BACKGROUND WATER QUALITY STATISTICAL CERTIFICATION

for Compliance with the Coal Combustion Residuals (CCR) Rule

Erickson Station

Lansing Board of Water & Light

November 19, 2020

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Table of Abbreviations and Acronyms

Abbreviation	**Definition**
BDL	below detection limits
BTV	background threshold value
CCR	Coal Combustion Residuals
COI	constituent of interest
EDD	electronic data deliverable
EPA	Environmental Protection Agency
MDL	method detection limit
ND	non-detects
SOP	Standard Operating Procedure
SSI	statistically significant increase
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
UPL	upper prediction limit

Certification

Background Water Quality Statistical Certification for Compliance with the Coal Combustion Residuals Rule

I hereby certify to the best of my knowledge that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area.

I am duly licensed Professional Engineer under the laws of the State of Michigan.

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1.0 Introduction

The U.S. Environmental Protection Agency's (EPA's) final Coal Combustion Residuals (CCR) Rule establishes a comprehensive set of requirements for the management and disposal of CCR (or coal ash) in landfills and surface impoundments by electric utilities. Erickson Power Station ("Erickson" or "Site"), located in Delta Township, Eaton County, Michigan (Figure 1), is owned and operated by Lansing Board of Water and Light (BWL) and contains a single coal-fired generator capable of producing 165 megawatts of electricity. The CCR generated at Erickson is stored in dewatering tanks (hydro-bins) and three active CCR impoundments: the Forebay, Retention Basin, and Clear Water Pond (CWP). A 33-acre impoundment was physically closed by removal of CCR in 2014 is now referred to as the Former Impoundment (Figure 2). The three active impoundments are subject to the CCR Rule. Part §257.93 of the Rule requires that a certification be obtained from a professional engineer describing the statistical method selected to evaluate the groundwater monitoring data at the facility.

The objective of this report is to document the selection of the statistical method for each Appendix III and IV constituent of interest (COI) for each CCR facility. At Erickson, groundwater monitoring has been conducted to collect eight rounds of background sampling plus the initial detection monitoring as specified under CCR Rule Part §257.94. The water quality data collected from the monitoring wells located upgradient of the CCR unit has been compiled and statistically analyzed to develop background threshold values (BTVs) for each COI for each CCR facility. The statistical method chosen to represent background water quality is the upper prediction limit (UPL) and is one of the methods described in the CCR Rule Part §257.93 (f)(3). This background water quality report documents the background sample events and describes the statistics performed to develop the BTVs.

2.0 Facility Description

Erickson Power Station is located in Delta Township, Eaton County, Michigan (Figure 1). The Erickson Power Station coal-fired generation unit went into service in 1970. The station generates up to 165 megawatts of electric power from one coal-fired boiler, designated as Unit 1. Historically, fly ash and bottom ash were sluiced from the plant to the 33-acre impoundment system (now physically closed). From the impoundment, the water then flowed hydraulically to the Clear Water Pond (CWP). Water from CWP was sent back to the plant for use. From 2009 through 2014, the ash was removed from the 33-acre impoundment, and a new system was installed within the footprint of the Former Impoundment. It now consists of the Forebay, Retention Basin, and CWP which are currently in use.

The Forebay, Retention Basin, and CWP are subject to CCR Rule. Currently, bottom ash from the coal-fired boiler is sluiced from the plant to dewatering tanks (hydro-bins). The dewatered bottom ash is trucked to a sanitary landfill and the decant water is hydraulically fed through the current impoundment system, which consists of a series of three impoundments: the Forebay, Retention Basin, and CWP. The Forebay and Retention Basin were constructed in 2014 (the CWP was constructed in 1970). Water in the CWP is sent back to the plant. Figure 2 depicts the current impoundment system. There are no regulated outfalls associated with the system.

The operation and monitoring of all the CCR units are described further in the Erickson Station Groundwater Monitoring System Certification (HDR, 2020).

2.1 Monitoring Well Network

The CCR Rule requires, at a minimum, one upgradient and three downgradient monitoring wells per CCR unit to be completed in the uppermost aquifer. Section §257.91 of the Rule states that the operator: "*…may install a multiunit groundwater monitoring system instead of separate groundwater monitoring systems for each CCR unit."* In addition, the CCR Rule states that downgradient monitoring wells should be installed to: *"accurately represent the quality of groundwater passing the waste boundary of the CCR unit. The downgradient monitoring system must be installed at the waste boundary that ensures detection of groundwater contamination in the uppermost aquifer."*

The Forebay, Retention Basin, and CWP are separated from the Former Impoundment by embankments. BWL determined monitoring wells would not be installed in the embankments of active impoundments to maintain active embankment structural integrity. Additionally, monitoring wells would not be located within the footprint of the Former Impoundment because it remains a depression that impounds stormwater that falls within it and overflows from the Retention Basin. Based on the CCR requirements, hydrogeological data, site visits, and the embankments separating impoundments, three wells were originally sited to confirm the uppermost aquifer under the impoundments and determine the groundwater flow direction under the Site. These three wells (MW-1, MW-2, and MW-3) were sited to triangulate water table elevations to calculate the groundwater flow direction and gradient. The three wells were installed in October 2019 around the outside of the impoundments to evaluate groundwater conditions at the Site in order to advance CCR compliance. Based on the first few months of groundwater level data from wells MW-1, MW-2, and MW-3, it was confirmed that the groundwater flow direction is northeast and MW-1 is upgradient of the impoundments and MW-2 is downgradient. Due to the configuration of the impoundments relative to the northeastern groundwater flow direction, the closest location for installation of downgradient wells for monitoring the three active CCR impoundments is on the downgradient side of the Former Impoundment (Figure 2).

Three new wells were installed in January 2020 (MW-4, MW-5, and MW-6) to comprise a single multiunit monitoring network along the perimeter of the impoundments. The multiunit includes the three CCR impoundments, Forebay, Retention Basin, and CWP, and the non-CCR Former Impoundment. Wells MW-1 and MW-4 serve as upgradient wells and MW-2, MW-5, and MW-6 serve as downgradient wells for the multiunit. Wells are located to ensure the groundwater quality from these wells will detect CCR constituents in groundwater from all three of the CCR impoundments, if present. The sixth well, MW-3 is cross gradient to the impoundments and will be monitored only for water levels.

Figure 1. Vicinity Map for Erickson Power Station

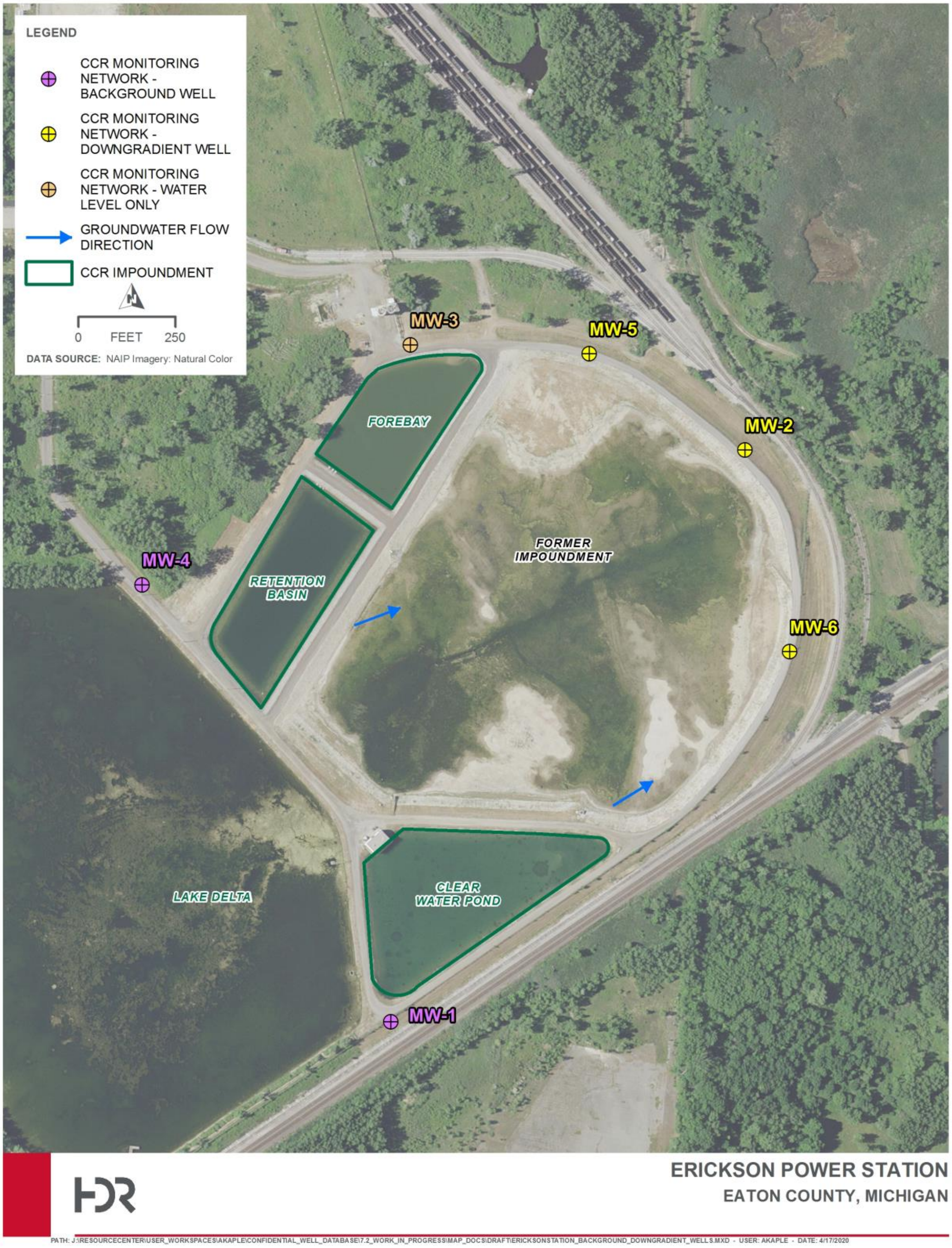


Figure 2. Erickson Power Station – CCR Unit and Monitoring Well Location Map

3.0 Monitoring Methods

3.1 Monitoring Frequency

As stipulated in the CCR Rule, eight background groundwater sampling events were completed to monitor the impoundments between April 14, 2020 and October 12, 2020. This Background Memorandum presents the statistics from the eight events, completed on the following dates:

- ✓ April 14, 2020
- ✓ May 13, 2020
- ✓ June 17, 2020
- ✓ July 14, 2020
- ✓ August 14, 2020
- ✓ September 14, 2020
- ✓ September 28, 2020
- ✓ October 12, 2020

3.2 Water Levels and Sample Collection

Water levels were recorded for each of the monitoring wells and groundwater quality samples were collected from the all of the wells (upgradient and downgradient), to calculate the background water quality the data from the upgradient wells was pooled (MW-1 and MW-4). Groundwater sample collection protocols followed the Groundwater Sample Collection Standard Operating Procedure (SOP) (HDR, 2020). The water samples were collected using a peristaltic pump and dedicated tubing. Water samples were delivered under Chain of Custody to Merit Laboratories, Inc, in Lansing, Michigan. Only the upgradient wells are discussed in this report, for development of BTVs. The downgradient wells will be discussed in the Annual Groundwater Monitoring and Corrective Action Reports (Annual Groundwater Reports).

3.3 Analytical Testing

Groundwater samples were analyzed for the parameters shown in , which include all of the parameters in Appendices III and IV of CCR Rule Part §257. In addition to the parameters listed in , each sample was also analyzed for Total Suspended Solids (TSS).

Table 1. Groundwater quality parameters

Appendix III Constituents for Detection Monitoring	Appendix IV Constituents for Assessment Monitoring
Boron	Antimony
Calcium	Arsenic
Chloride	Barium
Fluoride	Beryllium
pH	Cadmium
Sulfate	Chromium
Total Dissolved Solids (TDS)	Cobalt
Additional Parameters	Fluoride
Total Suspended Solids (TSS)	Lead
	Lithium
	Mercury
	Molybdenum
	Selenium
	Thallium
	Radium-226 and -228 combined

4.0 Water Levels and Flow Direction

Water levels were measured in the monitoring wells during each sample event. The potentiometric water contours for January and July 2020 are displayed in **Appendix A**, which illustrate that MW-1 and MW-4, chosen for development of BTVs are located upgradient of the CCR unit. Groundwater flow under the CCR unit is generally to the northwest.

5.0 Evaluation of Background Water Quality Data

5.1 Constituents

Laboratory reports from the eight background sampling events are provided in **Appendix B**. The statistical analyses detailed in the below sections pertain to samples collected from background monitoring wells MW-1 and MW-4 between April 12, 2020 and October 12, 2020.

A total of eight groundwater sampling events occurred between April 12, 2020 and October 12, 2020 for constituents listed in Appendix III and Appendix IV of the CCR Rule and for certain physical parameters. Only non-filtered Appendix III and IV sample results were utilized for the statistical analysis. Supplemental water quality parameters were analyzed to help provide context to observed patterns for Appendix III and IV constituents. For example, their results may determine if there are possible conditions that might impact the reliability of the data.

Reporting units, number of observations, number of non-detects (NDs), and percentage of NDs below detection limits (BDL) for each constituent are listed in **Error! Reference source not found.**. Events sampled on September 14, 2020, September 28, 2020 and October 12, 2020 for radium-226, radium-228, and radium-226+radium-228 (radium-226+228) are not included in the background analysis as the results were not reported by the lab by the date this report was completed. When those results are finalized the radium background values will be updated and this Memo will be amended.

Table 2. Preliminary Data Analysis

Constituent	Unit	No. Observations	No. BDL	% BDL
Appendix III				
Boron	mg/L	16	0	0%
Calcium	mg/L	16	0	0%
Chloride	mg/L	16	0	0%
Fluoride (Undistilled)	mg/L	16	16	100%
pH	su	16	0	0%
Sulfate	mg/L	16	0	0%
Total Dissolved Solids	mg/L	16	0	0%
Appendix IV				
Antimony	mg/L	16	16	100%
Arsenic	mg/L	16	0	0%
Barium	mg/L	16	0	0%
Beryllium	mg/L	16	16	100%
Cadmium	mg/L	16	16	100%
Chromium	mg/L	16	16	100%
Cobalt	mg/L	16	16	100%
Fluoride (Undistilled)	mg/L	16	16	100%
Lead	mg/L	16	16	100%
Lithium	mg/L	16	2	13%
Mercury	mg/L	16	16	100%
Molybdenum	mg/L	16	15	94%
Radium-226+228	pCi/L	12	0	0%
Selenium	mg/L	16	16	100%
Thallium	mg/L	16	16	100%
Supplemental				
Cond.	mS/cm	16	0	0%
Dissolved Oxygen	mg/L	16	0	0%
Oxidation Reduction Potential	mV	16	0	0%
Radium-226	pCi/L	12	3	25%
Radium-228	pCi/L	12	12	100%
Temperature	°C	16	0	0%
Total Suspended Solids	mg/L	16	6	38%
Turbidity	NTU	16	0	0%

Statistical analysis was performed and the data was analyzed for outliers, data distribution, and trends.

5.2 Outliers

Outliers are values that are not representative of the population from which they are sampled. The data set was screened for outliers using the Dixon's Outlier Test which is suitable for data sets containing less than 25 samples. The outlier test was conducted using a significance of 1 percent. For those constituents which had NDs, the NDs were removed prior to testing for outliers. No outliers were identified for Appendix III and Appendix IV constituents.

5.3 Data Distribution

Groundwater data was fitted to known distribution models using Goodness-of-Fit (GOF) tests incorporated in ProUCL. For data sets comprised of 50 or fewer samples, ProUCL's GOF module incorporates the Shapiro-Wilk to determine normal or lognormal distribution and Anderson-Darling to determine gamma distribution. Note that ProUCL does not provide GOF results for data sets with less than three detected values due to insufficient data. For purposes of estimating background concentration levels, these data sets with less than three detected values will be treated under nonparametric distribution assumptions with the maximum detected value chosen to represent the background concentration levels until more data can be collected.

Appendix III constituents boron, calcium, sulfate, and total dissolved solids and Appendix IV constituent lithium were found to have a nonparametric fit to their respective data sets. Molybdenum only has one detected value and will therefore be treated under nonparametric distribution assumptions. Additional sampling rounds are needed in order to determine if these constituents' data sets are better described using parametric distributions such as normal, lognormal, or gamma. Appendix IV constituents antimony, beryllium, cadmium, chromium, cobalt, fluoride (undistilled), lead, mercury, molybdenum, selenium, and thallium will also be treated under nonparametric distribution assumptions as they all have never detected samples. All remaining constituents have a parametric distribution.

5.4 Serial Correlation

Sources for serial correlation in groundwater samples can be due to temporal effects (i.e., autocorrelation) or seasonal effects (i.e., seasonality). Part §257.93(g)(6) of the CCR Rule requires that if necessary, the statistical method must include procedures to control or correct for seasonal as well as temporal correlation in the data.

5.4.1 Autocorrelation

Autocorrelation occurs when measurements collected at different points in time correlate with one another. A minimum of at least fifty samples is recommended to test for autocorrelation. Constituents will be analyzed for autocorrelation as additional sampling is conducted in order to determine if samples are autocorrelated.

5.4.2 Seasonality

Constituents in groundwater at background well locations may experience predictable recurring increases and decreases in concentrations, termed seasonality. The small data set, sixteen samples total (4 spring, 6 summer, and 6 fall), does not allow for accurate statistical analysis of seasonality. A minimum of eight samples per sampled season (spring, summer, and fall) is required to test for seasonal differences but at least twenty samples per season are recommended in order to deseasonalize the data. Constituents will be analyzed for seasonality using the Kruskal-Wallis, ANOVA and Log ANOVA tests as additional sampling is conducted in order to determine if samples are affected by seasonality.

5.5 Trends

A key assumption regarding background is constituent concentrations in groundwater should demonstrate stationary conditions through time, free of any trends. Constituents which follow a parametric distribution were analyzed for trends within the data set using a Maximum Likelihood Estimate (MLE) regression. For those that showed statistically significant upwards or downwards trends, trends were checked against results using piecewise linear-linear and a piecewise linear-linear-linear analyses as a visual aid. The linear-linear regression assumes and identifies one structural break within the time series, and the linear-linear-linear regression assumes two structural breaks within the time series.

The Mann-Kendall was used to analyze linear trends within data sets that do not adhere to a specific distribution model (i.e., nonparametric).

The MLE can be applied to data sets that can be fitted to a specific distribution model, do not demonstrate seasonality and contain NDs. MLE results for those constituents or physical parameters with sufficient number of detected values are depicted in .

The MLE regressions depict an increasing trends for arsenic, depth to water, and temperature and a decreasing trend for groundwater elevation. The piecewise regression analyses did not show any additional trends. Based on lack of correlation between trend tests, the small sample size (16) and condensed range of data, the predicted MLE regression trends are considered preliminary and require further statistical analysis with a larger data set.

Table 3. Maximum Likelihood Estimates (MLE) Regression

Parameter	Unit	N	No. BDL	% BDL	Slope	P-value	Trend
Appendix III							
Chloride	mg/L	16	0	0%	-0.00039	0.3	↔
pH	su	16	0	0%	0.000057	0.7	↔
Appendix IV							
Arsenic	mg/L	16	0	0%	0.0022	0.01	↑
Barium	mg/L	16	0	0%	-0.00035	0.3	↔
Radium-226+228	pCi/L	12	0	0%	0.00030	>0.9	↔
Supplemental							
Radium-226	pCi/L	12	3	25%	-0.0030	0.1	↔
Temperature	°C	16	0	0%	0.0010	0.02	↑
Total Suspended Solids	mg/L	16	6	38%	-0.00062	>0.9	↔
Turbidity	NTU	16	0	0%	-0.0040	0.5	↔

The Mann-Kendall test is suitable for data series with no discernable distributions, no seasonality, and only one value for the MDL. Mann-Kendall results for those constituents or physical parameters with no discernible distributions are depicted in **Table 4**. The Mann-Kendall test depicts and increasing trend for sulfate. Based on lack of correlation between trend tests, small sample size (16), and the condensed range of the data, the decreasing trend is considered preliminary and requires further statistical analysis with a larger data set.

Table 4. Mann-Kendall Tests

Parameter	Unit	N	No. BDL	% BDL	P-value	Trend
Appendix III						
Boron	mg/L	16	0	0%	0.4	↔
Calcium	mg/L	16	0	0%	0.2	↔
Sulfate	mg/L	16	0	0%	0.03	↑
Total Dissolved Solids	mg/L	16	0	0%	0.3	↔
Appendix IV						
Lithium	mg/L	16	2	13%	0.2	↔
Supplemental						
Cond.	mS/cm	16	0	0%	0.1	↔
Dissolved Oxygen	mg/L	16	0	0%	0.2	↔
Oxidation Reduction Potential	mV	16	0	0%	0.2	↔

5.6 Spatial Variability

Spatial variability refers to identifying whether there are statistically identifiable differences in mean concentrations or variance levels across the well field (i.e., the pooled background data). To evaluate the potential for spatial variability between the background wells, parametric and nonparametric analysis of variance (ANOVA) tests were used to test differences in sample mean or median levels at the 5 percent level of significance. Side-by-side box plots for each constituent were also used to determine if variation is significant from a visual perspective. The ANOVA tests for differences between wells are depicted in **Table 5**. Side-by-side box plots for Appendix III constituents, Appendix IV constituents, and supplemental parameters that were flagged for differences in wells by the ANOVA tests are shown in Table 5**, Figure 3. Side-by-Side Boxplots by Well** for Appendix III Constituents

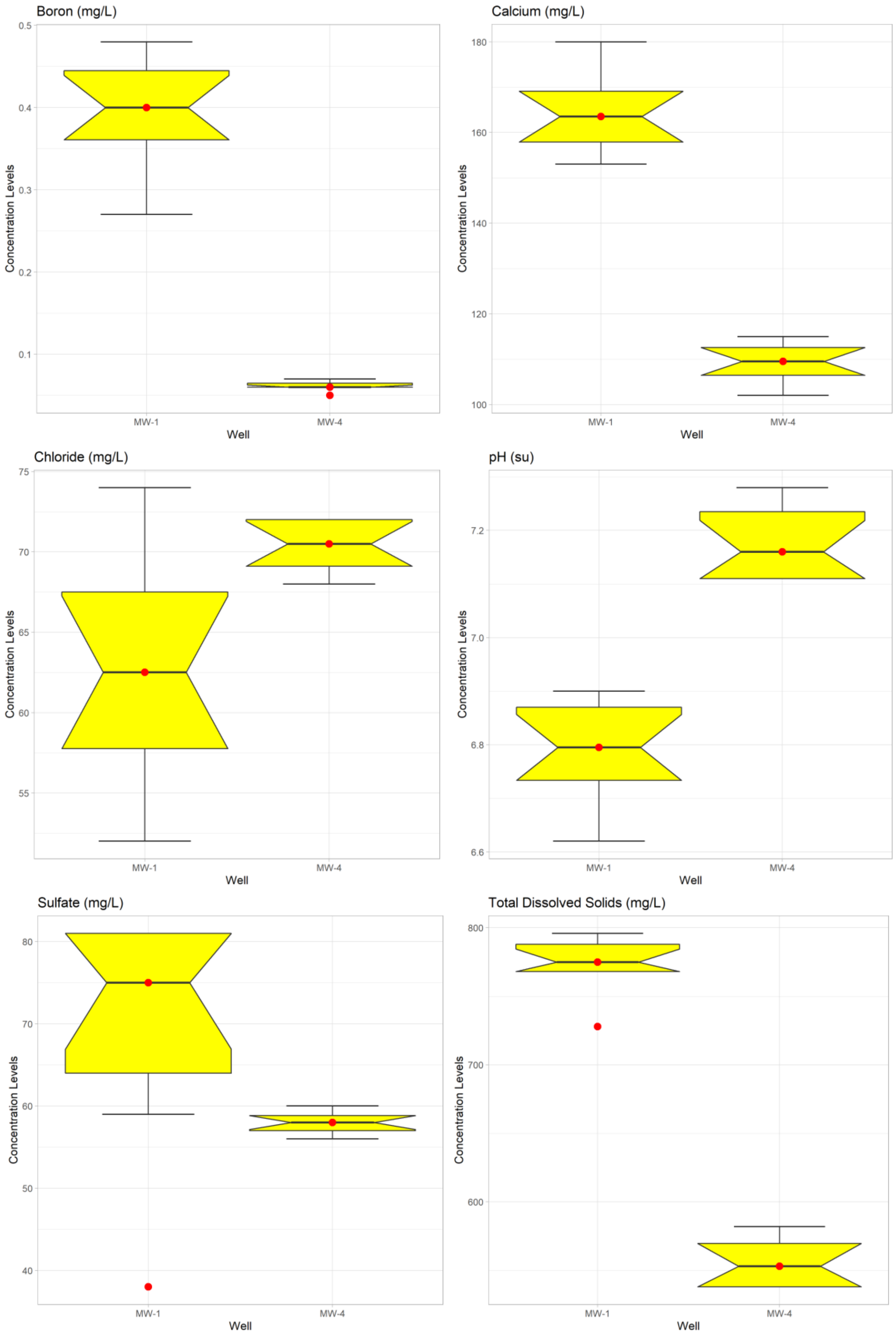
, and Figure 4, respectively.

Potential spatial variability between background wells MW-1 and MW-4 was identified for six Appendix III constituents (boron, calcium, chloride, pH, sulfate, and total dissolved solids), three Appendix IV constituents (arsenic, barium, lithium), and four supplemental parameters (conductivity, depth to water, total suspended solids, and turbidity). The observed spatial variability is indicative of the hydrogeological regime at the site and values between the two wells are within an acceptable order of magnitude of each other. Given the relatively small sample sizes of MW-1 and MW-4 (eight events), the statistically identified variability in concentrations for each constituent are preliminary and considered appropriate for the purpose of calculating background concentrations. The distributional patterns for constituents at the background wells will continue to be monitored for spatial variability and should be re-evaluated as the data set grows.

Table 5. Tests for Differences Between Wells Conducted at the 5% Level of Significance

Parameter	Unit	Sample Size		Test		
		MW-1	MW-4	Kruskal-Wallis	ANOVA	Log ANOVA
Appendix III						
Boron	mg/L	8	8	✓	✓	✓
Calcium	mg/L	8	8	✓	✓	✓
Chloride	mg/L	8	8	✓	✓	✓
pH	su	8	8	✓	✓	✓
Sulfate	mg/L	8	8	✓	✓	
Total Dissolved Solids	mg/L	8	8	✓	✓	✓
Appendix IV						
Arsenic	mg/L	8	8	✓	✓	✓
Barium	mg/L	8	8	✓	✓	✓
Lithium	mg/L	8	8	✓	✓	✓
Supplemental						
Conductivity	mS/cm	8	8	✓	✓	✓
Total Suspended Solids	mg/L	8	8	✓	✓	✓
Turbidity	NTU	8	8	✓	✓	✓

✓Constituent was flagged during statistical analysis


Boron (mg/L)

Calcium (mg/L)

Chloride (mg/L)

pH (su)

Sulfate (mg/L)

Total Dissolved Solids (mg/L)

Figure 3. Side-by-Side Boxplots by Well for Appendix III Constituents

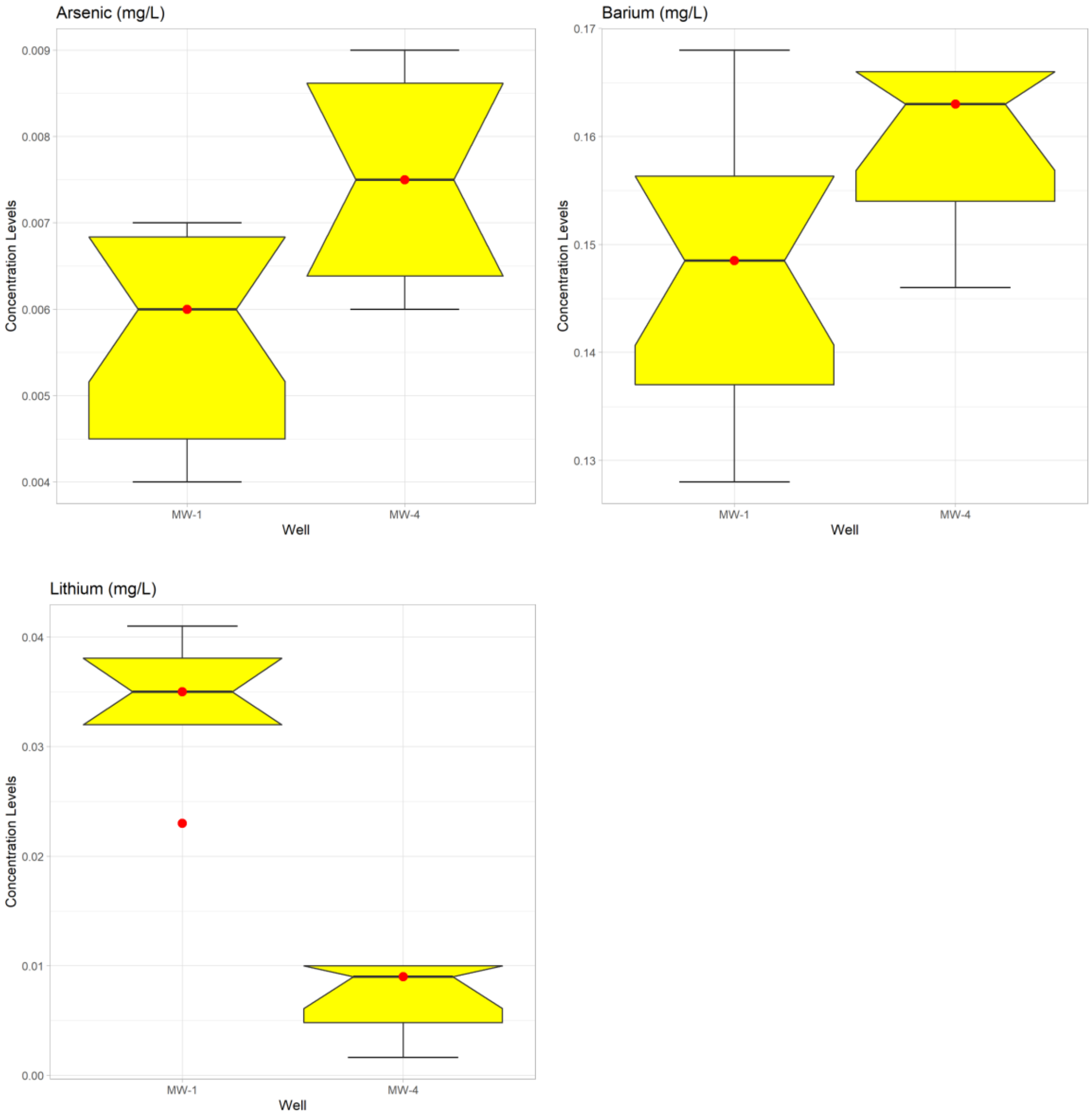


Figure 4. Side-by-Side Boxplots by Well for Appendix IV Constituents

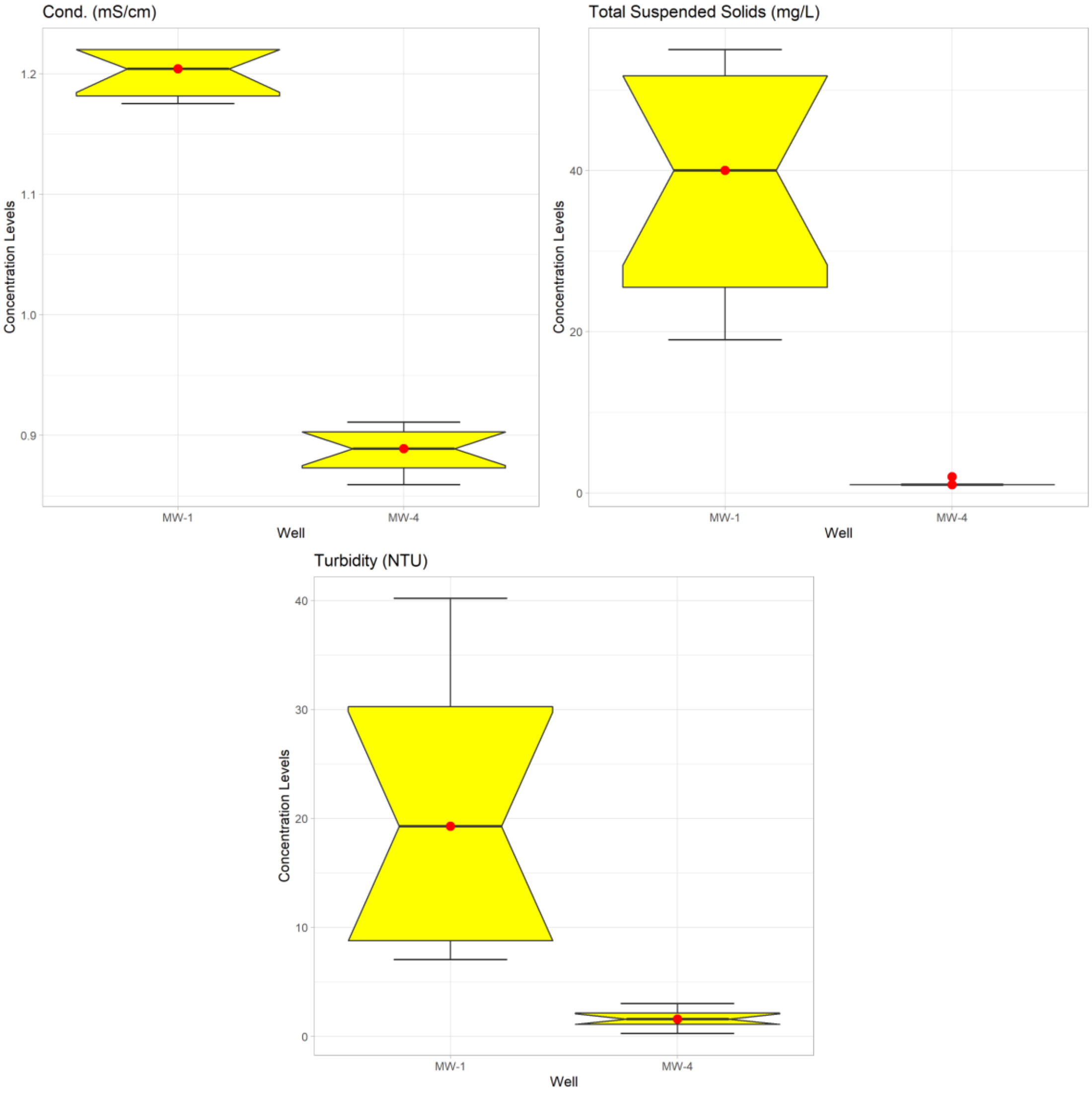


Figure 5. Side-by-Side Boxplots by Well for Field Parameters

5.7 Summary of Statistical Analysis

A summary of statistical results by constituent is depicted in **Table 6**. Based on the small sample size, additional sampling is necessary in order to determine the validity of outliers, whether parametric or nonparametric distributions best explain the data sets, if samples are affected by trends, and if there is spatial variability between the background wells.

Table 6. Summary of Statistical Results by Constituent

Parameter	**Outliers**	**Nonparametric Data Distribution**	**Trends**	**Spatial Variability (MW-1 & MW-4)**
Appendix III				
Boron		✓		✓
Calcium		✓		✓
Chloride				✓
Fluoride (Undistilled)		✓		
pH				✓
Sulfate		✓	✓	✓
Total Dissolved Solids		✓		✓
Appendix IV				
Antimony		✓		
Arsenic			✓	✓
Barium				
Beryllium		✓		
Cadmium		✓		
Chromium		✓		
Cobalt		✓		
Fluoride (Undistilled)		✓		
Lead		✓		
Lithium		✓		✓
Mercury		✓		
Molybdenum		✓		
Radium-226+228		✓		
Selenium		✓		
Thallium		✓		
Supplemental				
Conductivity		✓		✓
Dissolved Oxygen		✓		
Oxidation Reduction Potential		✓		
Radium-228		✓		
Temperature	✓		✓	
Total Suspended Solids				✓
Turbidity				✓

✓Constituent was flagged during statistical analysis

5.8 Detection Monitoring Background Threshold Values

For the purpose of estimating background threshold values (BTVs) to represent background concentration levels and for future use in evaluating whether samples selected from downgradient wells exhibit statistically significant increases (SSIs) during detection monitoring, all background samples per constituent from MW-1 and MW-4 were used.

The detection monitoring BTVs for Appendix III constituents are displayed in . The BTVs are the upper prediction limit (UPL) values from the background data. For constituents that have all ND background values, the maximum MDL is chosen to represent background and the double quantification rule (DQR) is used to evaluate whether there is an SSI. Under DQR, an SSI is registered for the well-constituent pair if the downgradient concentrations exhibit detects in two consecutive sampling events.

The UPLs are used during detection monitoring of the CCR Rule's implementation. UPLs are one of the statistical methods specified under 257.93(f)(3). The details as to which UPL formula was used per constituent are provided in the Data Management and Statistical Procedures Plan (HDR, 2018). Note that for pH, both the UPL and the lower prediction limit (LPL) are of interest as pH values above or below the prediction limits at the downgradient wells can be considered statistically significant. The test significance level per constituent has been estimated such that the cumulative false positive rate over all constituent/downgradient well pair comparisons that are not under DQR is approximately 10 percent. The number of verification samples per constituent has been selected to provide sufficient power to detect an SSI when an SSI has occurred conditional to the background sample size, its distributional properties, and the total number of statistical test comparisons. The UPLs are specifically designed to be applied to Appendix III constituents sampled at three different downgradient wells.

Table 7. Background Threshold Values for Detection Monitoring for each Appendix III Constituent

Constituent	**Unit**	**N**	**No. BDL**	**% BDL**	**Statistical Method**	**No. of Verification Samples**	**BTVs**
Boron	mg/L	16	0	0%	Nonparametric	2	0.480
Calcium	mg/L	16	0	0%	Nonparametric	2	180
Chloride	mg/L	16	0	0%	Parametric	0	87.8
Fluoride (Undistilled)	mg/L	16	16	100%	Nonparametric	na	0.130
pH (LPL)	su	16	0	0%	Parametric	0	6.22
pH (UPL)	su	16	0	0%	Parametric	0	7.82
Sulfate	mg/L	16	0	0%	Nonparametric	2	81.0
Total Dissolved Solids	mg/L	16	0	0%	Nonparametric	2	796

An 'na' indicates that the BTV is based on the maximum MDL and that the DQR is recommended for statistical evaluation.

5.9 Groundwater Protection Standards for Assessment Monitoring

The upper tolerance limits (UTLs) for Appendix IV constituents are displayed in **Table 8.** The Unified Guidance has recommended that the UTL be used as a fixed value similar to a groundwater protection standard where a GWPS or MCL does not exist for the constituent at the location (USEPA, 2009). The CCR requires that if no standard exists, then the background concentration is used (see parts §257.95 (d)(2), §257.95 (h) of the CCR Rule). The UTLs are used during assessment monitoring of the CCR Rule's implementation.

Table 8. Upper Tolerance Limits with 95% Coverage and 95% Confidence for Appendix IV Constituents

Constituent	**Unit**	**N**	**No. BDL**	**% BDL**	**Statistical Method**	**UTL**
Appendix IV						
Antimony	mg/L	16	16	100%	Nonparametric	0.00260
Arsenic	mg/L	16	0	0%	Parametric	0.0112
Barium	mg/L	16	0	0%	Parametric	0.187
Beryllium	mg/L	16	16	100%	Nonparametric	0.000220
Cadmium	mg/L	16	16	100%	Nonparametric	0.000190
Chromium	mg/L	16	16	100%	Nonparametric	0.000750
Cobalt	mg/L	16	16	100%	Nonparametric	0.000150
Fluoride (Undistilled)	mg/L	16	16	100%	Nonparametric	0.130
Lead	mg/L	16	16	100%	Nonparametric	0.000190
Lithium	mg/L	16	2	13%	Nonparametric	0.0390
Mercury	mg/L	16	16	100%	Nonparametric	0.0000160
Molybdenum	mg/L	16	15	94%	Nonparametric	0.00500
Radium-226+228	pCi/L	12	0	0%	Parametric	4.31
Selenium	mg/L	16	16	100%	Nonparametric	0.00210
Thallium	mg/L	16	16	100%	Nonparametric	0.000100

5.10 Assessment Monitoring Background Threshold Values

For the purpose of estimating background threshold values (BTVs) to represent background concentration levels and for future use in evaluating whether samples selected from downgradient wells exhibit statistically significant increases (SSIs) during assessment monitoring, all background samples per constituent from MW-1 and MW-4 were used.

The assessment monitoring BTVs for Appendix III and Appendix IV constituents are displayed in **Table 9**. The BTVs are the upper prediction limit (UPL) values from the background data. For constituents that have all ND background values, the maximum MDL is chosen to represent background and the double quantification rule (DQR) is used to evaluate whether there is an SSI. Under DQR, an SSI is registered for the well-constituent pair if the downgradient concentrations exhibit detects in two consecutive sampling events.

The UPLs are used during assessment monitoring of the CCR Rule's implementation. The details as to which UPL formula was used per constituent are provided in the Data Management and Statistical Procedures Plan (HDR, 2018). Note that for pH, both the UPL and the lower prediction limit (LPL) are of interest as pH values above or below the prediction limits at the downgradient wells can be considered statistically significant. The test significance level per constituent has been estimated such that the cumulative false positive rate over all constituent/downgradient well pair comparisons that are not under DQR is approximately 10 percent. The number of verification samples per constituent has been selected to provide sufficient power to detect an SSI when an SSI has occurred conditional to the background sample size, its distributional properties, and the total number of statistical test comparisons. The UPLs are specifically designed to be applied to the Appendix III and IV constituents sampled at three downgradient wells.

Table 9. Background Threshold Values for Assessment Monitoring for each Appendix III and Appendix IV Constituent

Constituent	Unit	N	No. BDL	% BDL	Statistical Method	No. of Verification Samples	BTVs
Appendix III							
Boron	mg/L	16	0	0%	Nonparametric	2	0.480
Calcium	mg/L	16	0	0%	Nonparametric	2	180
Chloride	mg/L	16	0	0%	Parametric	0	89.7
Fluoride (Undistilled)	mg/L	16	16	100%	Nonparametric	na	0.130
pH (LPL)	su	16	0	0%	Parametric	0	6.16
pH (UPL)	su	16	0	0%	Parametric	0	7.89
Sulfate	mg/L	16	0	0%	Nonparametric	2	81.0
Total Dissolved Solids	mg/L	16	0	0%	Nonparametric	2	796
Appendix IV							
Antimony	mg/L	16	16	100%	Nonparametric	na	0.00260
Arsenic	mg/L	16	0	0%	Parametric	0	0.0141
Barium	mg/L	16	0	0%	Parametric	0	0.205
Beryllium	mg/L	16	16	100%	Nonparametric	na	0.000220
Cadmium	mg/L	16	16	100%	Nonparametric	na	0.000190
Chromium	mg/L	16	16	100%	Nonparametric	na	0.000750
Cobalt	mg/L	16	16	100%	Nonparametric	na	0.000150
Fluoride (Undistilled)	mg/L	16	16	100%	Nonparametric	na	0.130
Lead	mg/L	16	16	100%	Nonparametric	na	0.000190
Lithium	mg/L	16	2	13%	Nonparametric	2	0.0410
Mercury	mg/L	16	16	100%	Nonparametric	na	0.0000160
Molybdenum	mg/L	16	15	94%	Nonparametric	2	0.00500
Radium-226+228	pCi/L	12	0	0%	Parametric	1	3.74
Selenium	mg/L	16	16	100%	Nonparametric	na	0.00210
Thallium	mg/L	16	16	100%	Nonparametric	na	0.000100

An 'na' indicates that the BTV is based on the maximum MDL and that the DQR is recommended for statistical evaluation.

6.0 References

U.S. Environmental Protection Agency (USEPA), 2009. 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.