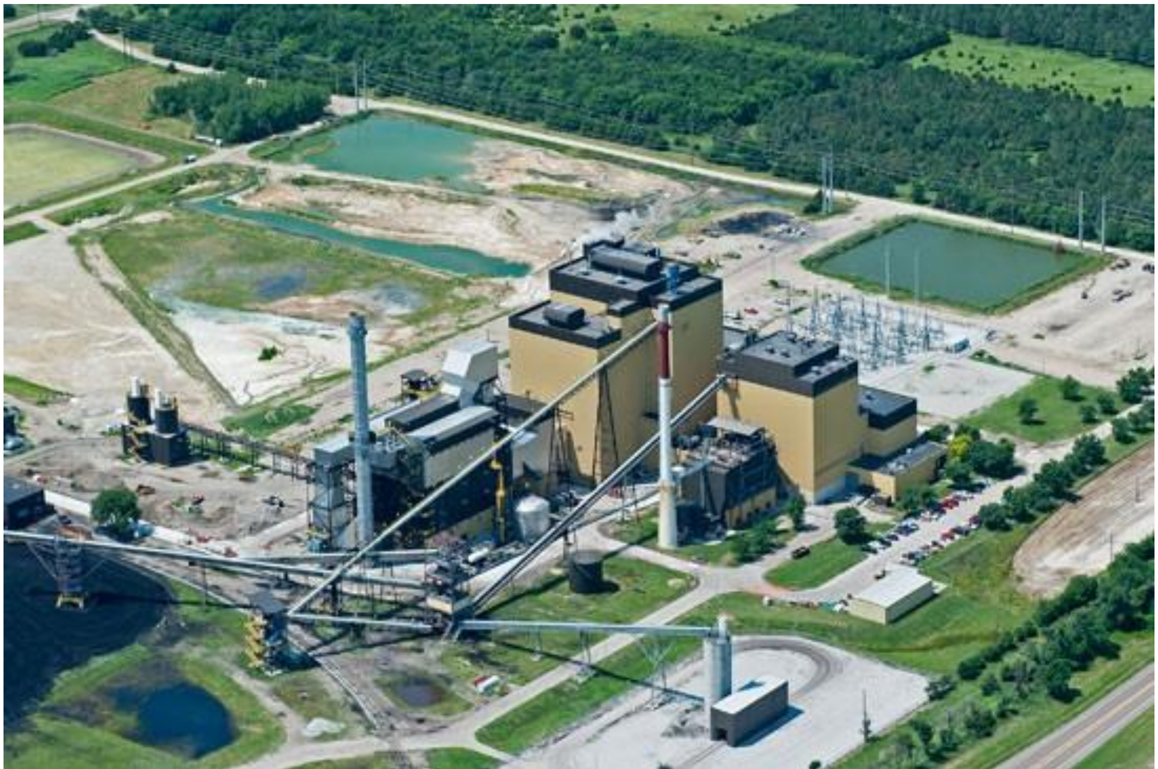

Groundwater Monitoring Statistical Methods Certification

WEC Temporary Ash Disposal Area

Whelan Energy Center
Public Power Generation Agency/
Hastings Utilities

Hastings, Nebraska
February 9, 2018

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Certification

I do hereby certify, to the best of my knowledge, information and belief:

- that the information contained in this certification is prepared in accordance with accepted practice of engineering;
- that the information contained herein is accurate as of the date of my signature below;
- that I have reviewed the statistical methods in this certification report for evaluating the groundwater monitoring data for the CCR management area Whelan Energy Center Temporary Ash Disposal Area, near Hastings, Nebraska and that these methods meet the requirements described in 40 CFR 257.93.

PROFESSIONAL (ENVIRONMENTAL) ENGINEER MEGAN B. SEYMOUR E-15931 STATE OF NEBRASKA	2/9/2018 Megan B. Seymour, P.E. — Date Nebraska License No. E-15931 My license renewal date is December 31, 2018.

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1 Introduction

On April 17, 2015 the U.S. Environmental Protection Agency (EPA) published the final rule for the regulation and management of Coal Combustion Residuals (CCR) under the Resource Conservation and Recovery Act (RCRA). The CCR rule is formally promulgated in the U.S. Code of Federal Regulations (CFR), Title 40, Parts 257 and 261 (EPA, 2015). The rule – effective on October 19, 2015 – applies to electric utilities and independent power producers that fall within NAICS code 221112, and the facility produces or stores CCR materials in surface impoundments or landfills. This regulation applies to the Whelan Energy Center (WEC) owned by Hastings Utilities and Public Power Generation Agency (PPGA) and operated by Hastings Utilities. The WEC Temporary Ash Disposal Area is permitted under the current Nebraska Department of Environmental Quality (NDEQ) Title 132 regulations for fossil fuel combustion ash disposal areas (NDEQ Permit No. NE0204129, Facility ID 58048). The WEC Temporary Ash Disposal Area is located approximately 2 miles east of the City of Hastings, Nebraska.

Previously, statistical analysis of groundwater data was completed in accordance to NDEQ Title 132 regulations, as specified in Appendix D (Groundwater Sampling and Analysis Plan) of the Title 132 Permit Application, dated October 7, 2016. The statistical methods in this Statistical Selection Report will be utilized in place of the statistical method from the Groundwater Sampling and Analysis Plan.

Pursuant to the 40 CFR, 257.93, the facility must develop a program to address the selection of statistical methods to be certified by a Qualified Professional Engineer. Section 257.93(f) of the CCR Rule states that "*The owner or operator of the CCR unit must select one of the statistical methods specified in paragraphs (f)(1) through (5) of this section to be used in evaluating groundwater monitoring data for each specified constituent. The statistical test chosen shall be conducted separately for each constituent in each monitoring well.*"

This report includes a summary of the statistical methodology selected for evaluating groundwater monitoring data at the above mentioned CCR unit and supports compliance with requirements outlined in Sections 257.93(f) and 257.93(g) of the CCR Rule. As a means to develop the most appropriate methods to validate assumptions, evaluate the groundwater data, and develop background concentrations, the statistical methodology is generally based on the USEPA "Unified Guidance"[1] and the ProUCL Technical Guide[2].

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[1] USEPA, Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance. Office of Resource Conservation and Recovery, Program Implementation and Information Division, USEPA, EPA 530/R-09-007, 2009.

[2] Singh, A. and Ashok Singh. ProUCL 5.1.002 Technical Guide Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. EPA/600/R07/041, 2015.

2 Statistical Methods

The statistical methods for evaluating groundwater monitoring data described in this document are consistent with method/paragraph (3) of Section 257.93(f), which includes a tolerance or predication interval procedure.

- "*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.*"

As a reference, Table 1 includes the professional engineer's confirmation that the required performance standards of Section 257.93(g) of the CCR Rule have been met, as appropriate, based on the proposed statistical test method, and indicates which sections of this report provide details that indicate compliance with the methodology performance standards. As the chosen statistical methodology is applied to the groundwater data for determining background concentrations and evaluating downgradient sampling results, revisions to the statistical methods may be warranted to ensure the groundwater monitoring data is evaluated appropriately. The methodology and certification will be updated as needed if revisions are appropriate.

Table 1: Summary of 40 CFR §257.93(g) Statistical Method Performance Standards (1) through (6)

Performance Standards	Compliance with Standard
(1) The statistical method used to evaluate groundwater monitoring data shall be appropriate for the distribution of constituents. Normal distributions of data values shall use parametric methods. Non-normal distributions shall use non-parametric methods. If the distribution of the constituents is shown by the owner or operator of the CCR unit to be inappropriate for a normal theory test, then the data must be transformed or a distribution-free (non-parametric) theory test must be used. If the distributions for the constituents differ, more than one statistical method may be needed.	**Yes.** See Sections 4.1 and 4.2. (Note that Gamma distribution is included in the methodology and will be used as appropriate.)
(2) If an individual well comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentrations or a groundwater protection standard, the test shall be done at a Type I error level no less than 0.01 for each testing period. If a multiple comparison procedure is used, the Type I experiment wise error rate for each testing period shall be no less than 0.05; however, the Type I error of no less than 0.01 for individual well comparisons must be maintained. This performance standard does not apply to tolerance intervals, prediction intervals, or control charts.	**Not Applicable.** This approach is not included in the chosen statistical test method.

Table 1: Summary of 40 CFR §257.93(g) Statistical Method Performance Standards (1) through (6)	
Performance Standards	**Compliance with Standard**
(3) If a control chart approach is used to evaluate groundwater monitoring data, the specific type of control chart and its associated parameter values shall be such that this approach is at least as effective as any other approach in this section for evaluating groundwater data. The parameter values shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern.	**Not Applicable.** This approach is not included in the chosen statistical test method.
(4) If a tolerance interval or a prediction interval is used to evaluate groundwater monitoring data, the levels of confidence and, for tolerance intervals, the percentage of the population that the interval must contain, shall be such that this approach is at least as effective as any other approach in this section for evaluating groundwater data. These parameters shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern.	**Yes.** See Sections 4.2 and 4.3.
(5) The statistical method must account for data below the limit of detection with one or more statistical procedure that shall be at least as effective as any other approach in this section for evaluating groundwater data. Any practical quantitation limit that is used in the statistical method shall be the lowest concentration level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions that are available to the facility.	**Yes.** See Sections 4.2 and 4.3.
(6) If necessary, the statistical method must include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.	**Yes.** See Section 4.

3 Groundwater Monitoring Data Set

Groundwater monitoring activities at the WEC Temporary Ash Disposal Area site commenced in November 2016 and continued through October 2017 in order to obtain a minimum of eight independent background samples and comply with the initial timeframe requirements included in §257.90(b) of the CCR Rule.

Sampling protocols can be found in the Sampling and Analysis Plan dated November 2016 developed by HDR Engineering, Inc. (HDR). The groundwater sampling was conducted by WEC personnel. The groundwater monitoring dataset will continue to be refined as additional data becomes available throughout the life of the CCR Rule groundwater monitoring program. As recommended in the EPA's Unified Guidance, background concentrations should be updated after every four to eight sampling events (USEPA, 2009). The field parameters and analytical results used in the statistical analysis for development of background concentrations as described in the report should be validated by a third party validation team.

3.1 Background

Based on the historical information about the Site, the upgradient monitoring wells that will currently be utilized for determination of background concentrations for the site will include the following monitoring wells:

- MW-5B
- MW-6
- MW-9

The statistical methods described in this report require a minimum of eight samples (i.e., observations) to be included in the background dataset. Based on the number of background wells and sampling events performed between November 2016 and October 2017, it is anticipated there will be sufficient data to perform the statistical analysis described herein to determine the initial background concentrations for the site.

Since the statistical analysis will include an interwell comparison approach, background results will be pooled if multiple background wells are representative of field conditions before determining the background concentrations.

3.2 Downgradient

The data from the last sampling event from the downgradient monitoring wells will be compared to background concentrations to determine if there are statistically significant increases (SSIs) over background. Additional details for comparing downgradient results to background are provided in Section 4.

4 Statistical Analysis

The statistical methods for evaluating groundwater monitoring data WEC Temporary Ash Disposal Area is further discussed in the following sections.

4.1 Preliminary Data Analysis

Preliminary data analysis (PDA) includes multiple steps used to assess and transform data (where necessary) for use in producing background concentrations. The PDA includes producing descriptive statistics such as sample size, number and percentage of detects and non-detects (NDs), location (mean, median) and spread statistics (standard deviation, skewness). Rosner's and Dixson's tests will be used to flag potential outliers. Side-by-side box-plots will be used to understand the level of spatial variability for the site with more than one background well. Graphical analysis will be used to aid in visualizing outliers (box-plots, Q-Q plots), distributions (scatter plots), and seasonality (side-by-side box-plots) depending on the quantity and quality of the data. If seasonality is observed (and there is sufficient data per season), de-seasonalization of the data will be done prior to testing for trends over time. The parametric maximum likelihood regression method can test for statistically significant trends even with the presence of NDs under parametric distribution assumptions. The Mann-Kendall test is appropriate for testing for statistically significant trends for non-parametric distributions. Various goodness-of-fit tests will be used to discern if a constituent's distribution is best explained by a parametric distribution such as the normal, lognormal or gamma, or by a non-parametric distribution.

4.2 Compute Background Concentrations

To identify statistically significant increases (SSIs) in downgradient monitoring wells, the Unified Guidance recommends computing background concentrations for constituents being evaluated using upper prediction limits (UPLs) during detection monitoring. UPLs are suitable for detection monitoring primarily due to the potential and likely need for retesting. Using the data from the selected period of record, UPLs will be computed for each constituent in Appendix III of the CCR Rule. The only constituent/parameter that may require both upper and lower prediction limits (LPL) is pH. A minimum of eight valid background samples should be obtained prior to producing UPLs.

The EPA's software package ProUCL has incorporated algorithms to produce UPLs under varying distribution assumptions such as normal, lognormal, gamma and non-parametric with and without NDs. For background samples with NDs, ProUCL incorporates the regression on order statistic (ROS) and Kaplan-Meier (KM) techniques to impute values for the NDs under parametric distributional assumptions prior to estimating the appropriate UPL test statistics. However, if during the period of the groundwater monitoring program at the facility, a comprehensive statistical software program is or may become available, PPGA/Hastings Utilities reserves the right to change software packages.

The formulation of the prediction limit may vary with the particulars of the test to be made and the characteristics of the data involved such as the type of distribution, the sample size, presence of NDs, and level of skewness; but for illustration, under normal distribution assumptions with no NDs, the formula for the prediction limit for 1 future or independent observation is:

$$UPL = \bar{x} + t_{1-\propto,n-1} S \sqrt{1 + \frac{1}{n}}$$

Where

$\bar{x}$	=	background sample mean
S	=	background standard deviation
t	=	Student's t with $n - 1$ degrees of freedom
∝	=	false positive rate (test significance level)
n	=	number of observations in the background dataset

The UPL offers the advantage of controlling false positive rates when testing an exact number of multiple independent or future observations. A false positive rate captures the risk that the UPL test statistic will indicate an SSI for a concentration when it is not true. A typical false positive rate is 5 percent.

The test significance level (∝) is the false positive error rate assigned to an individual test. Adjustments are required for the test significance level (∝) to adjust for the increase in the false positive rate when more than one sample of a constituent is tested for an SSI over background. The aggregation of the individual false positive rates over multiple comparisons should not exceed 10 percent, (i.e., the cumulative significance level) as recommended by the Unified Guidance.

4.3 Test for Statistically Significant Increases

For detection monitoring, the UPL test statistic will be the threshold for determining if a downgradient observation represents an SSI over background or not. Resampling of wells where an SSI has occurred can either verify the initial evidence of a release or disconfirm it, while avoiding unnecessary false positives.

If a downgradient observation is greater than the appropriate UPL during detection monitoring, then that concentration represents an SSI over background. One exception is pH. If a downgradient observation is less than the LPL, then an SSI for pH has occurred over background. The CCR Rule indicates that if an SSI over background is identified at the waste boundary for one or more Appendix III constituents during detection monitoring, then the owner or operator of the CCR unit must, within 90 days: 1) establish an assessment monitoring program, 2) demonstrate that a source other than the CCR unit caused the SSI over background, or 3) demonstrate that the SSI over background resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Written documentation must also be completed and certified by a qualified professional engineer within the 90 day timeframe.

If sources other than the CCR Unit, natural variability or errors have been ruled out as the reason for the SSI, the one-of-m pass method (i.e., verification sampling), as described in the Unified Guidance (see Chapter 19), allows for an efficient plan to confirm if an SSI over background identified during detection monitoring resulted from the CCR unit. Depending on the number of background samples and the desired site-wide false positive rate, and the available time period in which to do the resampling, either a 1-of-2 or 3 pass method is recommended should verification sampling be considered.

If it is determined that an SSI over background has occurred for one or more Appendix III constituents, assessment monitoring should be initiated as required in 40 CFR 257.95. The CCR owner must establish groundwater protection standard (GWPS) for each constituent detected in the groundwater, as required in 40 CFR 257.95(h). The GWPS shall be defined as the following:

- The U.S. EPA Maximum Contaminant Level (MCL) for constituents for which an MCL has been established;
- the background concentration for constituents for which an MCL has not been established, or
- the background concentration for constituents for which the background level is higher than the established U.S. EPA MCL.