COAL COMBUSTION RESIDUALS RULE
STATISTICAL METHODS CERTIFICATION
FIRSTENERGY GENERATION, LLC
HOLLOW ROCK FACILITY
JEFFERSON COUNTY, OHIO

Certification Statement 40 CFR § 257.93(f)(6) – Statistical Approach for the Evaluation of Groundwater Monitoring Data for the CCR Management Area

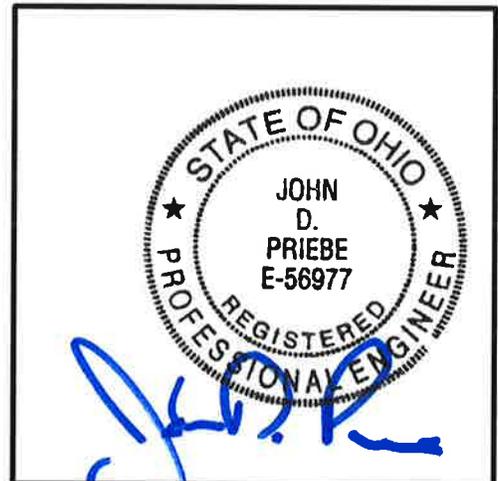**CCR Unit:** FirstEnergy Generation, LLC, Hollow Rock Facility, Landfill Unit

I, _John D. Priebe_ , being a Registered Professional Engineer in good standing in the State of Ohio do hereby certify, to the best of my knowledge, information, and belief that the information contained in this certification is prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the statistical approach selected for the groundwater monitoring system, as described in this document, is appropriate for evaluating the groundwater monitoring data for the CCR management area. The statistical method selected to evaluate the groundwater monitoring data for the CCR Unit is described below.

John D. Priebe
_____
Printed Name

_10-17-17_
_____
Date

Regulatory Guidance

Regulatory guidance provided in 40 CFR §257.90 specifies that a CCR groundwater monitoring program must include selection of the statistical procedures to be used for evaluating groundwater quality data as required by 40 CFR §257.93. Groundwater quality monitoring data has been collected under the detection monitoring program for the Hollow Rock Facility (a single CCR landfill unit) including analysis of eight independent groundwater samples from each background and downgradient well, as required by 40 CFR §257.94(b).

40 CFR §257.93(f) outlines the statistical methods available to evaluate groundwater monitoring data. The statistical test(s) chosen will be conducted separately for each constituent in each monitoring well and will be appropriate for the constituent data and the data set distribution.

In accordance with 40 CFR §257.93(f)(6), a qualified professional engineer must certify that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR unit.

Statistical Analysis Approach

When conducting statistical evaluations of groundwater datasets, it is most prudent to use a suite of statistical methods that are dependent on the character of the data and their distributions. For the groundwater data collected from the groundwater monitoring system at the Hollow Rock Facility, the statistical analyses will be based on an intrawell approach for the purpose of determining if the CCR unit has caused a statistically significant increase (SSI) for any Appendix III parameter. The single unit groundwater monitoring system contains eleven (11) downgradient wells that are installed in the uppermost aquifer. The intrawell statistical approach is appropriate for the monitored aquifer because the CCR Unit occupies the upgradient position on a topographic high with radial groundwater flow away from the landfill in all directions. The statistical algorithms used for the intrawell approach will be chosen based on the groundwater constituent data and their distributions, as well as consideration of natural seasonally- or spatially-varying groundwater constituent concentrations.

Eight rounds of baseline groundwater monitoring data were collected and analyzed for the 40 CFR § 257 Appendix III and Appendix IV constituents. Statistical testing of Appendix III monitoring results is required within 90 days of the completion of sampling and analysis (40 CFR § 257.93(h)(2).

A preliminary, exploratory statistical analysis was performed on the eight rounds of baseline data to initially assess the constituent data to determine the most appropriate statistical approach(es) for the data. The data were examined for outliers and the percentage of non-detect values to verify that the data collected are suitable for statistical analysis. The data were also examined using goodness-of-fit tests (to assign the most appropriate statistical distribution), time series plots, and areal maps to

evaluate whether seasonal or spatial variations in constituent concentrations are present. Based on this preliminary evaluation of the data, the statistical approach(es) identified herein is deemed appropriate for evaluating groundwater in accordance with the CCR rule.

Existing Statistical Analysis Program

The Hollow Rock Facility is a State of Ohio permitted solid waste landfill that received products from the energy generation process including CCR. The Permit-to-Install (PTI) was issued by the Ohio Environmental Protection Agency (OEPA) in December 2006. The PTI included the requirement to install a groundwater monitoring system in addition to construction/operating requirements. Construction activities were completed in 2008 and groundwater monitoring was initiated in 2009.

Statistical evaluations have been performed semi-annually on the groundwater analytical results since 2010 (end of the background sampling period). The data are evaluated in accordance with the *Statistical Analysis Program For Ground-Water Quality Monitoring, FirstEnergy Generation Corporation, Hollow Rock Facility, and Jefferson County, Ohio* document (Eagon 2015). The statistical program was designed using intrawell statistical methods to evaluate whether groundwater quality has been adversely impacted by the facility. Future evaluations using data from the wells identified as part of the CCR monitoring network at the site will be performed in accordance with the July 2015 statistical program document.

Statistical Methods for CCR Groundwater Program

The following sections describe the proposed statistical approaches which are generally consistent with the current statistical program (Eagon 2015).

Exploratory Data Analysis

The data will be initially evaluated to determine outliers for each constituent and its distribution (e.g., normal, lognormal, or non-normal). Outliers for constituents with less than or equal to 50% nondetect data will be conducted using Dixon's outlier test. For data with more than 50% nondetect data, the outlier identification process developed by the Ohio EPA Statistics Workgroup (Division of Drinking and Ground Waters) as documented in an April 7, 2006 letter from Ohio EPA (Crowell to Cobel, April 7, 2006) and Ohio EPA Guidance Document 0715 (DSIWM) dated September 12, 2012 will be used.

Distributional testing will be performed using the Shapiro-Wilk test for data sets comprised of less than or equal to 50 observations and the Shapiro-Francia test of normality will be used for datasets comprised of greater than 50 observations. Distributions will be determine using the ladder-of-powers for untransformed (raw data), ln (x), $x^{1/3}$, $x^{1/2}$, x^2, x^3. The first distribution in the ladder-of-powers having a Shapiro-Wilk W statistic greater than the critical value will be used to calculate the background summary statistics and determine the data distribution.

Control Charts

Shewhart-CUSUM control charts will be used to statistically analyze the compliance data for parameters where background is comprised of less than or equal to 50% nondetect data, and where data are normally distributed or where normality can be approximated,. Control chart factors will be selected based on the work of Gibbons (1999) and the Unified Statistical Guidance (EPA 2009) for multiple comparisons (multiple wells and constituents) and verification resampling. Detailed control chart procedures are provided in the current Statistical Analysis Program (Eagon 2015).

Nonparametric Prediction Limits

Intrawell nonparametric prediction limits will be used to statistically analyze constituent comprised of greater than 50 percent nondetect values or for constituents with less than or equal to 50% nondetect data that are found to have a non-normal distribution. A nonparametric prediction limit is determined as the largest observation (excluding outliers) recorded within the background period. For parameters comprised of 100 percent nondetect data, the most recent PQL will be set as the nonparametric prediction limit. It is noted that if there is a new lower PQL utilized by the laboratory in the future, the statistical limit will be maintained at the previous higher PQL until there are eight observations reported using the new lower PQL. The statistical limit will be re-evaluated once eight results at the lower PQL are available.

Semiannual sampling results will be compared to the nonparametric prediction limits to determine if results are statistically significant. For parameters for which background is comprised of 100% nondetect data, any compliance result identified at or above the nonparametric prediction limit will be considered an initial statistical exceedance and may be verified by resampling. For parameters where background is not comprised of 100% nondetect data, any compliance result identified above the nonparametric prediction limit will be considered statistically significant, pending the results of verification resampling.

 False Positive and Negative Rates (Statistical Power)

To determine the applicable false positive and false negative rates for the site, a simulation study was conducted based on the current monitoring network, constituents, detection frequencies, and distributional form of each monitoring constituent. Determining the false positive and false negative

rates allows the projection of the frequency of verification resamples and false assessments for the site as a whole for each monitoring event based on the results of the simulation study. The latest U.S. EPA guidance (i.e., the March 2009 Unified Statistical Guidance) states that the multiple comparison statistical method should provide a 10% site-wide false positive rate (calculated on an annual basis; or a maximum of 5% for each semiannual event, etc.) while maintaining a statistical power of >50% for a 3-sigma (i.e., standard deviation) release and a power of >80% at 4-sigma. This numeric standard is consistent with the statistical power included on the U.S. EPA reference power curve

Using a control chart factor of 5.5 and passage of "1 of 2" verification samples (in the event of an initial exceedance), the U.S. EPA recommended power of 50% for a 3-sigma release and a power of 80% for a 4-sigma release is met for the site monitoring wells. The use of 1 resample allows the false positive rate to be minimized at a level approximately equal to the USEPA recommended annual site-wide false positive rate of 10%.