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Groundwater Statistical Method Plan and Certification

Richmond Power and Light
Whitewater Valley Station Impoundment
Richmond, Indiana

GAI Project Number: C151119.04, Task 002.001

April 2019

RICHMOND POWER & LIGHT

Prepared by: GAI Consultants, Inc.
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Prepared for: Richmond Power and Light
2000 US 27 South
Richmond, Indiana 47374

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Certification/Statement of Professional Opinion

The Coal Combustion Residuals Statistical Method Plan (Plan) for the Whitewater Valley Station (Station) Surface Impoundment was prepared by GAI Consultants, Inc. (GAI). The Plan may contain findings and determinations that are based on certain information that GAI has relied on, but not independently verified. This Certification/Statement of Professional Opinion is therefore limited to the information available to GAI at the time the Plan was written. On the basis of and subject to the foregoing, it is my professional opinion as a Professional Engineer licensed in the State of Indiana that the Plan has been prepared in accordance with good and accepted engineering practices as exercised by other engineers practicing in the same discipline(s), under similar circumstances, at the same time, and in the same locale. It is my professional opinion that the Plan is accurate and has been prepared consistent with the requirements of § 257.93(f) of the United States Environmental Protection Agency's "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," published in the Federal Register on April 17, 2015, with an effective date of October 19, 2015, (40 CFR 257 Subpart D), and meeting the provisions of the "Extension of Compliance Deadlines for Certain Inactive Surface Impoundments: Response to Partial Vacatur," effective October 4, 2016.

The use of the words "certification" and/or "certify" in this document shall be interpreted and construed as a Statement of Professional Opinion and is not and shall not be interpreted or construed as a guarantee, warranty, or legal opinion.

GAI Consultants, Inc.

John R. Klamut, P.E.
Senior Project Manager

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1.0 Introduction

Richmond Power and Light (RPL) is evaluating and developing a strategy to comply with Indiana Department of Environmental Management (IDEM) impoundment closure requirements and the United States Environmental Protection Agency's Coal Combustion Residuals (CCR) Rule for the existing Impoundment (Site) at the Whitewater Valley Station (Station) located in Wayne County, Richmond, Indiana (IN).

The purpose of this document is to summarize the statistical methods that will be used to evaluate groundwater quality data at the Site to meet requirements of the CCR Rule prescribed in 40 Code of Federal Regulations (CFR) Part 257.93. As detailed in 40 CFR 257.93(f)(6), the owner or operator must obtain certification from a qualified Professional Engineer (P.E.) stating that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area. GAI Consultants, Inc. (GAI) has prepared this document to provide a narrative description and certification of the selected statistical methods for evaluating groundwater at the Site.

Based on the preliminary statistical analysis of the background Appendix III groundwater quality data detailed below, inter-well prediction/tolerance intervals have been chosen as the appropriate statistical analysis method for the Site. Prediction/tolerance intervals are an approved CCR Rule statistical method listed in 40 CFR 257.93(f)(3).

2.0 Statistical Test Methods

The chosen statistical methods will be in compliance with 40 CFR 257.93 and the Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance (EPA, March 2009). The statistical methods will evaluate if a statistically significant increase (SSI) of contaminant concentrations has occurred in groundwater samples when comparing a compliance monitoring sample analytical result with background (baseline) groundwater analytical results.

The requirements for statistical analysis of groundwater quality data collected under the CCR Rule are given in 40 CFR 257.93(f)-(h). The owner or operator of a CCR unit must select one of the statistical methods specified in the Section to evaluate the groundwater data. The methods include:

1. A parametric analysis of variance (ANOVA) followed by multiple comparisons procedures;
2. An ANOVA based on ranks followed by multiple comparisons procedures to identify significant evidence of contamination;
3. A tolerance or prediction interval procedure;
4. A control chart approach that gives control limits for each constituent; or
5. Another statistical test method that meets the performance standards specified by the CCR rule.

3.0 Groundwater Quality Data

The Site's CCR groundwater monitoring system consists of three upgradient background monitoring wells (MW-AS, MW-FS and MW-GSR) and five downgradient compliance monitoring wells (MW-BS, MW-CS, MW-DS, MW-IS, and MW-JS). In accordance with the CCR Rule, eight rounds of baseline groundwater monitoring data were collected and analyzed for the 40 CFR 257 Appendices III and IV constituents from all three upgradient wells and downgradient compliance wells MW-BS, MW-CS, and MW-DS between April 2017 and August 2018. Compliance wells MW-IS and MW-JS were installed in March of 2018 and have two and three rounds of background data, respectively.

4.0 Statistical Analysis

A preliminary statistical analysis was performed on the eight rounds of baseline groundwater quality data to assess the background constituent data and determine the most appropriate statistical method(s) for data analysis and comparisons. The following sections present a summary of the preliminary statistical analyses performed and general results.

4.1 Trend Test

Time series plots of Appendix III and IV parameters and a two-sided Mann-Kendall test at a 99 percent level of significance were conducted to visually and statistically evaluate potential trends in the background data. The following trends were observed:

- Calcium was found to be significantly decreasing in upgradient wells MW-AS and MW-FS;
- pH was found to be significantly increasing at upgradient well MW-GSR;
- Sulfate was found to be significantly decreasing at upgradient well MW-AS;
- Total Dissolved Solids (TDS) was found to be significantly decreasing at upgradient well MW-FS; and
- Barium, Cobalt, Lithium, and Molybdenum were found to be significantly decreasing at upgradient well MW-FS.

No significant trends were identified for the remaining parameters in any of the background wells.

Due to limitations on CCR Rule implementation timelines, the background data sets are relatively short duration for making such observations regarding overall trending or seasonality. Although the above significant trends in concentrations were observed at upgradient well locations, subsequent statistical tests were completed as if no trend were present. This was done because the rate of change is low relative to the absolute parameter concentrations. The possibility of an ongoing decrease or increase and the need for truncating the dataset for these parameters will be reevaluated after additional data are collected.

4.2 Equality of Variance

Levene's test for equality of variances was used to statistically evaluate differences in average concentrations among the Appendix III parameters in the upgradient background wells. Testing for equality of variance assists in the identification of the most appropriate statistical approach for each parameter. If Levene's test for equality of variances indicates insignificant differences between wells, then the background data can be pooled for inter-well comparisons. If the test detects a significant difference, other strategies, such as the use of intra-well tests, should be evaluated.

Results of the Levene's test indicate significant variation between background wells was observed for Appendix III parameters boron, fluoride, sulfate, and TDS. As such, these parameters were further evaluated for possible intra-well test procedures.

According to the CCR rule, the Site would be classified as an unlined CCR surface impoundment. Prior to the initiation of the groundwater characterization conducted in 2016 (GAI, 2016), no groundwater monitoring had been conducted at the Site. Therefore, groundwater quality was not generated prior to CCR materials being accepted at the Site. A required assumption for implementation of intra-well testing is that groundwater quality down-gradient of the Site has not been impacted by the Site. Because this assumption could not be made, intra-well analysis is not recommended at this time. As additional monitoring data are added to the database, the use intra-well analysis will be re-evaluated.

Based on this analysis, the background upgradient water quality for calcium, chloride, and pH will be pooled for parametric or non-parametric analysis. Because a significant difference was indicated for boron, sulfate, TDS, and fluoride, the data for these parameters will be pooled but only non-parametric analyses will be performed.

4.3 Outliers

Inconsistently large or small values (outliers) can be observed due to sampling, laboratory, transportation, transcription errors, or actual extreme values. The background dataset was pooled and each Appendix III parameter was screened for the existence of outliers using graphical tools such as time series plots. The pooled background dataset for each constituent was also evaluated using Dixon's Outlier test for 25 or less data points or Rosner's Outlier Test for more than 25 data points. The outlier tests were conducted at a 99 percent level of significance.

Based on a review of the time series plots and the Dixon's Outlier test, no outliers were identified in the background groundwater quality data set at the specified level of significance.

However, if an outlier is identified during future review of time series plots or outlier tests, the potential outliers will be evaluated prior to removing it from the dataset. A potential outlier will only be removed if multiple lines of evidence support the outlier designation. After review of the sampling documentation and laboratory quality control information, professional judgement will be used to determine the fate of a potential outlier. If determined to be valid, the result will be included in the statistical analysis. If the result is determined to be a true outlier, the result may be replaced with a corrected value or will be flagged and removed from future statistical analysis.

4.4 Low or Zero Values (Non-Detects)

Background concentrations that are reported as less than the laboratory reporting limit (RL) or the practical quantitation limit (PQL) are referred to as non-detects and will be evaluated differently, depending upon the percentage of non-detects to the reported concentrations for a given parameter. In the instance where at least one background concentration of a particular parameter in the background dataset is greater than the RL/PQL, the evaluation of non-detects will be as follows:

- For data sets with less than or equal to 15 percent non-detects, one-half the value of the RL/PQL will be substituted.
- If more than 15 percent but less than or equal to 50 percent of the overall data are less than the RL/PQL, either Aitchison's adjustment, Cohen's adjustment, or the Kaplan Meijer adjustment will be applied.
- For data sets with more than 50 percent and less than 100 percent non-detects, a non-parametric test shall be used.
- For data sets consisting of 100 percent non-detects, the Double-Quantification Rule will be applied.

4.5 Data Distribution Testing

The pooled background data for each Appendix III and Appendix IV parameter were tested using statistical software to determine the underlying data distribution (normal, lognormal, or unknown/no discernable distribution). Data distribution testing was conducted using the Shapiro-Wilks test for datasets with less than or equal to 50 values. As the background data sets grow, future evaluations may employ the Shapiro-Francia test for datasets of more than 50 values. The data distribution tests were conducted at a 95 percent significance level.

If data were found to be normally or lognormally (test of lognormal transformed data) distributed at a 95 percent significance level, and the data contain less than or equal to 50 percent non-detects, parametric statistical methods are applied. If data were found to be not normally or lognormally distributed (unknown or no discernable distribution), or the data contain greater less than 50 percent non-detects non-parametric statistical methods are applied.

5.0 Statistical Method

Based on the preliminary statistical analysis of the background Appendix III groundwater quality data detailed above, inter-well prediction/tolerance intervals have been chosen as the appropriate statistical analysis method for the Site. Specific methods for each Appendix III and Appendix IV parameter are provided in Table 1.

5.1 Prediction/Tolerance Limits

Prediction limits will be used to evaluate each Appendix III parameter based on the pooled upgradient background well dataset. The prediction limits will be calculated in accordance with the 2009 Unified Guidance using statistical software.

When data for a specific Appendix III parameter are determined to be normally or lognormally distributed, and the data contain less than or equal to 50 percent non-detects, the parametric 95 percent Upper Prediction Limit (UPL) will be calculated. In the case of pH, a two-sided prediction limit procedure will be used to calculate a parametric 95 percent UPL and a 95 percent Lower Prediction Limit (LPL). Parametric prediction limits will be calculated for Appendix III parameters chloride and pH.

When data are determined to be not normally or lognormally distributed (unknown or no discernable distribution), and/or the data contain greater than 50 percent non-detects, the non-parametric 95 percent UPL will be calculated. In the case of pH, a two-sided prediction limit procedure will be used to calculate a non-parametric 95 percent UPL and a 95 percent LPL. In general, the non-parametric prediction limit is calculated by setting the limit as a large order statistic selected from background. The non-parametric UPL will be the maximum concentration detected in the background dataset. For pH, the non-parametric LPL will be the minimum concentration detected in the background dataset. Non-parametric prediction limits will be calculated for boron, calcium, fluoride, sulfate, and TDS.

5.2 Double-Quantification Rule

In the case where a parameter in the background data set has not been detected at concentrations above the RL/PQL, an exceedance of the Site background is considered to have occurred when the parameter is detected at or above the RL/PQL in two consecutive sample and resample events at a particular compliance well (USEPA, 2009). In essence, for parameters with no detected values in the background data set, the RL becomes the 95 percent UPL.

5.3 Background Updates

As additional samples are collected in the future, prediction/tolerance intervals for the background dataset will be periodically updated. Monitoring points used to develop the background dataset will be reviewed, at a minimum, every other year or more frequently as needed. A minimum of four measurement values will be required to update the background dataset. Assuming semi-annual sampling events, background prediction/tolerance intervals will be updated every two or more years.

Before accepting more recent new data into the background dataset, statistical tests described above will be applied to compare recent data to the existing background dataset. If the comparison test does not indicate a statistically significant variance, the recent data will be pooled with the existing background data to calculate updated prediction/tolerance intervals. If a statistically significant variance is identified, data will not be pooled until such time as the cause of the variance can be determined.

5.4 Statistically Significant Increases/Detection Monitoring

A potential statistically significant increase (SSI) above background will have been considered to occur when a concentration of an Appendix III parameter in a compliance well is detected above the corresponding 95 percent UPL. A potential statistically significant decrease (SSD) will have been considered to have occurred when a pH concentration in a compliance well is below the 95 percent LPL.

To verify an SSI or SSD, a 1-of-2 resampling strategy of the compliance well(s) for the applicable parameter(s) will be conducted. Re-sampling must be completed within 90 days of the identification of the potential SSI or SSD. If the initial result and subsequent resample are both above the 95 percent UPL or below the 95 percent LPL, then an inter-well SSI or SSD will be considered verified.

Re-sampling to verify an SSI or SSD will only be conducted if the concentration measured during the previous monitoring event was not above the 95 percent UPL or was not below the 95 percent LPL. An inter-well SSI or SSD will be considered verified without resampling if the concentration during the previous monitoring event was above the 95 percent UPL or below the 95 percent LPL.

5.5 Assessment Monitoring

If Assessment Monitoring is initiated, a Groundwater Protection Standard (GPS) will be established for each Appendix IV parameter detected in the compliance wells. The GPS will be established as either:

- The maximum contaminant level (MCL) for parameters with established MCLs;
- The concentrations provided in 40 CFR 257.95(h)(2) derived from EPA Regional Screening Levels (RSL) for parameters without an establish MCL (cobalt, lead, lithium, molybdenum); or
- A statistically-derived background value if the derived values are greater than their corresponding MCL or RSL.

For GPS values that are established using background, a 95 percent Upper Tolerance Limit (95% UTL) based on the data distribution and detection percentage will be developed from the background data to establish the GPS. For each Appendix IV parameter detected in the compliance wells, a Lower Confidence Interval (LCL) will be calculated. If the LCL is less than or equal to the GPS for each detected Appendix IV parameter in each compliance well, a Statistical Significant Level (SSL) does not exist.

6.0 Summary

In accordance with 40 CFR 257.93(f), inter-well prediction/tolerance intervals have been chosen as the appropriate statistical analysis method for the Site. Although inter-well prediction/tolerance intervals have been selected for Site data analysis, subsequent monitoring data may necessitate additional evaluations regarding the appropriateness of the method. If deemed necessary, other statistical analysis methods approved under 40 CFR 257.93(f), such as analysis of variance, control charts, or intra-well analyses may be used to evaluate Site groundwater data. If the chosen statistical method is changed as a result of a larger database, this certification will be appropriately revised.

7.0 References

1. GAI Consultants, Inc., 2016. Groundwater Characterization Report, Richmond Power and Light Whitewater Valley Station, Impoundment Closure Plan, Richmond, Indiana.
2. Code of Federal Regulations (CFR), Title 40: Protection of the Environment. Part 257: Criteria for Classification of Solid Waste Disposal Facilities and Practices. Subpart D: Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments.
3. U.S Environmental Protection Agency (EPA), 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance, March 2009.

TABLE

Table 1

Selected Statistical Methods for Appendix III and IV Parameters

Parameter	% Non-Detect	Data Distribution	Planned Statistical Method
Appendix III			
Boron	0%	Unknown	Non-Parametric Prediction Limit
Calcium	0%	Unknown	Non-Parametric Prediction Limit
Chloride	0%	Normal	Parametric Prediction Limit
Fluoride	75%	Unknown	Non-Parametric Prediction Limit
pH	0%	Normal	Parametric Prediction Limit
Sulfate	0%	Unknown	Non-Parametric Prediction Limit
Total Dissolved Solids	0%	Unknown	Non-Parametric Prediction Limit
Appendix IV			
Antimony	100%	Unknown	Double-Quantification Rule
Arsenic	95.83%	Unknown	Non-Parametric Tolerance Limit
Barium	0%	Unknown	Non-Parametric Tolerance Limit
Beryllium	100%	Unknown	Double-Quantification Rule
Cadmium	66.67%	Unknown	Non-Parametric Tolerance Limit
Chromium	100%	Unknown	Double-Quantification Rule
Cobalt	33.33%	Unknown	Non-Parametric Tolerance Limit
Lead	100%	Unknown	Double-Quantification Rule
Lithium	33.33%	Unknown	Non-Parametric Tolerance Limit
Mercury	100%	Unknown	Double-Quantification Rule
Molybdenum	33.33%	Unknown	Non-Parametric Tolerance Limit
Radium 226 and 228 Combined	0%	Normal	Parametric Tolerance Limit
Selenium	100%	Unknown	Double-Quantification Rule
Thallium	100%	Unknown	Double-Quantification Rule