Prepared for:

Tampa, Florida

STATISTICAL ANALYSIS PLAN

Big Bend Power Station
Economizer Ash and Pyrite Pond System
13031 Wyandotte Road
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LIST OF ACRONYMS

ANOVA	Analysis of Variance
BBS	Big Bend Power Station
CCR	Coal Combustion Residuals
CCR Rule	Coal Combustion Residuals Rule
CFR	Code of Federal Regulations
EAPPS	Economizer Ash and Pyrite Pond System
GOF	Goodness-of-Fit
GWPS	Groundwater Protection Standard
KM	Kaplan-Meir
LCL	Lower Confidence Limit
MK	Mann-Kendall
ND	Non-detect
PE	Professional Engineer
Q-Q	Quantile-quantile
RCRA	Resource Conservation and Recovery Act
RL	Reporting Limit
ROS	Regression on Order Statistics
SP	Statistical Analysis Plan
SSI	Statistically Significant Increase
SWFPR	Site-wide False Positive Rate
TEC	Tampa Electric Company
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit

1. BACKGROUND

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 (**Figure 1**).

This Statistical Analysis Plan (SP) is to document and 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 will be used to establish background conditions and to evaluate groundwater monitoring data collected during detection monitoring (40 CFR 257.94) and assessment monitoring (40 CFR 257.95) as needed to ensure that the CCR units at the BBS are not adversely impacting groundwater. Included in this SP are the following:

1. Description of the statistical methods used to evaluate groundwater monitoring data [40 CFR 257.93(f)(6)];

2. Discussion of data review and preparation;

3. Guidance for implementing detection and assessment monitoring;

4. Discussion on establishing and updating background concentrations for specified constituents for use in detection and assessment monitoring;

5. Procedure for establishing Groundwater Protection Standards (GWPS) and

6. Professional Engineer (PE) Certification that the selected statistical method is appropriate for evaluating groundwater monitoring data [40 CFR 257.93(f)(6)] (**Appendix A**).

This document does not discuss statistical procedures for assessing corrective measures (40 CFR 257.96). Procedures and processes for addressing remedial action will be developed as required and necessary.

Site features/geology/lithology, design of the CCR monitoring well network, the Sampling and Analysis Plan including requirements, procedures, documentation, laboratory analytical procedures and quality control, and the Quality Assurance Plan are provided in the CCR Rule Groundwater Monitoring Program Plan, Big Bend Power Station, (October 2016). **Table 1** lists the five CCR monitoring wells that will be used in the statistical analysis and designation (background vs. downgradient). The CCR monitoring wells are shown on **Figure 2**.

1.1 Statistical Requirements of the CCR Rule

The statistical approach used to evaluate groundwater monitoring data must be 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. Additionally, owners or operators of CCR units must receive certification from a "qualified PE" indicating that the selected statistical methods are suitable for the analysis of groundwater data as well as provide description of the statistical methods that will be used for analysis [40 CFR 257.93(f)(6)].

The CCR Rule requires that one of the following statistical methods be selected to establish background concentrations for each constituent in each well at the BBS for use in detection and assessment monitoring [40 CFR 257.93(f)]:

1. Parametric analysis of variance (ANOVA) followed by multiple comparisons;
2. ANOVA based on ranks followed by multiple comparisons;
3. Tolerance / Prediction intervals;
4. Control charts; or,
5. Another statistical method that meets the performance standards outlined in 40 CFR 257.93(g) (as outlined below).

1.2 Performance Standards

The statistical method selected to analyze groundwater monitoring data at BBS must be performed in compliance with the following performance standards, when applicable [40 CFR 257.93(g)]:

1. The statistical method must be appropriate for the distribution of the constituents. If data follow a discernible probability distribution (e.g., normal, lognormal, or gamma distribution), then parametric methods can be used. Otherwise, non-parametric methods, which do not make any distributional assumptions, are to be used;

2. If an individual well comparison procedure (e.g., t-test) is used, a Type I error rate of no less than 0.01 must be maintained. If a multiple comparison method is used (e.g., ANOVA), the Type I experiment-wise error rate for each testing period must be at least 0.05, while a Type I error rate of at least 0.01 for individual well comparisons must be maintained;

3. If control charts are used, the type of control chart used must be "at least as effective" as the other statistical approaches outlined in 40 CFR 257.93(f) (USEPA 2015a);

4. If tolerance or prediction intervals are used, the selected confidence levels and coverage (for tolerance intervals) must result in the approach being "at least as effective" as the other methods outlined in 40 CFR 257.93(f) (USEPA 2015a);

5. Reporting limits (RL) used during statistical analysis must be the lowest achievable concentration within specified limits by laboratory analytical procedures and technology, and statistical tests must account for non-detected (ND) concentrations; and,

6. Seasonal and spatial variability, including temporal correlation, must be corrected or controlled.

1.3 Statistical Guidance and Software

The statistical methods outlined in this SP were selected based on the suggested framework and recommendations contained in Statistical Analysis of Groundwater Data at RCRA Facilities – Unified Guidance (USEPA, 2009), also known as the Unified Guidance. The Unified Guidance provides details on the statistical methods and performance standards required under the CCR Rule. More specifically, it provides the technical details on key statistical concepts, such as independence, stationarity, outliers, data distributions, handling of non-detects, establishing and updating background concentrations, and identifying statistically significant increases (SSI) in analyte concentrations from background.

The primary software that will be used to conduct the statistical evaluations is ProUCL version 5.0.02 (USEPA, 2015b). ProUCL was developed to help decision makers and project teams in making informative and correct decisions at environmental sites (e.g., RCRA). Since it was developed for a wide range of environmental data sets, it provides modules that incorporate a variety of robust estimation methods designed to handle left-censored (e.g., ND) and poorly behaved (e.g., skewed) data sets, particularly for the estimation of prediction and tolerance limits. Additionally, R Project for Statistical Computing (R Core Team, 2016) will be used in tandem with ProUCL to verify the results of the statistical tests and for data visualization. R is one of the most comprehensive statistical analysis packages available and is widely used among statisticians and data miners in both academia and industry. It incorporates all the standard statistical tests, models, and analyses, as well as providing a comprehensive language for managing and manipulating data.

2. DATA REVIEW AND PREPARATION

2.1 Physical Independence and Sampling Frequency

Most statistical analyses require separate sampling events to be statistically independent. In probability theory, two events (e.g., observing a particular constituent concentration in groundwater at two different time points) are statistically independent if the occurrence of one event does not affect the probability of occurrence of the other. For groundwater samples, the statistical independence can be compromised if the groundwater is slow-moving so that the same volume of groundwater is being sampled on closely-spaced consecutive sampling events. If samples are collected at time intervals that are sufficiently far apart, then the samples can be considered physically independent. To safeguard physical independence, the minimum time between sampling events must be longer than the residence time of groundwater that would be collected in the monitoring well. The minimum time interval between sampling events (t_{min}) can be determined by calculating the groundwater velocity (Darcy's equation), as follows:

$$v = \frac{Ki}{n} \quad (1)$$

$$t_{min} = \frac{v}{D} \quad (2)$$

where:

$v =$ groundwater velocity

$K =$ hydraulic conductivity

$i =$ hydraulic gradient

$n =$ effective porosity

$t_{min} =$ minimum time interval between sampling events

$D =$ well bore volume (i.e., diameter of well and surrounding filter pack)

The above analysis will provide confidence that separate volumes of groundwater are being sampled (i.e., physical independence), which increases the probability that the samples will be statistically independent. Note that Darcy's equation alone cannot guarantee temporal independence because several factors can influence the temporal pattern of constituents, and as such, cannot be exclusively relied upon to estimate statistical sampling frequency. However, semi-annual sampling, as required by the CCR Rule, may be sufficient in maintaining statistical independence.

2.2 Handling Non-Detects

Pursuant to 40 CFR 257.93(g)(5), statistical tests must account for ND data, which can be done by either (i) a substitution method (e.g., replacing NDs with 0 or ½ the RL, or full RL), or (ii) using robust statistical methods that can account for ND data (e.g., Kaplan-Meier [KM] or Regression on Order Statistics [ROS] for calculating the mean and standard deviation).

An example approach for managing ND data, based on the Unified Guidance is as follows. If ND data are infrequent (e.g., <15%), half of the RL can be used in place of these data without significantly biasing the results of a statistical test. If ND data are 15% to 50%, parametric methods that explicitly handle NDs (KM or ROS) or non-parametric methods insensitive to the presence of NDs should be used. If ND data are >50%, a non-parametric test is recommended. Where available, estimated results less than the RL (i.e., "J-flagged" data) should be used, and these data should be considered detections for the purposes of statistical analysis.

2.3 Identifying Outliers

Outliers are extreme values (i.e., larger or smaller than the majority of the data in a sample) that are not representative of the population from which they were drawn. Typically, these extreme outliers represent a systematic error (e.g., transcription error), low probability observations (far tails of the distribution), or observations coming from a different population. The presence of these outliers in a data set can distort the computations of most classical statistical methods, particularly when used to establish background values.

There are a variety of graphical and statistical tools that can be used to identify potential outliers, such as box plots (**Figure 3**), quantile-quantile (Q-Q) plots (**Figure 4**), and outlier tests (Rosner's or Dixon test). A box plot represents a convenient exploratory tool and provides a quick five-point summary of a data set including: the lowest and the highest data values, median (50th percentile = second quartile, Q2), 25th percentile (lower quartile, Q1), and 75th percentile (upper quartile, Q3). A box plot also provides information about the degree of dispersion (interquartile range (IQR) = Q3-Q1 = length/height of the box in a box plot), the degree of skewness (suggested by the length of the whiskers) and unusual data values known as outliers. On a box plot, data points can be considered extreme outliers if they meet one of the following criteria:

$$x_i < \tilde{x}_{0.25} - 3 \times IQR \quad (3)$$

or

$$x_i > \tilde{x}_{0.75} + 3 \times IQR \quad (4)$$

where:

$x_i =$ individual data point

$\tilde{x}_{0.25} =$ 25th percentile

$\tilde{x}_{0.75} =$ 75th percentile

$IQR =$ the interquartile range $= \tilde{x}_{0.75} - \tilde{x}_{0.25}$

Q-Q plots can also aid in identifying potential outliers. Q-Q plots are commonly used to compare a data set to a theoretical model (e.g., normal distribution). For example, a normal Q-Q plot has the normal quantiles on the x-axis and the concentration data quantiles on the y-axis. If the points follow a strong linear pattern, then that suggests the data follow a normal distribution. On a normal Q-Q plot, observations that are separated from the bulk of the data may represent potential outliers needing further investigation. Also, significant and obvious jumps and breaks in a normal Q-Q plot can be indications of the presence of more than one population and/or data gaps due to lack of enough data points (data sets of smaller sizes).

The two classical outlier tests, Dixon and Rosner tests, can be used on data sets with and without ND observations. These tests require the assumption of normality of the data set without the outliers as data sets consisting of outliers seldom follow a normal distribution. Dixon's test is used to identify statistical outliers when the sample size is ≤ 25. This test identifies outliers or extreme values in the left tail and in the right tail of a data distribution. Rosner's test can be used to identify up to 10 outliers in data sets of sizes >25.

However, even the statistical outlier tests do not provide positive identification of outliers. Consequently, the identification of an outlier requires further evaluation and sometimes consideration using professional judgment to decide whether the potential outlier is: (i) valid and will be included in the dataset, (ii) due to error and can be replaced with a corrected value, or (iii) flagged and maintained in the database, but is not used in statistical calculations and is not reported.

2.4 Determining the Distribution of the Data

In order to determine whether a parametric statistical method (i.e., one that assumes that the data follow a known probability distribution) or non-parametric statistical method (i.e., one that does not assume a particular distribution of the data) is selected to establish background values, the data must be tested against a discernible probability distribution. Many statistical analyses assume that the sample data are normally or lognormally distributed. If such an analysis is used, the assumption of normality can be tested using the goodness-of-fit tests (GOF), such as the Shapiro-Wilk test (for sample sizes ≤50) or the Lilliefors test (for sample sizes >50). ProUCL also provides GOF tests to test for a Gamma distribution, which include the Anderson-Darling test and the Kolmogorov-Smirnov test. Data distributions can also be tested by less computationally intensive means such as graphing data on a Q-Q plot as discussed in Section 2.3. If the data appear not follow a discernible probability distribution, then a non-parametric test should be used.

2.5 Testing for Temporal and Spatial Variation

Background data will be evaluated for statistically significant temporal trends using (a) simple linear regression with a *t*-test ($\alpha = 0.01$) on the slope and/or (b) the non-parametric Mann-Kendall (MK) trend test ($\alpha = 0.05$). Non-detect data are replaced with half of the minimum RL for these analyses. The linear regression can be used when data sets with <15% NDs, when regression residuals are normally distributed, and when the variance from the regression line does not change over time. A *t*-test on the estimated slope of the regression will indicate whether there is a statistically significant increasing or decreasing trend over time for each constituent at each well. The Mann-Kendall test is a non-parametric trend test that can be used for data sets with > 4 data points, ≤50% NDs, and multiple RLs. The MK statistic can determine whether a temporal trend is statistically significant. Note that a statistically significant increasing trend in background data (or a statistically significant decreasing trend in pH) could indicate an existing release from the CCR unit or another source, and further investigation may be needed to determine the source of this trend.

In cases where trending background constituent concentrations are identified, the trend component within the data may need to be corrected for (USEPA, 2009). One way to correct for trending concentrations is to de-trend the data by computing a linear regression on the data and use the regression residuals in the production of upper tolerance limits (UTLs) (USEPA, 2009). De-trending of datasets should only occur if similar trends are observed in all background wells (USEPA, 2009). If a shift in concentrations is the cause of the trend, then earlier background data can be discarded to remove the trend. Prior to de-trending background data, the cause of any trend will be considered (USEPA, 2009), especially if the trend is upward, which may indicate influence from a CCR Unit.

To evaluate spatial variability among the background wells (assuming no significant trends over time), a test for the comparison of means is conducted. For only two background wells, a parametric *t*-test or non-parametric Wilcoxon rank-sum will be used. For more than two background wells, a parametric or non-parametric one-way ANOVA will be conducted for each constituent. All tests for comparison of means will be conducted at a 5% level of significance (i.e., $\alpha = 0.05$). Additionally, for both parametric and non-parametric ANOVA, data from each background well must be tested for equality of variance. The variances can be tested visually using box-and-whisker plots and/or analytically using Levene's test ($\alpha = 0.01$).

If the comparison of mean test indicates no statistically significant differences between the background wells, then an inter-well comparison approach is appropriate. If the results of the test indicate statistically significant differences among background wells, then there is evidence to suggest that spatial variability exists. As with temporal trends, the existence of spatial variability could indicate an existing release from the CCR unit or another source, and further investigation may be needed to determine the source of this variability. If the spatial variability is not caused by a release from the CCR unit, then an intra-well comparison approach is appropriate.

3. BACKGROUND SAMPLING

At BBS, a minimum of eight statistically independent samples will be collected from all background and downgradient wells and analyzed for all Appendix III and Appendix IV parameters (**Table 2**) in accordance with 40 CFR 257.94(b). Background monitoring results will be used to establish background constituent concentrations for use in detection and (if necessary) assessment monitoring [40 CFR 257.91(a)(1)].

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4. DETECTION MONITORING

During detection monitoring, indicator (Appendix III) parameters (**Table 2**) are monitored to detect potential release from the CCR unit into groundwater. Detection monitoring will be performed in accordance with 40 CFR 257.94 at BBS. Detection monitoring samples will be collected semi-annually from each background and compliance well and analyzed for Appendix III constituents.

Within 90 days of receiving sample analysis results, the concentration of each Appendix III constituent in each compliance well will be compared to background according to the performance standards in Section 1.2 and statistical procedures outlined herein to determine if a statistically significant increase (SSI) above background has occurred [40 CFR 257.93(h)(2)].

If an SSI above background is detected in any compliance well, data should be evaluated to determine if the cause of the SSI was from the CCR unit. Within 90 days of detecting an SSI, demonstrations can be performed to determine if the SSI was caused by a release from another source, sampling and analysis error, or from natural variability. Demonstrations must be documented and certified by a PE.

Detection monitoring may resume if demonstrations indicate the CCR unit was not the cause of the SSI. Assessment monitoring must begin if demonstrations unsuccessfully identify an alternate cause of the SSI or if demonstrations are not conducted within the allocated timeframe.

4.1 Detection Monitoring Statistical Analysis

For detection monitoring at BBS, either the prediction or tolerance interval (using either the intra-well or inter-well approach) is the selected statistical method that will be used to establish background concentrations for Appendix III parameters. The exact approach will be selected after the background data has been received and reviewed using the statistical methods outlined in **Section 2**.

Prediction intervals provide a range in values within which a newly and independently obtained (often labeled as a future observation) site observation falls with a given probability (or some level of confidence, e.g., 95%). The prediction interval accounts for variability inherent not only in future measurements, but also the additional uncertainty in the prediction limit itself. The upper prediction limit (UPL) is applicable for detection monitoring because the concern is generally for exceedances greater than the value. The only Appendix III parameter that will require both upper and lower tolerance limits is pH.

The UPL is calculated as follows:

$$\mathrm{UPL} = \bar{x} + ks \quad (5)$$

where:

$\bar{x} =$ mean concentration of the background dataset

$s =$ standard deviation of the background dataset

$k =$ multiplier based on the characteristics of the site and the statistical test

Values for k are chosen to maintain a site-wide false positive rate (SWFPR) less than 10% and depend on the following: (1) number of wells, (2) number of constituents being evaluated, (3) size of the background dataset, (4) retesting regime (see Unified Guidance, Chapter 19), and (5) whether intra-well or inter-well comparisons are being used.

Tolerance intervals provide a range of values in which a specified proportion (referred to as coverage) of data will reside with some level of confidence. A one-sided tolerance interval is referred to as a tolerance limit. Again, the upper tolerance limit (UTL) is of interest for detection monitoring because the concern is generally for exceedances greater than the value.

The UTL is calculated as follows:

$$\text{UTL} = \bar{x} + \tau s \quad (6)$$

Similar to the UPL calculation, $\bar{x}$ is the mean concentration and s is the standard deviation of the background dataset. However, in this case the multiplier τ is different from that of the UPL calculation and is a function of the chosen coverage and confidence and the size of the background dataset.

After completion of data review and preparation, the UPL/UTL will be calculated for each Appendix III parameter. To determine if an SSI above background has occurred, the concentration of each Appendix III constituent in each compliance well will be compared to the UPL/UTL.

The method used to calculate UPLs/UTLs is dependent on the distribution of background dataset. Parametric UPLs/UTLs will be calculated when data follow a discernible probability distribution, otherwise a non-parametric UPLs/UTLs will be calculated at a confidence level of 95%. Non-parametric UPLs/UTLs will also be calculated for data sets containing >50% NDs. All UTLs will be calculated using a coverage of at least 90%. The coverage will be determined on a dataset-specific basis to ensure that the false negative rate is appropriately low.

Different analyses can be used for different constituents and different monitoring wells within a CCR unit depending on the background data. Although inter-well comparisons are preferable, they should only be used when there are no trends and no statistically significant population differences among background wells; otherwise, a significant test result may only indicate natural spatial variability instead of an SSI. For instance, if background wells have similar chloride data but different boron data, then inter-well comparisons may be considered for chloride analysis and intra-well comparisons may be considered for boron analysis. Similarly, the use of an UTL over an UPL to establish background concentrations for Appendix III parameters can be justified on a site-specific or statistical basis. Example justifications include:

1. If no resampling and retesting will occur during detection monitoring at BBS;
2. Comparisons between tolerance and prediction intervals indicate that a tolerance interval constructed using a coverage of at least 90 percent and confidence level of 95 percent yield similar power and accuracy to that of a prediction interval with a 1-of-2 retesting scheme; and,
3. Both non-parametric prediction and tolerance intervals are represented by the maximum concentration value within a dataset.

5. ASSESSMENT MONITORING

Assessment monitoring will be initiated at BBS if an SSI above background is detected in any compliance well and is attributed to the CCR unit. Within 90 days of detecting an SSI, and annually thereafter, groundwater will be sampled and analyzed for all Appendix IV constituents (**Table 1**) [40 CFR 257.95(b)]. Within 90 days of receiving the results from the initial assessment monitoring sampling event, and semi-annually thereafter, groundwater will be sampled for all Appendix IV constituents that were detected during the sampling event in addition to all Appendix III constituents [40 CFR 257.95(d)(1)].

During assessment monitoring, GWPS must be assigned to each Appendix IV constituent detected in groundwater [40 CFR 257.95(d)(2)]. The GWPS must be the federal MCL (**Table 2**) or background concentration, whichever is greater [40 CFR 257.95(h)(1)]. For constituents in which no federal MCL has been established, GWPSs must be the background concentration [40 CFR 257.95(h)(2)].

Facilities can return to detection monitoring when all Appendix III and detected Appendix IV parameter concentrations are less than or at background and the GWPS for two consecutive sampling events [40 CFR 257.95(e)]. Conversely, for facilities to remain in assessment monitoring and not progress with an assessment of corrective measures, concentrations must be less than the GWPS [40 CFR 257.95(f)].

5.1 Assessment Monitoring Statistical Approach

Assessment monitoring data must be compared to the GWPS to assess whether corrective action is warranted at the facility. Once a GWPS is established (see **Section 7**), new data from the compliance wells must be evaluated to determine whether they are statistically significantly higher than the GWPS. The statistical analyses listed in 40 CFR 257.93(f) are appropriate for comparing new data to a background dataset, but are not appropriate for comparing new data to a fixed standard (i.e., the MCL). In these cases, the Unified Guidance recommends using constructing a confidence interval around the mean or median and using the lower confidence limit (LCL) to compare against the MCL (see Chapters 21 and 22 of USEPA, 2009 for further details). Note that the new data must be reviewed and prepared using the procedures outlined in **Section 2** before developing these confidence intervals.

Additionally, assessment monitoring data should be compared to background data to assess whether the facility can move from assessment monitoring back to detection monitoring. The prediction or tolerance interval will be the selected statistical method used to establish background concentrations for all Appendix IV constituents that were detected in groundwater [40 CFR 257.95(h)]. Similar to detection monitoring, the upper limit of the tolerance interval is of interest. Parametric and non-parametric UPLs/UTLs will be calculated using a confidence level of 95% and the UTLs will be calculated using a coverage of at least 90%. UPLs/UTLs will be calculated for each detected Appendix IV constituent after completion of data review and preparation using the same procedures outlined in **Section 4.1** (Detection Monitoring Statistical Analysis).

6. UPDATING BACKGROUND CONCENTRATIONS

Background datasets should be updated after every four to eight sampling events (USEPA 2009). If assessment monitoring has been initiated, only sample results collected from background wells should be considered for incorporation into the existing dataset.

A Student's *t*-test or the nonparametric Wilcoxon rank-sum test (also known as the Mann-Whitney test) should be conducted to compare the set of new data points against the existing background dataset, as appropriate. A significance level of 5% is recommended given the relatively small size of the datasets, particularly if background is updated every four measurements and particularly if the nonparametric Wilcoxon rank-sum test is used.

If the *t*-test or Wilcoxon rank-sum test does not indicate significant differences, the new data should be combined with the existing background data to calculate an updated UPL. Increasing the size of the background dataset will increase the power of subsequent statistical tests.

If the *t*-test or Wilcoxon rank-sum test indicates a statistically significant difference between the two populations, then the data should be reviewed to evaluate the cause of the difference. If the differences appear to be caused by a release, then the previous background dataset should continue to be used and the site should enter assessment monitoring. If there is no evidence of a release, the new dataset should be considered more representative of present-day groundwater conditions and used for background.

Once background datasets are updated, spatial variability should be assessed to determine whether pooling data and using inter-well comparisons are appropriate, as outlined in Section 2.5.

7. DEVELOPMENT OF GROUNDWATER PROTECTION STANDARDS

In accordance with §257.95 (d)(2), GWPS are established if statistically significant increases of Appendix IV constituents over background are identified. An upper tolerance limit (UTL) with 95% confidence and 95% coverage will be used as the representative background concentration. The UTLs for each detected Appendix IV constituent will be used to determine appropriate GWPSs. If the UTL for a constituent is greater than its associated MCL, the UTL is the GWPS. If no MCL has been established for a constituent, the background UTL is the GWPS.

If the GWPS is set to the background UTL, then each compliance well observation can be compared using a simple direct comparison to the GWPS. If the GWPS is set to the MCL, then the new compliance well data will be used to construct a lower confidence limit (LCL) to compare against the GWPS.

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TABLES

TABLE 1
LIST OF CCR MONITORING AND BACKGROUND WELLS
TEC Big Bend Station Economizer Ash and Pyrite Pond System
Gibsonton, FL

Well ID	Designation
BBS-CCR-BW1	Background
BBS-CCR-BW2	Background
BBS-CCR-1	Downgradient
BBS-CCR-2	Downgradient
BBS-CCR-3	Downgradient

TABLE 2
MONITORED CONSTITUENTS UNDER THE CCR RULE
TEC Big Bend Station Economizer Ash and Pyrite Pond System
Gibsonton, FL

Constituent	Constituent Reference		EPA Primary or Secondary MCL (ug/L)
	40 CFR 257 Appendix III	40 CFR 257 Appendix IV	
Arsenic (Total)		X	10
Antimony (Total)		X	6
Barium (Total)		X	2,000
Beryllium (Total)		X	4
Boron (Total)	X		NA
Cadmium (Total)		X	5
Calcium (Total)	X		NA
Chloride	X		250,000
Chromium (Total)		X	100
Cobalt (Total)		X	NA
Fluoride	X		4,000
Lead (Total)		X	15
Lithium (Total)		X	NA
Mercury (Total)		X	2
Molybdenum (Total)		X	NA
pH	X		6.5-8.5 (STD Units)
Radium 226 and 228 (Total)		X	5 (pCi/L)
Selenium (Total)		X	50
Sulfate	X		250,000
Total Dissovled Solids	X		500,000
Thallium (Total)		X	2

Notes:
1. EPA = US Environmental Protection Agency
2. MCL = Maximum Contaminant Level
3. ug/L = Micrograms per liter
4. STD Units = Standard Units
5. pCi/L = picoCuries per liter

FIGURES

Economizer Ash and Pyrite Pond System
Location Map

TEC Big Bend Station
Gibsonton, FL

Legend

Jackson Branch

Economizer Ash Ponds

Note:
Source of 2014 Aerials: Florida Department of Transportation, Surveying and Mapping Office.

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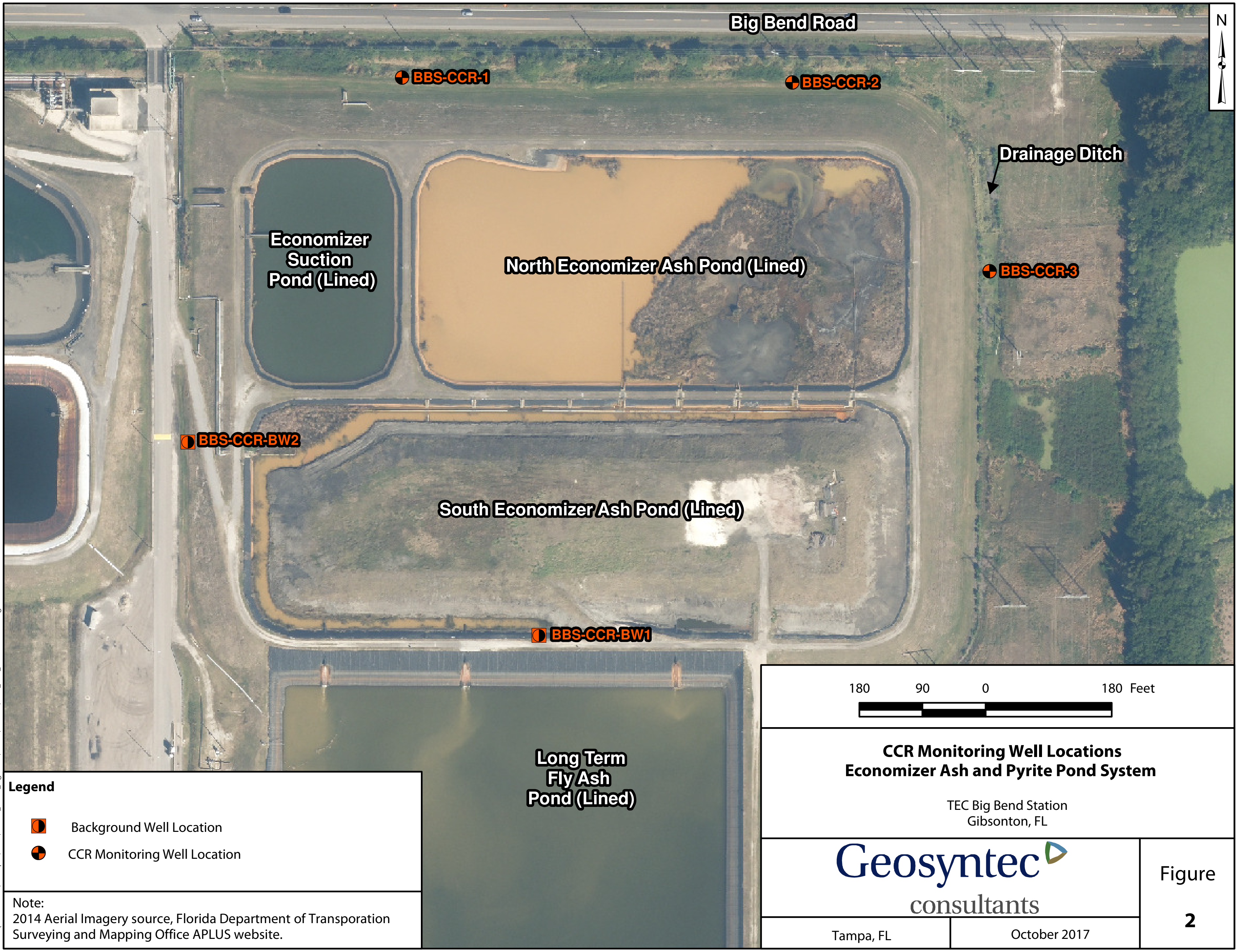
Figure 1

Path: (Titusville-01Data)T:\GIS\FR2033_TECO_BigBend\MXDs\201607\EAPPS.mxd 29 Aug 2016 JRB



Legend

- Background Well Location
- CCR Monitoring Well Location

Note:
2014 Aerial Imagery source, Florida Department of Transporation Surveying and Mapping Office APLUS website.

CCR Monitoring Well Locations
Economizer Ash and Pyrite Pond System

TEC Big Bend Station
Gibsonton, FL

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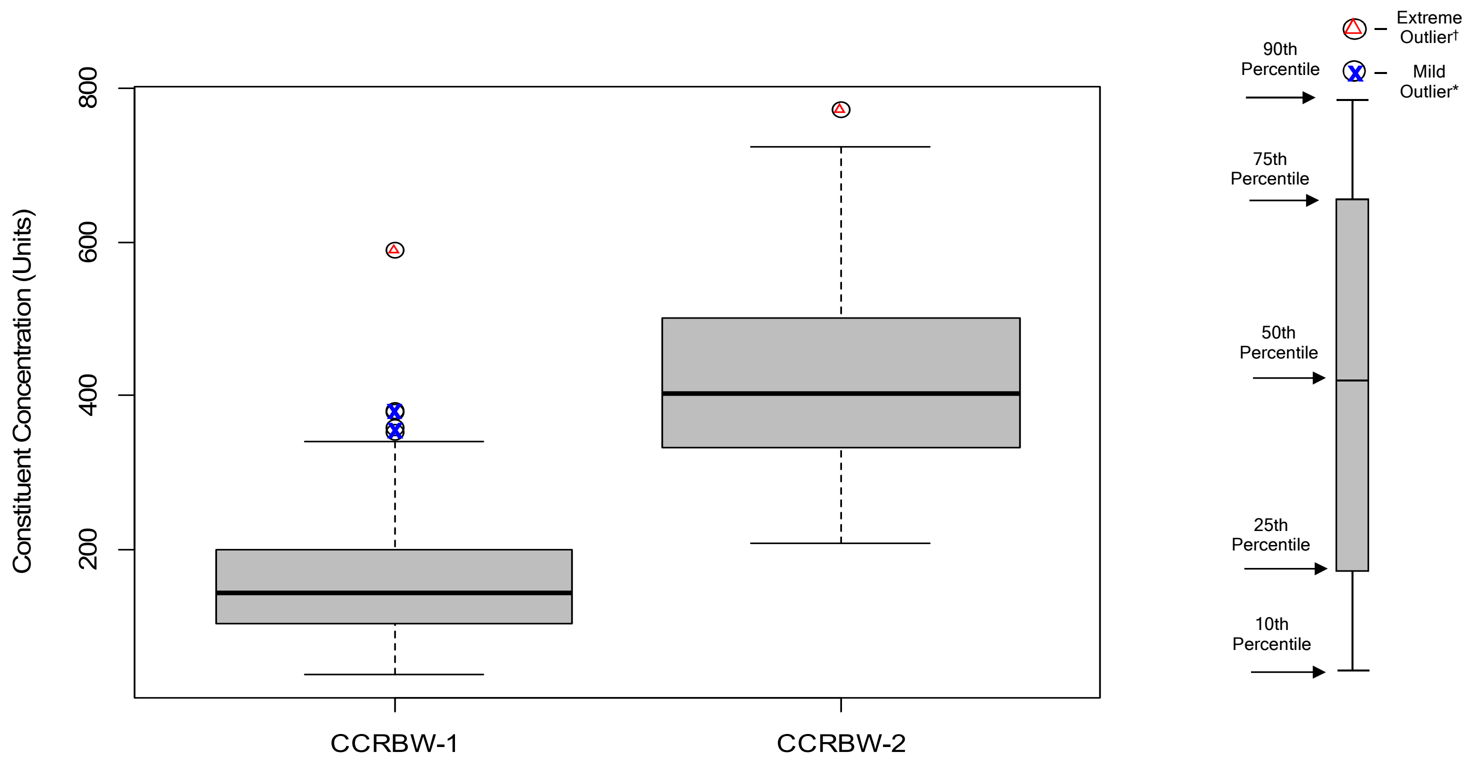
Figure **2**

Path: \\Titusville-01\DATA\ T:\GIS\FR2033_TECO_BigBend\MXDs\201607\CCR_MW_Locs.mxd 29 August 2016 JRB



Notes:

Detection limit is used for non-detects unless otherwise noted.

IQR = interquartile range, equals 3rd quartile (75th percentile) - 1st quartile (25th percentile)

† Potential Extreme Outlier:
Result value is
< 25th percentile - 3 x IQR or
> 75th percentile + 3 x IQR

* Potential Mild Outlier:
Result value is
< 25th percentile - 1.5 x IQR or
> 75th percentile + 1.5 x IQR

Example Box Plot
TEC Big Bend Station Economizer Ash and Pyrite Pond System, Gibsonton, FL

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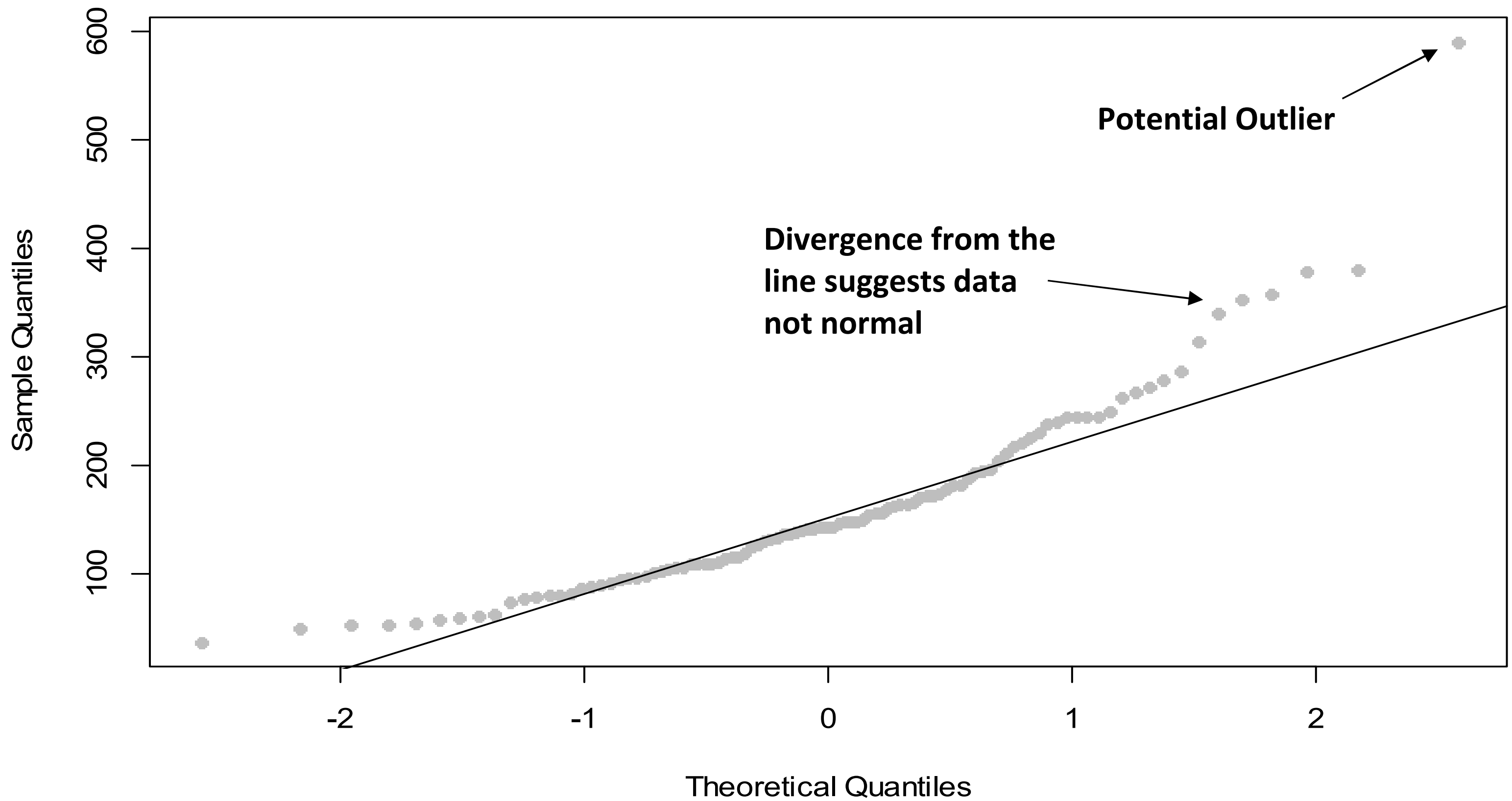
Figure 3

P:\PRJ\Users\Cathy Crea\Stats for Other Offices\TECO\[BBS Statsitical Analysis Plan Figures.xlsx]Figure 3



Notes:

Detection limit is used for non-detects unless otherwise noted.

Example Normal Q-Q Plot

TEC Big Bend Station Economizer Ash and Pyrite Pond System, Gibsonton, FL

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Figure

4

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APPENDIX A

Professional Engineer Certification

GROUNDWATER SAMPLING AND ANALYSIS PROGRAM
SELECTION OF STATISTICAL METHOD CERTIFICATION
CCR LANDFILL: TAMPA ELECTRIC COMPANY – BIG BEND POWER STATION (BBS)
CCR UNIT: ECONOMIZER ASH AND PYRITE POND SYSTEM

GEOSYNTEC CONSULTANTS ("Consultant") has been retained by Tampa Electric Company (TEC) to prepare the following assessment of the above-referenced coal combustion residuals ("CCR") landfill (or, if applicable, CCR landfill lateral expansion) to determine if the selection of statistical method is appropriate for evaluating groundwater monitoring data as required by 40 C.F.R. § 257.93. Presented below are the project background, assessment, limitations, and certification.

1.0 BACKGROUND

Pursuant to 40 C.F.R. § 257.90 (b) owners and operators of new and existing CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of a CCR unit must develop a groundwater sampling and analysis program that includes selection of the statistical procedures to be used for evaluating groundwater monitoring data as required by 40 C.F.R. § 257.93. 40 C.F.R. § 257.93(f) requires the owner or operator of the CCR unit to select one of the statistical methods specified in (1) through (5) below to be used in evaluating groundwater monitoring data for each specified constituent. The statistical test chosen must be conducted separately for each constituent in each monitoring well.

(1) A parametric analysis of variance followed by multiple comparison procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's mean and the background mean levels for each constituent.
(2) An analysis of variance based on ranks followed by multiple comparison procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well's median and the background median levels for each constituent.
(3) A tolerance or prediction interval procedure, in which an interval for each constituent is established from the distribution of the background data and the level of each constituent in each compliance well is compared to the upper tolerance or prediction limit.
(4) A control chart approach that gives control limits for each constituent.
(5) Another statistical test method that meets the performance standards of 40 C.F.R. § 257.93(g).

Pursuant to 40 C.F.R. § 257.93(f)(6), the owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area. The certification must include a narrative description of the statistical method selected to evaluate the groundwater monitoring data.

In support of Consultant's assessment, the Consultant completed an evaluation of the statistical method selected for evaluating the groundwater monitoring data associated with the above-reverenced CCR unit and determined that sufficient information is available to make the certification required under 40 C.F.R. § 257.93(f)(6).

2.0 NARRATIVE DESCRIPTION OF CHOSEN STATISTICAL METHOD

Based upon a review of applicable information, Consultant concludes as follows:

The statistical method set out in 40 C.F.R. § 257.93(f)(3) "Tolerance Interval" was selected to evaluate the groundwater monitoring data. This method for the CCR Unit, designated as BBS Economizer Ash and Pyrite Pond System (EAPP), was selected based on the review of the statistical requirements set out in 40 C.F.R. § 257.93 and the site history and current site conditions, and professional experience with statistical evaluations of environmental water quality data. The implementation of the Tolerance Interval is in accordance with the USEPA Unified Guidance "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities Unified Guidance" dated March 2009. The Unified Guidance recommends the use of the Prediction Interval method for detection monitoring because it mathematically incorporates future verification sampling events (i.e., in situations when a statistically significant increase over background is observed and a well is resampled). However, the Tolerance Interval was selected over the Prediction Interval because the semi-annual sampling program does not include the possibility of collecting independent verification sampling events.

3.0 LIMITATIONS

The signature of Consultant's authorized representative on this document represents that to the best of Consultant's knowledge, information, and belief in the exercise of its professional judgment, it is Consultant's professional opinion that the aforementioned information is accurate as of the date of such signature. Any opinion or decisions by Consultant are made on the basis of Consultant's experience, qualifications, and professional judgment and are not to be construed as warranties or guaranties. In addition, opinions relating to environmental, geologic, and geotechnical conditions or other estimates are based on available data, and actual conditions may vary from those encountered at the times and locations where data are obtained, despite the use of due care.

4.0 CERTIFICATION

I, Todd D. Anderson, being a Registered Professional Engineer, in accordance with the Florida Professional Engineer's Registration, do hereby certify to the best of my knowledge, information, and belief, that, pursuant to 40 C.F.R. § 257.93, the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area dated October 17, 2017, and is true and correct and has been prepared in accordance with generally accepted good engineering practices.

SIGNATURE: ____________________

FLORIDA P.E. NO.: 51277

DATE: 17-OCT-17

TODD D. ANDERSON
LICENSE
No 51277
STATE OF
FLORIDA
PROFESSIONAL ENGINEER