



Groundwater Statistical Evaluation Plan

Coal Combustion Residual Coal Combustion Residual Landfill

801 Fort Street
Trenton, Michigan

October 2017



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*801 Fort Street
Trenton, Michigan*

October 2017

*Prepared For
DTE Electric Company*

A handwritten signature in black ink, appearing to read "Graham Crockford".

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Table of Contents

Section 1 Introduction	1-1
1.1 Regulatory Framework	1-1
1.2 Site Hydrogeology	1-1
Section 2 Groundwater Monitoring System.....	2-1
2.1 Groundwater Monitoring System.....	2-1
2.2 Constituents for Detection Monitoring.....	2-1
2.3 Constituents for Assessment Monitoring.....	2-1
Section 3 Statistical Analysis	3-1
3.1 Establishing Background	3-1
3.2 Data Evaluation and Data Distributions.....	3-2
3.2.1 Background Determination	3-3
3.2.2 Outlier Evaluation.....	3-3
3.2.3 Testing for Normality	3-3
3.2.4 Evaluation of Non-Detects.....	3-4
3.3 Parametric Tolerance or Prediction Limits.....	3-4
3.4 Non-Parametric Tolerance or Prediction Limits.....	3-5
3.5 Double Quantification Rule.....	3-5
3.6 Verification Resampling.....	3-5
Section 4 Evaluation of Detection Monitoring Data.....	4-1
4.1 Statistical Evaluation during Detection Monitoring.....	4-1
Section 5 Assessment Monitoring.....	5-1
Section 6 Certification.....	6-1
Section 7 References.....	7-1

List of Figures

Figure 1 Monitoring Network and Site Plan

Section 1

Introduction

1.1 Regulatory Framework

The United States Environmental Protection Agency (U.S. 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) on April 17, 2015. The CCR Rule, which became effective on October 19, 2015, applies to the Sibley Quarry CCR Landfill (SQLF). Pursuant to the CCR Rule, no later than October 17, 2017, the owner or operator of a CCR unit must develop the groundwater sampling and analysis program to include selection and certification of the statistical procedures to be used for evaluating groundwater in accordance with Title 40 Code of Federal Regulations (CFR) §257.93. This certification must include a narrative description of the statistical method that will be used for evaluating groundwater monitoring data.

TRC Engineers Michigan, Inc., the engineering entity of TRC Environmental Corporation (TRC), prepared this Groundwater Statistical Evaluation Plan (Statistical Plan) for the SQLF CCR unit on behalf of DTE Electric Company (DTE Electric). This Statistical Plan was prepared in accordance with the requirements of §257.93 and describes how data collected from the groundwater monitoring system will be evaluated. As part of the evaluation, the data collected during detection monitoring events (post October 17, 2017), are evaluated to identify statistically significant increases (SSIs) in detection monitoring parameters (Appendix III of the CCR Rule) to determine if concentrations in detection monitoring well samples exceed background levels.

The CCR Rule is not prescriptive with regards to the actual means and methods to be used for statistically evaluating groundwater data, and there is flexibility in the method selection, as long as specific performance metrics are met. A description of statistical methods that meet the performance objectives of the CCR Rule are described in U.S. EPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (Unified Guidance, USEPA, 2009).

1.2 Site Hydrogeology

The SQLF CCR unit is located approximately one-half mile west of the Detroit River. The Sibley quarry was originally developed to mine limestone beginning in the mid-1800s and was mined to over 300 feet below ground surface (feet-bgs) in some areas before becoming inactive. In 1951, Detroit Edison (now DTE Electric) acquired Sibley Quarry and began to manage CCR in the SQLF. As part of normal operations, beginning in 1951, the SQLF has been continuously

dewatered to approximately 300 feet-bgs maintaining a water level in the bottom of the quarry by pumping an average of approximately 1.5 million gallons per day.

The SQLF resides in an area characterized by near surface deposits of glacio-lacustrine clay and silt units on top of thick strata of dolomite and limestone bedrock. The SQLF is located in an area where the Dundee Formation (mostly limestone) and the Detroit River Group (limestone, dolostone and some sandstone) underlie the unconsolidated glacial drift and are the uppermost aquifer. At SQLF, the Dundee Formation is overlain by anywhere from less than 15 feet to more than 70 feet of unconsolidated material, most of which is clay-rich soil with some fill. The top of the Dundee Formation limestone/dolostone bedrock was encountered at depths ranging from 16.5 to 74.5 feet-bgs and, including the underlying Detroit River Group limestone/dolostone/sandstone, extended to depths ranging from 235 to over 310 feet-bgs. The underlying Sylvania Sandstone was encountered at depths ranging from 235 to 300 feet-bgs in some locations at the SQLF.

As expected, data show that groundwater levels are significantly lower within the bedrock in monitoring wells that are the closest to the quarry where significant pumping is, with water levels ranging from 120 to more than 210 feet-bgs. Groundwater flow is consistently inward toward the base of the quarry due to continuous pumping at the quarry that hydraulically controls groundwater flow. Quarry dewatering results in all the perimeter uppermost aquifer CCR monitoring wells being upgradient of the SQLF CCR unit.

Because the uppermost aquifer is in an area where pumping has been performed continuously before CCR disposal began, and will be continued to be dewatered, a continuous inward hydraulic gradient is maintained. As a result, the uppermost aquifer perimeter monitoring wells cannot have been affected by the SQLF CCR unit operations to date, nor could they be in the future under current pumping conditions. Given that groundwater flow is inward toward the quarry, all of the perimeter monitoring wells in the groundwater monitoring system are located in an up gradient position relative to the landfill; therefore, monitoring of the SQLF CCR unit using inter-well statistical methods (upgradient to downgradient) is not possible. Instead, based on these hydrogeologic conditions, intra-well statistical approaches are the appropriate method to evaluate groundwater data statistically. Consequently, intra-well statistical tests will be used during detection monitoring.

Section 2

Groundwater Monitoring System

2.1 Groundwater Monitoring System

A groundwater monitoring system has been established for SQLF CCR unit (TRC, October 2017), which established the following locations for detection monitoring. The locations are shown on Figure 1.

MW-101	MW-102	MW-103
MW-104	MW-105	MW-106
MW-107	MW-108A	

2.2 Constituents for Detection Monitoring

Subsection 257.94 describes the requirement for detection monitoring for Appendix III parameters. Detection monitoring will be performed semiannually unless an alternative frequency is made on a site-specific basis. The detection monitoring parameters are identified in Appendix III of §257.94 and consist of the following:

Boron	Calcium	Chloride
Fluoride	pH	Sulfate
Total Dissolved Solids (TDS)		

2.3 Constituents for Assessment Monitoring

Assessment monitoring per §257.95 is required when a SSI over background has been detected for one or more of the constituents identified in Appendix III to Part 257 – Constituents for Detection Monitoring. In the event that assessment monitoring is triggered through the statistical evaluation of detection monitoring parameters, the following assessment monitoring parameters will be sampled:

Antimony	Arsenic	Barium
Beryllium	Cadmium	Chromium
Cobalt	Fluoride	Lead
Lithium	Mercury	Molybdenum
Selenium	Thallium	Radium 226 and 228 (combined)

Section 3

Statistical Analysis

Groundwater sampling and analytical requirements are described in §257.93. The owner or operator of the CCR unit must select a statistical method specified in §257.93(f) to be used in evaluating groundwater monitoring data. The test shall meet the performance standards outlined in §257.93(g). The goal of the statistical evaluation plan is to provide a means to formulate an opinion or judgement as to whether the CCR unit has released contaminants into groundwater. This plan describes the statistical procedures to be used to determine if a statistically significant increase (SSI) or in the case of pH, a statistically significant difference (SSD), indicating that data is from a different population than background. This plan was developed using applicable guidance, including the *Unified Guidance*. In addition to using applicable guidance documents, commercially available statistical evaluation tools will be utilized by SQLF CCR unit to develop statistically derived limits so that detection monitoring results can be compared to background.

The CCR Rule allows a variety of methods for conducting statistical evaluations. The specific procedure for a given data set depends on several factors including the proportion of the data set with detected values and the distribution of the data. These will not be known until the data are collected. It is generally anticipated, however, that the tolerance or prediction interval procedure will be the preferred method of conducting detection monitoring data evaluation to the extent that the data support the use of that method. This statistical procedure is described below in this section of the plan and in detail in the *Unified Guidance*.

3.1 Establishing Background

Background groundwater quality shall be established prior to October 17, 2017. Per §257.93(d), the owner or operator of the CCR unit must establish background groundwater quality in hydraulically upgradient or background well(s). The development of a groundwater statistical evaluation program for detection monitoring involves the proper collection of background samples, regardless of whether an inter-well or intra-well monitoring strategy is implemented. Background may be established at wells that are not located hydraulically upgradient from the unit if it meets the requirement of §257.91(a)(1). A determination of background quality may include sampling of wells that are not hydraulically upgradient of the CCR management area where:

1. Hydrogeologic conditions do not allow the owner or operator of the CCR unit to determine what wells are hydraulically upgradient; or
2. Sampling at other wells will provide an indication of background groundwater quality that is as representative as or more representative than that provided by the upgradient wells.

The purpose of obtaining adequate background groundwater data is to approximate, as accurately as possible, the true range of ambient concentrations of targeted constituents. Background groundwater data should eliminate, to the extent possible, statistically significant concentration increases not attributable to the CCR unit. Specifically, the owner or operator of a CCR unit must install a groundwater monitoring system that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit. The sampling frequency should be selected so that the samples are physically independent. These background groundwater parameters can be adequately qualified by doing the following:

- Collecting the minimum number of samples that satisfy the requirements of the statistical methods that are used (i.e., that result in adequate statistical power);
- Incorporating seasonal and/or temporal variability into the background data set; and

Incorporating the spatial component of variability into the background data set (i.e., the variability that comes with obtaining samples from different locations within the same groundwater zone).

The initial background/baseline sampling period is a minimum of eight events for Existing CCR units that were in operation on October 19, 2015. This provides a minimal background data set to initiate statistical comparisons. Over time, the short baseline period may result in a high risk of false positive statistical results. The facility may periodically update background data to account for variability in background conditions. The *Unified Guidance* recommends that background data be updated every 4 to 8 measurements (i.e., every two to four years if samples are collected semi-annually, or one to two years if samples are collected quarterly). The background data will be reviewed for trends or changes that may necessitate discontinuation of earlier portions of the background data set.

3.2 Data Evaluation and Data Distributions

DTE Electric will evaluate the groundwater data for each constituent included in the groundwater monitoring program using intra-well tolerance or prediction limits. The tolerance or prediction interval statistical procedure establishes an interval that bounds the ranges of expected concentrations representative of unaffected groundwater using the distribution of background data. The upper tolerance or prediction limit of that interval is then used for comparison to the concentration level of each constituent in each compliance well. Development of the tolerance or prediction limits used for comparison during detection monitoring will be conducted in accordance with the *Unified Guidance*. The following is a summary of descriptive statistics and tolerance or prediction limit choices.

3.2.1 Background Determination

Statistical limits will be calculated after the collection of a minimum of eight independent samples. The analytical results from the eight “background” samples will be used to determine the statistical limits for each individual parameter. For inter-well comparisons, background data should be “pooled” creating a single, combined background dataset from the background monitoring wells. For intra-well, the background data set is comprised of the historical data set established at each individual monitoring well.

The background dataset (and hence the prediction limits) will be updated as appropriate (as discussed above in Section 3.1) to maintain necessary statistical sensitivity. New data will be compared to the existing background data set to determine if there are outlier values, and whether the data are statistically similar. If there are no outliers and the data are statistically similar, the new data will be added to the existing background data set.

3.2.2 Outlier Evaluation

Outliers and anomalies are inconsistently large or small values that can occur as a result of sampling, analytical, or transcription errors; laboratory or field contamination; or shelf-life exceedance; or extreme, but accurately detected environmental conditions (e.g., spills). Data will be reviewed graphically using tools such as time concentration trend plots, box and whisker plots and/or probability plots to illustrate and identify outliers, trends, or otherwise unusual observations at each monitoring location. This will be accomplished prior to further in-depth review of the data sets to identify any obvious field or laboratory anomalies. Data points that are determined to be non-representative will be ‘flagged’ for further detailed evaluation prior to removing from the background data or designating as an outlier.

3.2.3 Testing for Normality

Statistical tests often assume that data are normally distributed or that data can be normalized by various standard methods. The assumption of normality can be tested in various ways. Formal normality testing such as utilizing the Shapiro-Wilk test (for $n < 50$) or the Shapiro-Francia Test (for $n > 50$) or calculation of a coefficient of skewness may be utilized in accordance with the *Unified Guidance*. Alternatively, graphing data on a probability plot can also be used to test for normality. If the data appear to be non-normal, mathematical transformations of the data may be utilized such that the transformed data follow a normal distribution (e.g., lognormal distributions). Alternatively, non-parametric tests may be utilized when data cannot be normalized.

The following are guidelines for decision making during normality testing:

1. If the original data show that the data are not normally distributed, then apply a natural log-transformation to the data and test for normality using the above methods.
2. If the original or the natural log-transformed data confirm that the data are normally distributed, then apply a normal distribution test.
3. If neither the original nor the natural log-transformed data fit a normal distribution, then apply a distribution-free test.

3.2.4 Evaluation of Non-Detects

Background concentrations that are reported as less than the practical quantitation limit (PQL) (herein referred to as non-detects) will be evaluated differently, depending upon the percentage of non-detects to the reported concentrations for a given parameter at a given monitoring well. The evaluation of non-detects was as follows:

Less Than 15% Non-detects

For data that was normally or lognormally distributed and less than 15% non-detects, one-half the value of the method detection limit will be used to calculate the prediction limit. If normally or lognormally cannot be met using one-half of the method detection limit, and if the method detection limits were equal, alternating zero with the value of the method detection limit will be considered in order to determine the normality of the data set.

15% to 50% Non-detects

If more than 15% but less than 50% of the overall data are less than the detection limit, either Aitchison's adjustment, or Cohen's adjustment, or the Kaplan Meijer adjustment will be used to determine the statistical limits in accordance with the *Unified Guidance*.

51% to 100% Non-detects

For data sets that contain greater than 50% non-detects, the non-parametric statistical limits will be utilized as described below.

3.3 Parametric Tolerance or Prediction Limits

Tolerance and prediction intervals are similar approaches to establish statistical ranges constructed from background or baseline data. However, tolerance limits define the range of data that fall within a specified percentage with a specified level of confidence (where a proportion of the population is expected to lie), whereas prediction limits involve predicting the

upper limit of possible future values based on a background or baseline data set and comparing that predicted limit to compliance well data.

Intra-well tolerance or prediction limits are calculated using baseline period or background data from each well. The tolerance or prediction limit will be calculated in accordance with the *Unified Guidance*. If the data set is log-normally distributed the tolerance or prediction limits will be calculated using the log-normally transformed data, and subsequently un-transformed to normal units.

In §257.93(g)(2) it states that for multiple comparisons, each testing period should have a Type I error rate no less than 0.05 while maintaining an individual well Type I error rate of no less than 0.01. Per §257.93(g)(4), these Type I limits do not apply directly to tolerance intervals or prediction intervals; however, the levels of confidence for the tolerance or prediction limit approach must be at least as effective as any other approach based on consideration of the number of samples, distribution, and range of concentration values in the background data set for each constituent.

3.4 Non-Parametric Tolerance or Prediction Limits

Parameters that consist of mainly non-detect data usually violate the assumptions needed for normal based tolerance or parametric prediction intervals. Therefore, as recommended in the *Unified Guidance*, the non-parametric tolerance or prediction limit method will be chosen.

A non-parametric upper tolerance or prediction limit is constructed by setting the limit as a large order statistic selected from background (e.g., the maximum background value). This method has lower statistical power than parametric methods; therefore, it is important to control outliers within the dataset to maintain adequate statistical power that this method can provide. Due to the lack of statistical power of this method, it will only be used when other methods are not available.

3.5 Double Quantification Rule

The double quantification rule is discussed in Section 6.2.2 of the *Unified Guidance*. In the cases where the background dataset for a given well is 100% non-detect, a confirmed exceedance is registered if any well-constituent pair exhibits quantified measurements (i.e., at or above the reporting limit) in two consecutive sample and resample events. This method will be used for non-detect data sets.

3.6 Verification Resampling

In order to achieve the site wide false positive rates (SWFPR) recommended in the *Unified Guidance*, a verification resampling program is necessary. Without verification resampling, the

SWFPR cannot be reasonably met, and much larger statistical limits would be required to achieve a SWFPR of 5% or less. Furthermore, the resulting false negative rate would be greatly increased. Under these circumstances, if there is an exceedance of a tolerance limit or prediction limit for one or more of the parameters, the well(s) of concern will be resampled within 30 days of the completion of the initial statistical analysis. Only constituents that initially exceed their statistical limit (i.e., have no previously recorded SSIs) will be analyzed for verification purposes. This verification sampling must be performed within the same compliance period as the event being verified. If the verification sample remains statistically significant, then statistical significance will be considered. If the verification sample is not statistically significant, then no SSI will be recorded for the monitoring event.

Section 4

Evaluation of Detection Monitoring Data

4.1 Statistical Evaluation during Detection Monitoring

According to §257.94(e), if the facility determines, pursuant to §257.93(h), that there is a SSI over background levels for one or more of the Appendix III constituents, the facility will, within 90 days of detecting a SSI, establish an assessment monitoring program ~~or~~ demonstrate that:

- A source other than the CCR unit caused the SSI, or
- The SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.

The owner or operator must complete a written demonstration (i.e., Alternative Source Demonstration, ASD), of the above within 90 days of confirming the SSI. If a successful ASD is completed, a certification from a qualified professional engineer is required, and the CCR unit may continue with detection monitoring.

If a successful ASD is not completed within the 90-day period, the owner or operator of the CCR unit must initiate an assessment monitoring program as required under §257.95, described further in Section 5. The facility must also include the ASD in the annual groundwater monitoring and corrective action report required by §257.90(e), in addition to the certification by a qualified professional engineer.

Section 5

Assessment Monitoring

As discussed in Section 4, the facility must begin assessment monitoring for the CCR unit if a SSI is identified, and the SSI cannot be attributed to an ASD. Per the CCR Rule, assessment monitoring must begin within 90 days of identification of a SSI that is not attributed to an alternative source. During the 90-day period, wells included in the groundwater monitoring system will be sampled for Appendix IV constituents pursuant to §257.95(b). Within 90 days of obtaining the results from the first assessment monitoring event, all of the wells will be sampled for Appendix III and the detected Appendix IV parameters in the initial assessment monitoring event.

If assessment monitoring is triggered pursuant to §257.94(e)(1), data are compared to Groundwater Protection Standards (GPSs) or background groundwater quality. The CCR Rule [§257.95(h)] requires GPSs to be established for Appendix IV constituents that have been detected during baseline sampling. The GPS is set at the EPA maximum contaminant level (MCL) or a value based on background data. The MCLs will be the GPSs for those constituents that have MCLs unless the background concentration is greater than the MCL, which in that case, the statistically-determined background values becomes the GPS. For all other parameters that do not have MCLs, the GPS defaults to a statistically-based limit developed using background data. For GPSs that are established using background, tolerance limits are anticipated to be used to calculate the GPS. The background will be updated every two years, along with the resulting GPS, consistent with the *Unified Guidance*. If additional assessment monitoring parameters become detected during the assessment monitoring, GPSs will be developed for those parameters in the same manner as the initial parameters.

Consistent with the *Unified Guidance*, the preferred method for comparisons to a fixed standard will be confidence limits. An exceedance of the standard occurs when the 95 percent lower confidence level of the downgradient data exceeds the GPS. Confidence intervals will be established in a manner appropriate to the data set being evaluated (proportion of non-detect data, distribution, etc.). If the statistical tests conclude that an exceedance of the GPS or background has occurred, verification resampling may be conducted by the facility. Once the resampling data are available, the comparison to the GPS or background will be evaluated.

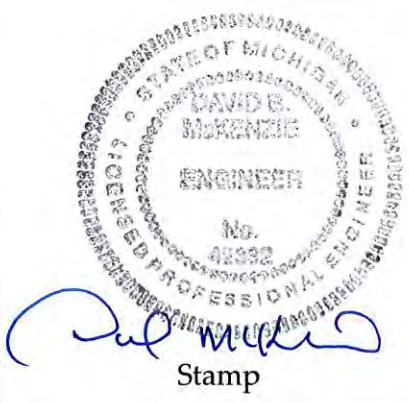
Section 6 Certification

**Statistical Methods Certification per 40 CFR §257.93(f)
Sibley Quarry Landfill
Trenton, Michigan**

The U.S. EPA's Disposal of Coal Combustion Residuals from Electric Utilities Final Rule Title 40 CFR Part 257 §257.93 requires that the owner or operator of an existing CCR unit develop the groundwater sampling and analysis program to include the selection of the statistical procedures to be used for evaluating groundwater monitoring data. The owner or operator 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 to meet the requirements of Title 40 CFR §257.93.

CERTIFICATION

By means of this certification, I certify that I am a qualified professional engineer as defined by Title 40 CFR §257.53, that I have reviewed this Statistical Evaluation Plan, and that the statistical methods described herein are appropriate and meet the requirements of Title 40 CFR §257.93. This document is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of Title 40 CFR §257.93.

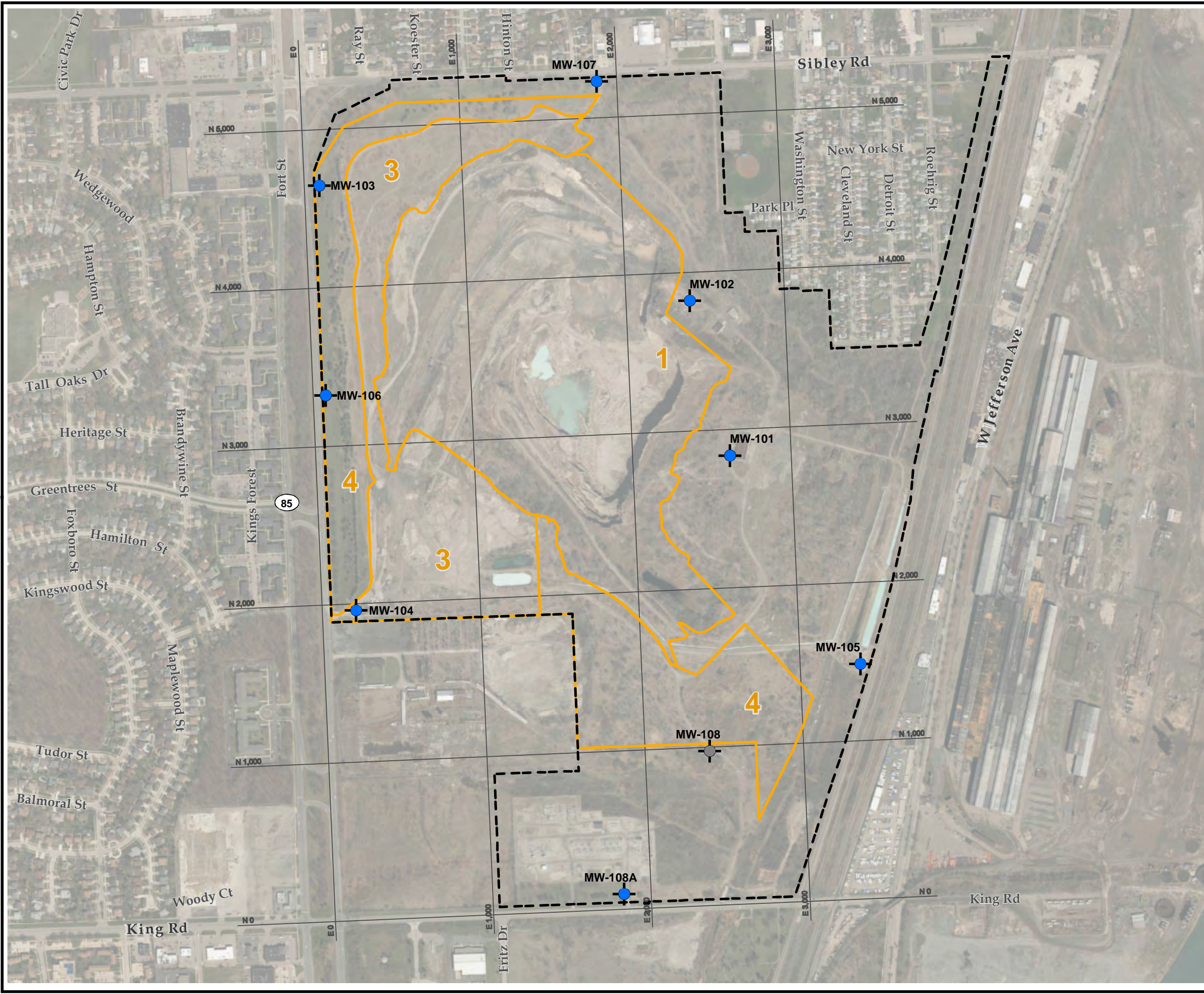
Name: David B. McKenzie, P.E.	Date: October 31, 2017	 <p>Stamp</p>
Company: TRC Engineers Michigan, Inc.	Expiration Date: <div style="text-align: center; color: blue; font-family: cursive;"> October 13, 2017 </div>	

Section 7

References

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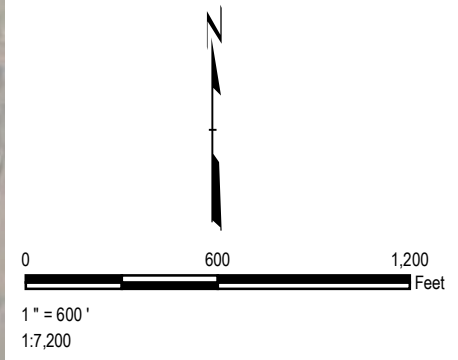
Figure



LEGEND

- MONITORING WELLS
- ABANDONED MONITORING WELL
- SIBLEY QUARRY PROPERTY LINE
- SOLID WASTE DISPOSAL AREA BOUNDARY
- FILL AREA DESIGNATION

- NOTES**
1. BASE MAP IMAGERY FROM ESRI/MICROSOFT, "WORLD IMAGERY", WEB BASEMAP SERVICE LAYER, 2011.
 2. SITE LAYOUT INFORMATION FROM GEOREFERENCED CAD FILE. FEATURES ARE APPROXIMATE.
 3. SURVEY PERFORMED BY THE DTE SURVEY GROUP IN AUGUST 2015, MAY 2016 AND JANUARY 2017.



PROJECT:		DTE ELECTRIC COMPANY SIBLEY QUARRY 801 FORT STREET TRENTON, MICHIGAN	
TITLE:			
MONITORING NETWORK AND SITE PLAN			
DRAWN BY:	SUENMICHTR	PROJ NO.:	254222.0002
CHECKED BY:	SCIESZKA C	FIGURE 1	
APPROVED BY:	BUENING V		
DATE:	OCTOBER 2017		
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