

Memorandum

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Subject: Summary of Statistical Analyses of Baseline Groundwater Samples
Economizer Ash and Pyrite Pond System
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On April 17, 2015, the United States Environmental Protection Agency (USEPA) published 40 Code of Federal Regulations (CFR) Parts 257 and 261: Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule (USEPA, 2015). This regulation addresses the safe disposal of coal combustion residuals (CCR) as solid waste under Subtitle D of the Resource Conservation and Recovery Act (RCRA) and is referred to herein as the CCR Rule. The CCR Rule became effective on October 14, 2015. The rule provides national minimum criteria for “the safe disposal of CCR in new and existing CCR landfills, surface impoundments, and lateral expansions, design and operating criteria, groundwater monitoring and corrective action, closure requirements and post closure care, and recordkeeping, notification, and internet posting requirements.” The groundwater monitoring requirements of the CCR Rule apply to the economizer ash and pyrite pond system (EAPPS) at Tampa Electric Company’s (TEC) Big Bend Power Station (BBS) in southeast Hillsborough County in Gibsonton, Florida.

Geosyntec Consultants (Geosyntec) has prepared this technical memorandum to summarize the statistical analyses performed on the baseline groundwater samples collected from the groundwater monitoring system (GMS) established at the EAPPS. These activities have been undertaken by TEC to comply with the requirements set forth in 40 CFR 257.50 “Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments” pertaining to the EAPPS. TEC installed

a groundwater monitoring system at the EAPPs that complies with 40 CFR 257.91 and performed baseline groundwater sampling events in accordance with 40 CFR 257.93. Geosyntec's statistical analyses were performed in accordance with the *Statistical Analysis Plan* dated 15 October 2017.

BACKGROUND

The groundwater monitoring system (GMS) was installed at the EAPPs in May 2016 and consists to two background monitoring wells, BBS-CCR-BW1 and BBS-CCR-BW2, and three downgradient monitoring wells, BBS-CCR-1, BBS-CCR-2, and BBS-CCR-3. TEC conducted eleven baseline groundwater sampling events from the GMS between June 2016 and October 2017 and analyzed the samples for Appendix III and Appendix IV constituents as required in 40 CFR 257.93. The inorganic data were reviewed based on the following: *CCR Groundwater Monitoring Program Plan*, Big Bend Power Station, Apollo Beach, Florida, September 2016, USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, August 2014 (OSWER 9355.0-131, EPA 540-R-013-001), as well as by the pertinent methods referenced by the data package and professional and technical judgment.

Geosyntec prepared a *Statistical Analysis Plan* to provide details on the selection of statistical methods in accordance with the provisions set forth in 40 CFR 257.93 "Groundwater sampling and analysis requirements." These statistical methods were used to establish background conditions and to evaluate groundwater monitoring data collected during detection monitoring (40 CFR 257.94) to evaluate if the CCR units at the BBS are adversely impacting groundwater quality.

METHODOLOGY AND APPROACH

The statistical approach used to evaluate groundwater monitoring data was selected from a suite of methods provided in 40 CFR 257.93(f) (1 through 5) and performed in accordance with a set of performance standards provided in 40 CFR 257.93(g), when applicable.

The approach included the following steps for each Appendix III constituent:

1. Graphical display of data and assessment of equal variance;
2. Evaluate trends and seasonality in the background dataset for each constituent.
3. Identify potential outliers;
4. Evaluate the population distribution of the background dataset for each constituent;
5. Calculate the frequency of non-detects (NDs), and summary statistics (e.g., minimum, maximum, and mean) of the background dataset for each constituent;

6. Calculate appropriate upper limits (95%-95% upper tolerance limit [UTL] and a 95% upper prediction limit [UPL]); and
7. Compare upper limits to the most recent concentrations in the compliance (or downgradient) wells to determine if a statistically significant increase (SSI) above background has occurred.

Assumptions:

- The laboratory reporting limit was substituted for non-detects in all datasets.
- The laboratory reported value for estimated (J-flagged) concentrations were retained in all datasets.
- When a duplicate sample was collected at a background monitoring well, only the higher of the primary and duplicate sample concentrations were included in the aggregated dataset.

BACKGROUND GROUNDWATER QUALITY STATISTICS

The results of the Appendix III constituents (e.g., boron, calcium, chloride, fluoride, pH, sulfate, and total dissolved solids) detected in groundwater samples from the two background monitoring wells were used to establish background concentrations for these constituents (**Table 1**). Based on professional judgment, the sulfate concentration of 41.7 milligrams per liter (mg/L) detected in BBS-CCR-BW2 on 7/20/17 was deemed an analytical error and was removed from the dataset.

Potential outliers:

- A sulfate concentration of 217 mg/L at BBS-CCR-BW1 was identified as a potential low concentration outlier but was retained in the dataset.
- The TDS concentration of 5,050 mg/L at BBS-CCR-BW1 was identified as a potential high concentration outlier but was retained in the dataset.

Increasing trends:

- An increasing pH trend is statistically present at BBS-CCR-BW2 based on the non-parametric Mann Kendall analysis.

Each of the Appendix III constituents exhibited a non-parametric distribution among the two background wells. The two background wells did show spatial variability for all the Appendix III constituents. An intra-well comparison is often used in these circumstances; however, this approach is not appropriate for the EAPPS since there is no groundwater data representative of pre-operational conditions (e.g., prior to

EAPPS) and therefore no information if the background wells may have already been impacted prior to their construction. Consequently, the data from the two background monitoring wells were aggregated for each constituent to create a single pooled background dataset, consisting of 22 observations (11 events x 2 monitoring wells). Two non-parametric upper limits were calculated for each constituent: a 95%-95% upper tolerance limit (UTL) and a 95% upper prediction limit (UPL), both of which result in the maximum detected concentration among both background wells. However, the 95%-95% UTL could not achieve a confidence level above 67%, but the UPL did achieve 95% confidence. As such, the 95% UPL was used to evaluate SSI for each constituent.

DETECTION MONITORING

Groundwater samples were collected from the GMS in October 2017 to serve as the first detection monitoring event. The comparison of the detection monitoring results to the background values for the Appendix III constituents is shown in **Table 2**. A statistically significant increase (SSI) over background was observed for pH in two compliance monitoring wells (BBS-CCR-1 and BBS-CCR-2).

CONCLUSIONS

As specified in 40 CFR 257.94(3) (e), TEC will either provide (i) a demonstration that the SSI is due to sampling or analysis error, another source, or natural variability or (ii) commence with assessment monitoring within 90 days of this SSI (e.g., by 15 April 2018). The pH values of 6.83 and 6.87 identified as SSIs are within the natural range of groundwater at BBS based on historical values which have been measured across BBS. In the absence of SSIs for other Appendix III constituents, the SSIs for pH do not appear to be attributable to a release from the EAPPS, but are instead attributable to natural variability. Therefore, TEC will continue with detection monitoring as applicable for the EAPPS.

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TABLE 1 - BACKGROUND STATISTICS, TEC BIG BEND STATION ECONOMIZER ASH AND PYRITE POND SYSTEM, APOLLO BEACH, FL

Parameter	Units	Number of Samples	Number of NDs	Percent NDs	Minimum Result	Average Result	Maximum Result	Potential Outlier?	Trend?	Background Concentration		
										Distribution	95% UPL ²	Comment
Boron	mg/L	22	22	0	3.27	27.32	59.1	None	No	NP	59.1	Confidence for UTL = 67.6%
Calcium	mg/L	22	22	0	237	499	781	None	No	NP	781	Confidence for UTL = 67.6%
Chloride	mg/L	22	22	0	84.9	543.8	1140	None	No	NP	1140	Confidence for UTL = 67.6%
Fluoride	mg/L	22	21	5	<0.01	0.332	0.559	None	No	NP	0.559	Confidence for UTL = 67.6%
pH (field)	STD	22	22	0	6.38	6.55	6.70	None	Yes (BBS-CCR-BW2)	NP	(6.38, 6.70)	Confidence for UTL = 30.18%
Sulfate	mg/L	21 ¹	21	0	217	876	1550	217 (BBS-CCR-BW1)	No	NP	1547	Confidence for UTL = 65.9%
Total Dissolved Solids	mg/L	22	22	0	966	2709	5050	5050 (BBS-CCR-BW1)	No	NP	5050	Confidence for UTL = 67.6%

Notes:

< - concentration not detected at or above the adjusted reporting limit

mg/L - milligrams per litre

ND - non-detect

NP - non-parametric

STD - standard units

UTL - upper tolerance limit

UPL - upper prediction limit

1 - A concentration of 41.7 mg/L detected at BBS-CCR-BW2 on 7/20/17 was removed from the data set as a laboratory error based on professional judgment.

2 - The 95% UPL was calculated based on either a normal, lognormal, or Gamma distribution. If data did not follow a discernible distribution, then a non-parametric 95% UPL was calculated. A two-sided prediction interval was calculated for pH.

TABLE 2 - DETECTION MONITORING RESULTS, TEC BIG BEND STATION ECONOMIZER ASH AND PYRITE POND SYSTEM, APOLLO BEACH, FL

Analytical Parameter		Boron, total	Calcium, total	Chloride, total	Fluoride, total	pH (field)	Sulfate, total	Total Dissolved Solids
Units		mg/L	mg/L	mg/L	mg/L	STD	mg/L	mg/L
Background Concentration Value		59.1	781	1140	0.559	(6.38, 6.70)	1550	5050
Well ID	Sample Collection Date	October 2017 Detection Monitoring Results						
BBS-CCR-1	10/13/2017	19.9	596	716	0.201	6.83	1230	3470
BBS-CCR-2	10/13/2017	0.888	169	70.9	0.182	6.87	432	1030
BBS-CCR-3	10/13/2017	0.373	190	153	0.333	6.44	503	1310

Notes:

- Bold, highlighted text indicates statistically significant increase above background concentration values.

< - concentration not detected at or above the adjusted reporting limit.

mg/L - milligrams per liter

STD - standard units