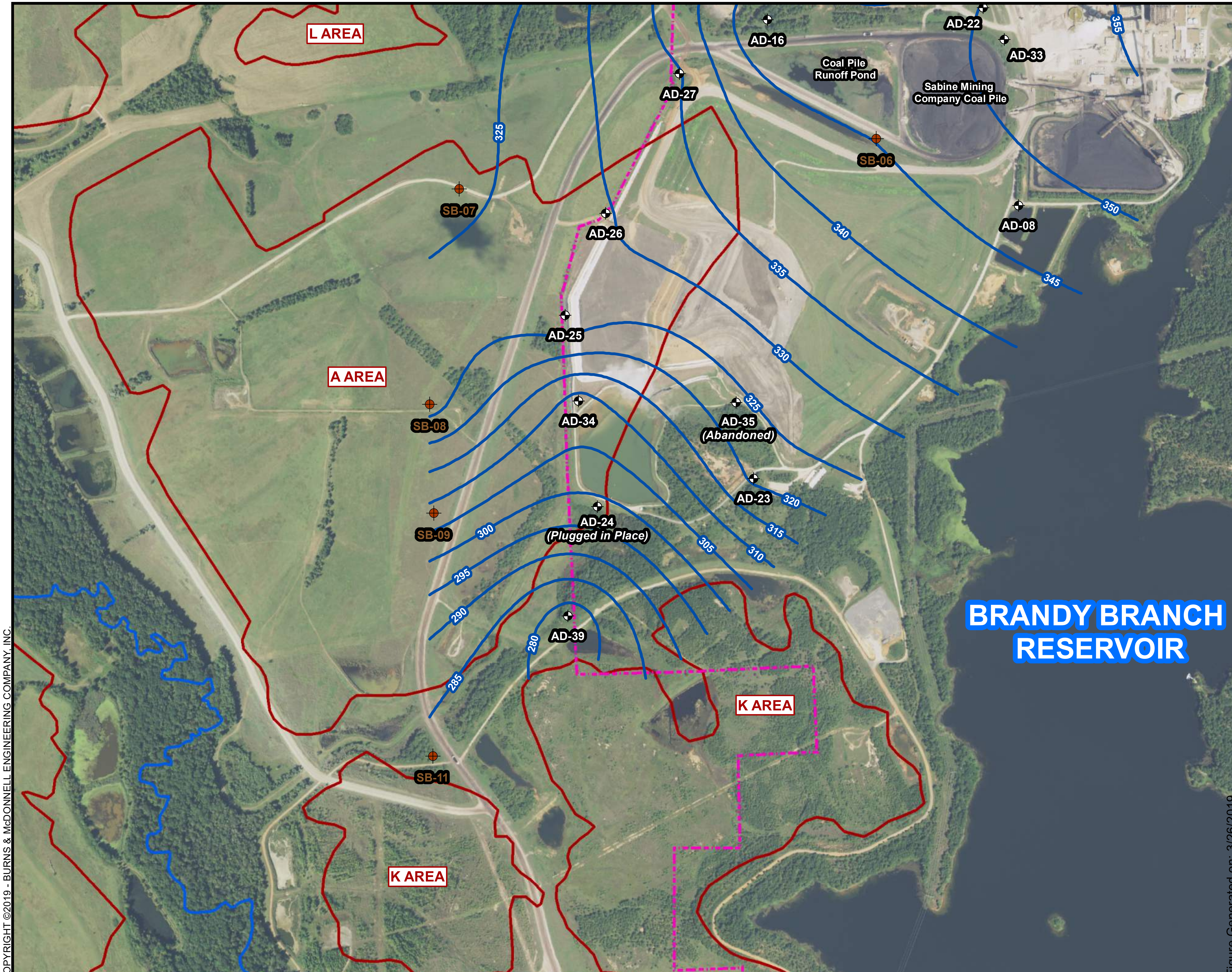


LEGEND

- AEP CCR WELL
- SOIL BORING
- GROUNDWATER CONTOURS 3/12/19
- HATLEY CREEK
- PROPERTY BOUNDARY
- MINE AREAS

NOTES

1) PROPERTY BOUNDARY PROVIDED BY AKRON CONSULTING, LLC.
2) GROUNDWATER CONTOURS PLOTTED AT 5'/CONTOUR.
3) GROUNDWATER CONTOURS DRAFTED BASED ON ELEVATIONS COLLECTED ON 3/12/19

N

0 500 1,000 2,000 Feet

FIGURE 2-2
POTENTIOMETRIC SURFACE MAP
AEP PIRKEY POWER PLANT
HALLSVILLE, TEXAS

BURNS & McDONNELL.

Figure Generated on: 3/26/2019

3.0 ALTERNATE SOURCE EVALUATION SUMMARY

This section of the ASD Evaluation Report presents lines of evidence that CCR constituents, at concentrations above GWPSs at the Landfill, resulted from sources other than the Landfill.

3.1 Coal Mine Drainage

Water levels at monitoring well AD-34 are consistently above the ground surface and represent artesian conditions. Prior to the installation of AD-34 and landfill cell and stormwater runoff pond expansion in 2015, groundwater from the former lignite (reclaimed) mine discharged to the ground surface in the area of AD-34. Figure 3-1 shows two aerial photographs in the area of AD-34. The December 2009 photo depicts surface flow from the mine drainage with the future location of monitoring well AD-34 located adjacent to the historical surface discharge of mine drainage (AD-34 was installed in December 2015). The August 2018 photo shows the current well location relative to the Landfill Pond Road and the 2015 Cell.

Studies of coal mine draining have identified the presence of cadmium and cobalt in coal mine drainage water. One such study summarizes analytical results for water samples from 128 untreated coal mine drainage discharges (Hyman and Watzlaf, 1997). For samples included in this study, 119 of 128 were analyzed for cadmium and 110 of 128 were analyzed for cobalt. The average of the detected cadmium concentrations was 0.014 mg/L and average of the detected cobalt concentrations 0.794 mg/L. In another EPA study, 15 samples of runoff water from coal mine reclamation areas were analyzed for cadmium and the average of the detected cadmium concentrations was 0.019 mg/L (USEPA, 1982). The runoff water samples for this study were not analyzed for cobalt. A study published in 2008 included analysis of cadmium results for 140 abandoned coal mines in Pennsylvania. For the 99 abandoned bituminous coal sites included in the study the median cadmium concentration was 0.023 mg/L (Cravotta III, 2008). The data from these studies indicates that untreated coal mine drainage similar to conditions at the Landfill affect groundwater conditions. Therefore, impacts from coal mine drainage in the area of AD-34 and coal mine drainage is a source of cadmium and cobalt.

Figure Generated On: 4/19/2019

LEGEND

- AEP CCR WELL
- PROPERTY_BOUNDARY
- RUNOFF FROM MINE DRAINAGE

NOTE

1) 2009 AND 2017 AERIAL PHOTO SOURCE: GOOGLE EARTH
2) MONITORING WELL AD-34 WAS INSTALLED ON: DECEMBER 11TH, 2015

N

0 30 60 120 Feet

FIGURE 3-1
HISTORICAL COAL MINE DRAINAGE MAP
AEP PIRKEY POWER PLANT
HALLSVILLE, TEXAS

BURNS McDONNELL

3.2 Historical Cadmium Concentrations

Table 3-1 presents historical concentrations of cadmium in samples from sentinel wells AD-25 and AD-26 and Table 3-2 presents historical concentrations of cadmium in samples from monitoring well AD-34.

Table 3-1: Historical Cadmium Concentrations for AD-25 and AD-26

Well Location	Sample Date	Cadmium (mg/L)
AD-25	4/12/2011	0.008
	12/14/2011	0.004
	6/19/2012	0.003
	1/22/2013	0.001
	7/17/2013	0.002
	1/21/2014	0.009
	7/8/2014	0.013
AD-26	4/12/2011	0.004
	12/14/2011	0.005
	6/19/2012	0.003
	1/22/2013	0.005
	7/17/2013	0.004
	1/21/2014	0.003
	7/8/2014	0.012

Notes: mg/L = milligram per liter

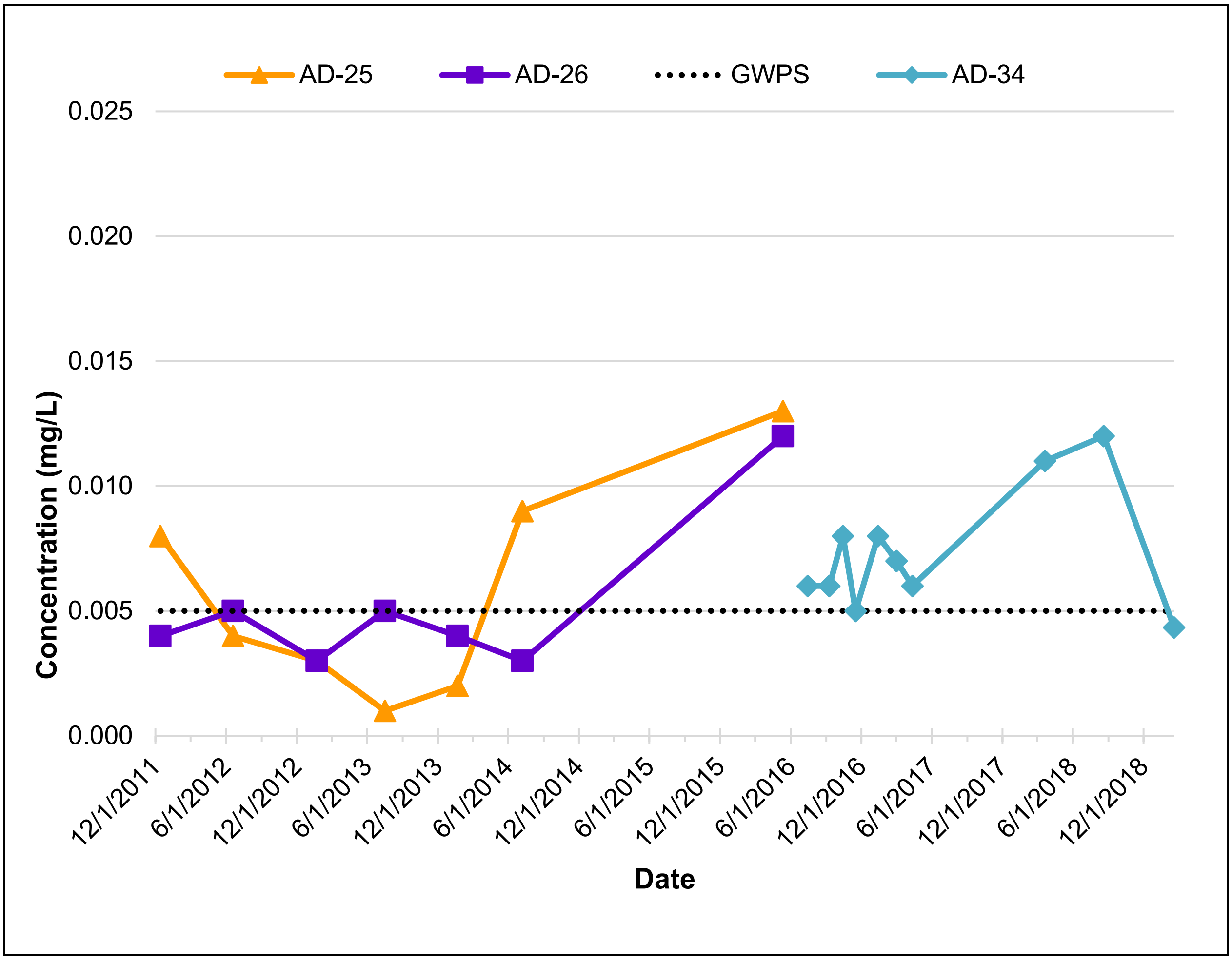
Table 3-2: Historical Cadmium Concentrations for AD-34

Well Location	Sample Date	Cadmium (mg/L)
AD-34	5/10/2016	0.006
	7/13/2016	0.006
	9/8/2016	0.008
	10/12/2016	0.005
	11/15/2016	0.008
	1/11/2017	0.007
	2/28/2017	0.006
	4/10/2017	0.011
	3/21/2018	0.012
	8/20/2018	0.00434

Notes: mg/L = milligram per liter

Figure 3-2 shows concentrations of cadmium over time in sentinel wells AD-25 and AD-26 along with concentrations of cadmium over time in samples from monitoring well AD-34. A comparison of these historical results indicates that recent cadmium concentrations in samples from AD-34 are within the range of historical cadmium concentrations in samples from sentinel wells located immediately hydraulically upgradient of AD-34. These cadmium concentrations are also at levels consistent with the average and median concentrations for water affected by former coal mining activities discussed in Section 3.1. It should also be noted that the cadmium concentrations in the sentinel and monitoring wells exhibit natural variability over time. This data indicates former lignite coal mining is a source cadmium at AD-34.

Figure 3-2: Cadmium Concentrations at AD-25, AD-26 and AD-34



3.3 Historical Cobalt Concentrations

Table 3-3 presents historical concentrations of cobalt in samples from monitoring well AD-34. Historical samples from AD-25 and AD-26 were not analyzed for cobalt. A comparison between AD-34 historical and recent results indicate that recent cobalt concentrations are generally consistent over time and have been within a relatively narrow range. The February 2019 concentration of cobalt at sentinel well AD-25, located immediately hydraulically upgradient of AD-34, is approximately two times higher than the average concentration at AD-34 and is slightly lower than the average concentration for coal mine drainage water discussed in Section 3.1. This data indicates former lignite coal mining is a source of cobalt at AD-34.

Table 3-3: Cobalt Concentrations for AD-25, AD-26, and AD-34

Well Location	Sample Date	Cobalt (mg/L)
AD-25	2/18/2019	0.63
AD-26	2/18/2019	0.19 F
AD-34	5/10/2016	0.301
	7/13/2016	0.296
	9/8/2016	0.306
	10/12/2016	0.297
	11/15/2016	0.292
	1/11/2017	0.284
	2/28/2017	0.294
	4/10/2017	0.299
	3/21/2018	0.279
	8/20/2018	0.249

Notes: mg/L = milligram per liter, F = Matrix Spike (MS) and/or MS Duplicate (MSD) Recovery is outside acceptable limits

3.4 Comparison of Groundwater and Landfill Sample Results

This section presents a comparison of concentrations of leachate from the Landfill and the adjacent stormwater runoff pond to evaluate if they are a potential source of cadmium and cobalt in AD-34. Table 3-4 shows the most recent analytical sampling results for monitoring wells and sentinel wells in the area of the Landfill. This table also notes if the monitoring or sentinel well is considered hydraulically upgradient, downgradient, or cross-gradient of the Landfill and if the monitoring or sentinel well is in a former lignite mining area. As presented in Table 3-4, cadmium and cobalt were detected at very low concentrations in the Landfill leachate and stormwater runoff pond samples. Cadmium concentrations from both potential sources (i.e., Landfill leachate and stormwater runoff pond samples) are an order of magnitude (i.e., ten times) lower than concentrations at AD-34, AD-25, and AD-26 in the former lignite mining area. Cobalt concentrations in the Landfill leachate and stormwater runoff pond samples are three orders of magnitude (i.e., 1,000 times) lower than concentrations at AD-34, AD-25, and AD-26 in the former lignite mining area. Cadmium and cobalt concentrations were highest in samples from nature and extent wells and sentinel wells in former lignite mining area.

Two CCR constituents detected at relatively high levels in the Landfill leachate and stormwater runoff ponds were chloride and molybdenum. Chloride is a conservative (non-reactive) ion and can be used to evaluate the potential influence of leachate on groundwater quality and molybdenum metal transport can be similar to other metals associated with CCR. The highest concentrations of chloride and molybdenum were detected in the Landfill leachate and stormwater runoff pond samples. Molybdenum was not detected above the laboratory reporting limit in the most recent samples collected from monitoring and sentinel wells and the concentration of molybdenum in the Landfill leachate and stormwater runoff pond water samples was four to five orders of magnitude (i.e., 10,000 to 100,000 times) higher than the detected levels at upgradient and downgradient sentinel wells. Chloride concentrations at nature and extent wells, sentinel wells and monitoring wells ranged from 2.5 mg/L to 38 mg/L, were variable among the well groupings, and were an order of magnitude (i.e., ten times) lower than chloride concentrations in the Landfill leachate and stormwater runoff pond. The comparison of the results demonstrates little correlation between the concentration of key constituents in groundwater and leachate samples indicating that the Landfill and the stormwater runoff pond are not a source of cadmium and cobalt in AD-34.

Additionally, concentrations in downgradient wells AD-23, AD-35, and AD-39 are similar to concentrations in upgradient wells, indicating that the Landfill is not affecting groundwater conditions in these downgradient wells. Also, AD-34 concentrations are more similar to concentrations in nature and extent wells and sentinel wells (also installed within the former lignite mine area), further indicating that former lignite mining area is a source of cadmium and cobalt in AD-34.

The highest concentrations of cobalt in recent groundwater samples from the area of the Landfill were from wells installed within the former lignite mining area and the highest cobalt concentration was detected at AD-25 located immediately upgradient of AD-34. Similarly, the highest concentrations of cadmium were detected in wells installed within the former lignite mining area. Lower cadmium concentrations further to the west of the Landfill may be the result of increased pH in these areas reducing the solubility and mobility of cadmium in groundwater. This pattern of high cadmium and cobalt groundwater concentrations indicate that the former lignite mining area is a source of cadmium and cobalt in AD-34.

Table 3-4: Other Notable Constituents

Sample Location/Type	Former Lignite Mine (Reclaimed) Area	Sample Date	Cadmium (mg/L)	Chloride (mg/L)	Cobalt (mg/L)	Molybdenum (mg/L)
Upgradient Monitoring Wells						
AD-8	No	8/20/2018	0.00018	18	0.0159	0.00002
AD-12	No	8/20/2018	0.00001	10	0.00172	0.00004
AD-27	No	8/21/2018	0.00046	10	0.0246	0.00007
Landfill						
Leachate	--	3/6/2019	0.0003 J	640	0.00043 J	3.7

Sample Location/Type	Former Lignite Mine (Reclaimed) Area	Sample Date	Cadmium (mg/L)	Chloride (mg/L)	Cobalt (mg/L)	Molybdenum (mg/L)
Stormwater Runoff Pond	--	3/6/2019	0.0001 J	110	0.00091 JF	0.52
Downgradient Monitoring Wells						
AD-23	No	8/20/2018	0.00001 J	9	0.000803	0.00007 J
AD-34	Yes	8/20/2018	0.00434	10	0.249	0.00003 J
AD-35	No	8/20/2018	0.00012	38	0.0119	0.00004 J
AD-39	No	3/7/2019	0.005 U	2.5 JB	0.0036 J	0.01 U
Cross-gradient and Downgradient Sentinel and Nature and Extent Wells (former lignite mining area)						
AD-25	Yes	2/18/2019	0.0029	6.2 B	0.63	0.01 U
AD-26	Yes	2/18/2019	0.0035	34	0.19 F	0.01 U
SB-07	Yes	3/6/2019	0.0005 U	18.3	0.0235	0.001 U
SB-08	Yes	2/28/2019	0.0002 J	22 B	0.037	0.01 U
SB-09	Yes	3/6/2019	0.0008	32.7	0.0878	0.001 U
SB-11	No	3/11/2019	0.0005 U	14.5	0.0228	0.001 U

Notes: mg/L = milligram per liter; B = Compound was found in the blank and sample; F = Matrix Spike (MS) and/or MS Duplicate (MSD) Recovery is outside acceptable limits; J = Result is less than the reporting limit but greater than or equal to the Method Detection Limit (MDL) and the concentration is an approximate value; U = Indicates the analyte was analyzed for but not detected above the MDL.

3.5 Soil Sampling Results

Soil sample analytical results are summarized in Appendix A, Table A-3. Concentrations of cobalt were generally an order of magnitude (i.e., ten times) higher than the concentrations of cadmium detected in the soil samples in the area of the Landfill. Groundwater concentrations exhibit a similar pattern with cobalt concentrations and are generally at least an order of magnitude higher than the cadmium concentrations in groundwater. The highest concentrations of both cadmium and cobalt were detected in soil samples collected in former lignite mining area (four of the five soil sampling locations were in former lignite mining (reclaimed) area). The pattern for groundwater concentrations is also similar with the highest cobalt and cadmium concentrations found in the former lignite mining area. This pattern of high cadmium and cobalt groundwater concentrations indicate that the former lignite mining area is a source of cadmium and cobalt in AD-34.

4.0 SUMMARY AND CONCLUSIONS

This section of the ASD Evaluation Report provides a summary of the notable observations and conclusions resulting from a review of the groundwater, leachate, stormwater runoff pond water sample, and soil sample results for the Site. The following observations and conclusions provide multiple lines of evidence that the source of cadmium and cobalt concentration above the GWPS at AD-34 is the former lignite mining area.

- Monitoring well AD-34 is located in reclaimed mine spoils from former lignite mining operations and is in an area where historical coal mine drainage discharged to the ground surface. AD-34 is located hydraulically downgradient of portions of former lignite mining area and portions of the landfill.

- Recent cadmium concentrations in groundwater samples from AD-34 are similar to historical cadmium concentrations in groundwater samples from nature and extent wells in reclaimed mine spoils located immediately hydraulically upgradient of AD-34 (AD-25 and AD-26) and are similar to concentrations found in coal mine drainage impacted water. This data is evidence that former lignite coal mining is a source of cadmium at AD-34.

- The February 2019 concentration of cobalt at sentinel well AD-25 located immediately hydraulically upgradient of AD-34 is approximately two times higher than the average concentration at AD-34 and is slightly lower than the average concentration found in coal mine drainage impacted water. This data is evidence that former lignite coal mining is a source of cobalt at AD-34.

- Cadmium and cobalt were detected at very low concentrations in the Landfill leachate and stormwater runoff pond samples as well as upgradient monitoring wells. Cadmium and cobalt concentrations were highest in samples from monitoring wells, sentinel well, and nature and extent well in former lignite mining (reclaimed) areas. Conversely, the highest concentrations of chloride and molybdenum were detected in the Landfill leachate and stormwater runoff pond samples. The lack of correlation between key constituents in groundwater and leachate samples and lack of correlation among wells is evidence that the Landfill and stormwater runoff pond are not the source of cadmium and cobalt at AD-34.

- The highest concentrations of cadmium and cobalt were consistently detected in wells in the former lignite mining area. This pattern of high cadmium and cobalt groundwater concentrations is evidence that the former lignite mining area is the source of cadmium and cobalt in AD-34.

- The pattern for the highest soil sample concentrations was similar to the groundwater pattern with the highest concentrations of both cadmium and cobalt detected in soil samples from the former lignite mining area (four of the five soil sampling locations were in former lignite mining area). This pattern of high cadmium and cobalt soil concentrations is evidence that the former lignite mining area is a source of cadmium and cobalt at AD-34.

Per EPA's Solid Waste Disposal Facility Criteria Technical Manual, Subpart E (EPA530-R-93-017, November 1993), this ASD has documented that:

- <u>An alternative source exists.</u> The highest concentrations of cadmium and cobalt in groundwater and soil samples were consistently detected in wells in the former lignite mining area. Literature documents coal mine impacted sites have high concentration of cadmium and cobalt. Previous studies of coal mine discharges have identified similar elevated concentrations of cadmium and cobalt.

- <u>Hydraulic connection exists between the alternative source and the groundwater monitoring well(s) with the significant increase.</u> The established Landfill monitoring well network and newly installed shallow sentinel wells in the area of the Landfill are all screened within the same hydrostratigraphic zone of the uppermost aquifer and former lignite mining area and non-mined area are hydraulically connected.

- <u>Constituent(s) are present at the alternative source or along the flow path from the alternative source prior to possible release from the [CCR] unit.</u> The highest concentrations of cadmium and cobalt were consistently detected in wells in the former lignite mining area and as shown on Figure 2-2 former lignite mining areas are located hydraulically upgradient from AD-34.

- <u>The relative concentration and distribution of constituents in the zone of contamination are more strongly linked to the alternative source than to the [CCR] unit when the fate and transport characteristics of the constituents are considered.</u> The highest concentrations of cadmium and cobalt were consistently detected in wells in the former lignite mining area. Cadmium concentrations in Landfill leachate was an order of magnitude (i.e., ten times) lower than concentrations at AD-34, AD-25, and AD-26 in the former lignite mining area. Cobalt concentrations in Landfill leachate are three orders of magnitude (i.e. 1,000 times) lower than concentrations at AD-34, AD-25, and AD-26 in the former lignite mining area.

- The concentration observed in groundwater could not have resulted from the [CCR] unit given the waste constituents and concentrations in the [CCR] unit leachate and wastes, and site hydrogeologic conditions. Cadmium concentration in the Landfill leachate was an order of magnitude (i.e., ten times) lower than concentrations detected at AD-34, AD-25, and AD-26 located in the former lignite mining area. Cobalt concentrations in Landfill leachate are three orders of magnitude (i.e. 1,000 times) lower than concentrations at AD-34, AD-25, and AD-26 located in the former lignite mining area.

- The data supporting conclusions regarding the alternative source are historically consistent with hydrogeologic conditions and findings of the monitoring program. As discussed in Sections 3.2 and 3.3 cadmium and cobalt concentrations have shown some natural variability but are generally consistent over time.

As summarized above, there are multiple lines of evidence demonstrating that the source of cadmium and cobalt concentrations in samples from monitoring well AD-34 resulting in an SSL above the GWPS is the former lignite mining spoils located beneath portions of the Landfill and to the west of the Landfill.

5.0 REFERENCES

AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.

Arcadis, 2016. Landfill – CCR Groundwater Monitoring Well Network Evaluation. Prepared for American Electric Power Service Corporation. May.

Arcadis, 2018. 2018 Landfill Lateral Expansion – CCR Location Restriction Evaluation, October.

Cravotta III, C.A. 2008. *Dissolved metals and associated constituents in abandoned coal-mine discharges, Pennsylvania, USA. Part 2: Geochemical controls on constituent concentrations*, Applied Geochemistry 23 (2008), pp 203–226

Flawn, P.T., 1965. Geologic Atlas of Texas, Tyler Sheet. University of Texas at Austin, Bureau of Economic Geology. March.

Hyman, D.M. and Watzlaf, G.R., 1997. *Metals and Other Components of Coal Mine Drainage as Related to Aquatic Life Standards*, Proceedings America Society of Mining and Reclamation, 1997 pp 531-545.

Geosyntec Consultants, 2018. Statistical Analysis Summary – H.W. Pirkey Power Plant. Hallsville, Texas. January 3.

U. S. Environmental Protection Agency (USEPA), 1982. Development Document for Effluent Limitations Guidelines and Standards for the Coal Mining. EPA 440/1-82/057.

U. S. Environmental Protection Agency (USEPA), 1993. Solid Waste Disposal Facility Criteria Technical Manual, Subpart E. EPA530-R-93-017.

U. S. Environmental Protection Agency (USEPA), 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007.

APPENDIX A - DATA SUMMARY TABLES

Sample Area:		Landfill	Landfill
Sample ID:		**LANDFILL LEACHATE-1**	**LANDFILL STORMWATER RUNOFF POND-1**
Sample Type:		Water	Water
Screened Interval (ft bgs):		Surface	Surface
Date Sampled:		2/11/2019	2/11/2019
Appendix III			
Boron	mg/L	5000.0 U	1000.0 U
Calcium	mg/L	590.0	290.0
Chloride	mg/L	640.0	110.0
Fluoride	mg/L	0.5 J	0.75 J
pH	-	9.6	8.85
Sulfate	mg/L	2200.0 B	1100.0 B
Total Dissolved Solids	mg/L	5100.0	2000.0
Appendix IV			
Antimony	mg/L	0.0044 B	0.0026 J B
Arsenic	mg/L	0.045	0.0048 J
Barium	mg/L	0.048 J	0.071 J F1
Beryllium	mg/L	0.00011 J	0.004 U
Cadmium	mg/L	0.0003 J	0.00012 J F1
Chromium	mg/L	0.005 U	0.0005 J F1
Cobalt	mg/L	0.00043 J	0.00091 J F1
Fluoride	mg/L	0.5 J	0.75 J
Lead	mg/L	0.00029 J B	0.00014 J B
Lithium	mg/L	0.042	0.014 J
Mercury	mg/L	0.0005	0.0002 U F1
Molybdenum	mg/L	3.7	0.52
Selenium	mg/L	0.13	0.037
Thallium	mg/L	0.002 U	0.002 U
Combined Ra 226/228	pCi/L	0.528 U	0.375 U

NA - Data Not Yet Available from Lab.
B - Compound was found in the blank and sample.
J - Result is less than the Reporting Limit (RL) but greater than or equal to the Method Detection Limit (MDL) and the concentrat
U - Indicates the analyte was analyzed for but not detected.
M1 - Matrix Spike (MS) recovery exceeded Quality Control (QC) limits. Batch accepted based on laboratory control sample (LC
D3 - Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.
F1 - MS and/or MS Duplicate (MSD) Recovery is outside acceptable limits.
* - LCS and/or LCSD is outside acceptable limits.
^ - Instrument related QC outside acceptable limits.

Sample Area:		Landfill	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill
Sample ID:		**SB-7 / 35-45**	**SB-7 / 60-70**	**SB-8 / 25-35**	**SB-8/55-65**	**SB-8/80-90**	**SB-9 / 20-30**	**SB-9 / 50-60**	**SB-10 / 40-50**
Sample Type:		Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Screened Interval (ft bgs):		35-45	60-70	25-35	55-65	80-90	20-30	50-60	40-50
Date Sampled:		3/4/2019	3/4/2019	2/28/2019	3/1/2019	3/1/2019	3/1/2019	2/23/2019	2/23/2019
Appendix III									
Boron	mg/L	0.174	0.186	0.2 J	0.16 J	0.19 J	0.203	0.204	0.23 J
Calcium	mg/L	18.6	37.3	38.0	53.0	71.0	54.7	170.0	5.7
Chloride	mg/L	18.3	18.2	22 B	12 B	30 B ^	32.7	6.8	20.0 B F1
Fluoride	mg/L	0.21	0.29	0.32 J	0.12 J	0.084 J	1.6	0.48	0.23 J
pH	-	5.6	6.1	4.7	5.3	6.3	6.1	4.8	7.5
Sulfate	mg/L	131.0	348.0 M1	350 B	1400 B	300 B	747.0	2580.0	48.0 B
Total Dissolved Solids	mg/L	346.0	614.0	690.0	1000.0	650.0	968.0	3830.0	310.0
Appendix IV									
Antimony	mg/L	0.001 U	0.001 U	0.003 U	0.003 U	0.003 U	0.001 U	0.001	0.003 U
Arsenic	mg/L	0.0037	0.0161	0.0012 J	0.0087	0.005 U	0.0038	0.0232 U M1	0.00099 J
Barium	mg/L	0.109	0.0974	0.087 J	0.028 J	0.048 J	0.258	0.0144	0.067 J
Beryllium	mg/L	0.0005 U	0.0005 U	0.0011 J	0.00078 J	0.00088 J	0.0029	0.005	0.00033 J
Cadmium	mg/L	0.0005 U	0.0005 U	0.00024 J	0.005 U	0.005 U	0.00082	0.0005 U	0.005 U
Chromium	mg/L	0.005 U	0.005 U	0.005 U	0.005	0.005 U	0.005 U	0.01 U D3	0.0033 J
Cobalt	mg/L	0.0235	0.0701	0.037	0.029	0.0049 J	0.0878	0.163	0.0015 J
Fluoride	mg/L	0.21	0.29	0.32 J	0.12 J	0.084 J	1.6	0.48	0.23 J
Lead	mg/L	0.001 U	0.001 U	0.005 U	0.0015 J	0.005 U	0.001 U	0.001 U M1	0.0012 J
Lithium	mg/L	0.103	0.2	0.059	0.17	0.16	0.0684	0.3	0.045
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.001 U	0.001 U	0.01 U	0.01 U	0.01 U	0.001 U	0.001 U	0.0013 J
Selenium	mg/L	0.001 U	0.001 U	0.01 U	0.01 U	0.01 U	0.009	0.0166 U M1	0.01 U
Thallium	mg/L	0.001 U	0.001 U	0.002 U	0.002 U	0.002 U	0.001 U	0.001 M1	0.002 U
Combined Ra 226/228	pCi/L	5.38 ± 1.37	5.22 ± 1.39	NA	NA	NA	10.9 ± 2.14	7.53 ± 1.52	NA

NA - Data Not Yet Available from Lab.

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M1 - Matrix Spike (MS) recovery exceeded Quality Control (QC) limits. Batch accepted based on laboratory control sample (LCS) recovery.

D3 - Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

F1 - MS and/or MS Duplicate (MSD) Recovery is outside acceptable limits.

* - LCS and/or LCSD is outside acceptable limits.

^ - Instrument related QC outside acceptable limits.

Sample Area:		Landfill	Landfill	Landfill	Landfill	Landfill
Sample ID:		**SB-11/5-15**	**SB-11/33-43**	**AD-25**	**AD-26**	**AD-39**
Sample Type:		Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Screened Interval (ft bgs):		5-15	33-43	MW	MW	MW
Date Sampled:		3/11/2019	3/11/2019	2/18/2019	2/18/2019	2/22/2019
Appendix III						
Boron	mg/L	0.1 U	0.276	0.055 J *	0.12 J	1.1 J
Calcium	mg/L	10.2	17.3	83.0	95.0	44
Chloride	mg/L	14.5	26.1	6.2 B	34.0	2.5 J B
Fluoride	mg/L	0.82	0.2 U	2.8	3.6	0.059 J
pH	-	5.1	6.9	3.51	3.37	5.89
Sulfate	mg/L	159.0	97.4	1500.0 B	1500.0 B	120.0 B
Total Dissolved Solids	mg/L	294.0	314.0	2100.0	2000.0	260.0
Appendix IV						
Antimony	mg/L	0.001 U	0.001 U	0.0011 J B	0.0016 J ^ B	0.0030 U
Arsenic	mg/L	0.001 U	0.001	0.013	0.0037 J	0.0075
Barium	mg/L	0.0914	0.0456	0.0079 J	0.012 J	0.024 J
Beryllium	mg/L	0.0006	0.0005 U	0.0091	0.0084	0.0040 U
Cadmium	mg/L	0.0005 U	0.0005 U	0.0027 J	0.0035 J	0.0050 U
Chromium	mg/L	0.005 U	0.005 U	0.0011 J	0.0022 J	0.0033 J
Cobalt	mg/L	0.0228	0.0023	0.6	0.19 F1	0.0036 J
Fluoride	mg/L	0.82	0.2 U	2.8	3.6	0.059 J
Lead	mg/L	0.001 U	0.001 U	0.00075 J	0.00065 J	0.0050 U
Lithium	mg/L	0.0111	0.0576	0.13	0.16	0.040 U
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.001 U	0.001 U	0.01 U	0.01 U	0.010 U
Selenium	mg/L	0.001 U	0.001 U	0.00062 J	0.01 U	0.010 U
Thallium	mg/L	0.001 U	0.001 U	0.002 U	0.002 U	0.0020 U
Combined Ra 226/228	pCi/L	8.47 ± 1.64	4.59 ± 1.10	NA	NA	NA

NA - Data Not Yet Available from Lab.

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U - Indicates the analyte was analyzed for but not detected.

M1 - Matrix Spike (MS) recovery exceeded Quality Control (QC) limits. Batch accepted based on laboratory control sample (LCS) recovery.

D3 - Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

F1 - MS and/or MS Duplicate (MSD) Recovery is outside acceptable limits.

* - LCS and/or LCSD is outside acceptable limits.

^ - Instrument related QC outside acceptable limits.

Sample Area:		Landfill	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill
Sample ID:		**SB-6 / 6-7**	**SB-6 / 16-17**	**SB-7 / 7-8**	**SB-7 / 22-23**	**SB-8 / 6-7**	**SB-8 / 25-26**	**SB-9 5-6**	**SB-9 20-21**
Sample Type:		Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sampled Interval (ft bgs):		6-7	16-17	7-8	22-23	6-7	25-26	5-6	20-21
Date Sampled:		2/22/2019	2/22/2019	2/28/2019	2/28/2019	2/27/2019	2/27/2019	3/4/2019	3/4/2019
Isotopic Uranium & Thorium (6020/Alpha Spec)									
Uranium-233/234	pCi/g	0.534	0.355	0.539	0.217	0.604	0.314	NA	NA
Uranium-235/236	pCi/g	0.0459 U	0.0342 U	0.0243 U	-0.00247 U	0.0108 U	0.0380	NA	NA
Uranium-238	pCi/g	0.596	0.325	0.581	0.271	0.564	0.433	NA	NA
Uranium	mg/kg	60.0 U	64.0 U	1.1	0.59 J	0.93	0.71	NA	NA
Thorium-228	pCi/g	0.537	0.839	0.610	0.324	0.584	0.356	NA	NA
Thorium-230	pCi/g	0.477	0.382	0.579	0.357	0.583	0.427	NA	NA
Thorium-232	pCi/g	0.604	0.559	0.464	0.472	0.724	0.382	NA	NA
Thorium	mg/kg	60.0 U	64.0 U	4.4	4.3	4.2	3.7	NA	NA
Appendix IV + Boron									
Antimony	mg/kg	1.2 U	1.3 U	0.40 U	0.42 U	0.38 U	0.40 U		
Arsenic	mg/kg	6.9	6.9	6.9	23	2.7	18		
Barium	mg/kg	51	15 J	66	41	18 J	10 J		
Boron	mg/kg	23 U	25 U	3.4 J	7.1 J	3.7 J	3.4 U		
Beryllium	mg/kg	0.28 J	0.20 J	0.50	0.37 J	0.35 J	0.36 J		
Cadmium	mg/kg	0.067 J	0.094 J	0.095 J	0.12 J	0.085 J	0.12 J		
Chromium	mg/kg	23	21	12	12	4.2	18		
Cobalt	mg/kg	1.5 J	6.4 U	3.1 J	12	5.5 J	2.4 J		
Fluoride	mg/kg	1.1 U	0.95 J	3.1	2.5	0.75 U	0.75 U		
Lead	mg/kg	7.4	4.7	9.3	6.2	9.1	6.1		
Lithium	mg/kg	4.6 J	0.98 J	3.8 J	7.2	2.4 J	2.1 J		
Mercury	mg/kg	0.032 U	0.044 U	0.033 J	0.018 J	0.042	0.017 U		
Molybdenum	mg/kg	0.80 J	0.52 J	0.39 J	0.26 U	0.40 J	0.47 J		
Selenium	mg/kg	1.2 U	0.74 J	0.70 J	0.70 J	0.58 J	0.67 J		
Thallium	mg/kg	2.3 U	2.5 U	0.38 U	0.40 U	0.36 U	0.38 U		
Combined Ra 226/228	pCi/L	NA	NA	NA	NA	NA	NA		

- Analyte Not Requested

NA - Data Not Yet Available from Lab

B - Compound was found in the blank and sample.

J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

U - Indicates the analyte was analyzed for but not detected.

H - Sample was prepped or analyzed beyond the specified holding time.

M1 - Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.

D3 - Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

F1 - MS and/or MSD Recovery is outside acceptable limits.

F2 - MS/MSD RPD exceeds control limits.

* - LCS and/or LCSD is outside acceptable limits.

^ - Instrument related QC outside acceptable limits.

Sample Area:		Landfill	Landfill	Landfill	Landfill
Sample ID:		**SB-10/6.5-7.5**	**SB-10/10-11**	**SB-11 / 8-9**	**SB-11 / 10-11**
Sample Type:		Soil	Soil	Soil	Soil
Sampled Interval (ft bgs):		6.5-7.5	10-11	8-9	10-11
Date Sampled:		2/19/2019	2/19/2019	3/11/2019	3/7/2019
Isotopic Uranium & Thorium (6020/Alpha Spec)					
Uranium-233/234	pCi/g	0.353	0.319		
Uranium-235/236	pCi/g	0.0535	0.0470 U		
Uranium-238	pCi/g	0.240	0.263		
Uranium	mg/kg	0.47	1.0		
Thorium-228	pCi/g	0.848	0.741		
Thorium-230	pCi/g	0.449	0.396		
Thorium-232	pCi/g	0.831	0.612		
Thorium	mg/kg	4.7	11.0		
Appendix IV + Boron					
Antimony	mg/kg	1.1 U	1.2 U	1.1 U M1	1.1 U
Arsenic	mg/kg	23	18	2.0	1.7
Barium	mg/kg	6.4 J	7.6 J	14.5	9.8
Boron	mg/kg	23 U	24 U	11.4 U	11.1 U
Beryllium	mg/kg	0.044 J	0.082 J	0.57 U	0.55 U
Cadmium	mg/kg	0.13 J	0.11 J	0.57 U	0.55 U
Chromium	mg/kg	15	21	10.9	9.0
Cobalt	mg/kg	5.7 U	5.9 U	1.1 U	1.1 U
Fluoride	mg/kg	1.2 U	1.2 U	24.0 U M1	25.4 U
Lead	mg/kg	5.3	5.6	4.8	3.7
Lithium	mg/kg	5.7 U	1.1 J	5.2	2.0
Mercury	mg/kg	0.025 J	0.020 J	0.048 U	0.054 U
Molybdenum	mg/kg	0.77 J	1.1 J	5.7 U	5.5 U
Selenium	mg/kg	1.1 U	1.5	1.1 U	1.1 U
Thallium	mg/kg	2.3 U	2.4 U	1.1 U	1.1 U
Combined Ra 226/228	pCi/L	NA	NA	NA	NA

- Analyte Not Requested

NA - Data Not Yet Available from Lab

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F1 - MS and/or MSD Recovery is outside acceptable limits.

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* - LCS and/or LCSD is outside acceptable limits.

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CREATE AMAZING.

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