ECF-300FF5-19-0095
Revision 0

CALCULATION OF UPPER CONFIDENCE LIMITS FOR RCRA MONITORING AT THE 300 AREA PROCESS TRENCHES TO SUPPORT THE JANUARY - JUNE 2019 SEMI-ANNUAL REPORT

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company

P.O. Box 1600
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

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APPROVED
By Lynn M. Ayers at 6:32 am, Sep 19, 2019

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ENVIRONMENTAL CALCULATION COVER PAGE

SECTION 1 - Completed by the Responsible Manager

Project:	RELEASE / ISSUE
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Calculation Title and Description: Calculation of Upper Confidence Limits for RCRA Monitoring at the 300 Area Process Trenches to Support the January - June 2019 Semi-Annual Report	

Qualifications Summary

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Professional Licenses:

Brief Narrative of Experience: Dr. DiFilippo has extensive experience addressing the fate and transport of organic and inorganic chemicals in the environment. She has conducted numerous studies of groundwater transport, statistical geochemical analysis, groundwater age-dating, dense non-aqueous phase liquid (DNAPL) dissolution, enhanced DNAPL remediation technologies, and the use of innovative technologies for measuring in-situ concentrations of organic contaminants in sediment pore-water. At Hanford, Dr. DiFilippo has provided remediation support in the form of water-level mapping, evaluation of monitored natural attenuation (MNA) and enhanced attenuation (EA), development of methodology to asses the impact of surface water-groundwater interactions on contaminant concentrations and trends, and assessment of statistical methodologies for evaluating RCRA compliance at both interim and final status sites.

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Brief Narrative of Experience: Leland Scantlebury's professional experience includes evaluating spatial and time series data, software development, and the application and calibration of groundwater models. He is a skilled programmer in multiple languages including Fortran, Python, R, VBA, and JavaScript and has used this knowledge to create complex statistical analysis and visualization tools to aid in model calibration, performance evaluation, and environmental investigation. At Hanford, Leland has provided support in annual report evaluations (RCRA and AEA calculations, river-stage and analytical calculations for system performance evaluation and river protection). Before joining SSP&A, Leland interned with CHPRC at Hanford and acquired significant experience on data analyses and evaluations relevant to Hanford remediation activities.

ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

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Professional Geologist: Idaho, No. 1248 Registered Geologist: Oregon, No. G2219

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SECTION 2 - Completed by Preparer

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ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

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SECTION 5 - Applicable if Calculation is a Risk Assessment or Uses an Environmental Model

Prior to Initiating Modeling:

Required training for modelers completed:
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Terms

ECF	environmental calculation file
HEIS	Hanford Environmental Information System
RCRA	*Resource Conservation and Recovery Act of 1976*
UCL	upper confidence limit

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1 Purpose

This environmental calculation file (ECF) presents calculations of 95% upper confidence limits (UCLs) on the mean for *cis*-1,2-dichloroethylene (*cis*-1,2-DCE) and trichloroethene (TCE) at the 300 Area Process Trenches *Resource Conservation and Recovery Act of 1976* (RCRA) site. The 95% UCLs are compared to the applicable concentration limits in the WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste* (hereinafter referred to as the Hanford Facility RCRA Permit). This ECF includes available results for RCRA groundwater samples collected from June 2016 through June 2019.

2 Background

The 300 Area Process Trenches are located within the 300-FF-1 Operable Unit (Figure 1) and were used for disposal of liquid waste from the 300 Area facilities. The final status groundwater monitoring plan was incorporated into the Hanford Facility RCRA Permit, Revision 8c, on May 24, 2017 (Modification 8C.2018.Q1). The groundwater monitoring plan, which is now included in the Hanford Facility RCRA Permit, supersedes WHC-SD-EN-AP-185, *Groundwater Monitoring Plan for the 300 Area Process Trenches*.

The groundwater monitoring plan requires calculation of 95% UCLs on the mean for *cis*-1,2-DCE and TCE based on the last eight (8) independent samples collected under the previous plan (WHC-SD-EN-AP-185) plus any samples collected under the current groundwater monitoring plan, and comparison of the 95% UCLs to the concentration limits established in the Hanford Facility RCRA Permit. Once eight semiannual samples have been collected under the current groundwater monitoring plan, sample results collected under the previous plan no longer will be included in data sets. For the 300 Area Process Trenches, the calculation of 95% UCLs only is required for the six downgradient RCRA wells (Figure 1).

When all data for a well/analyte pair are less than the concentration limit, calculation of the 95% UCL on the mean is not required and the data are evaluated visually to ensure compliance.

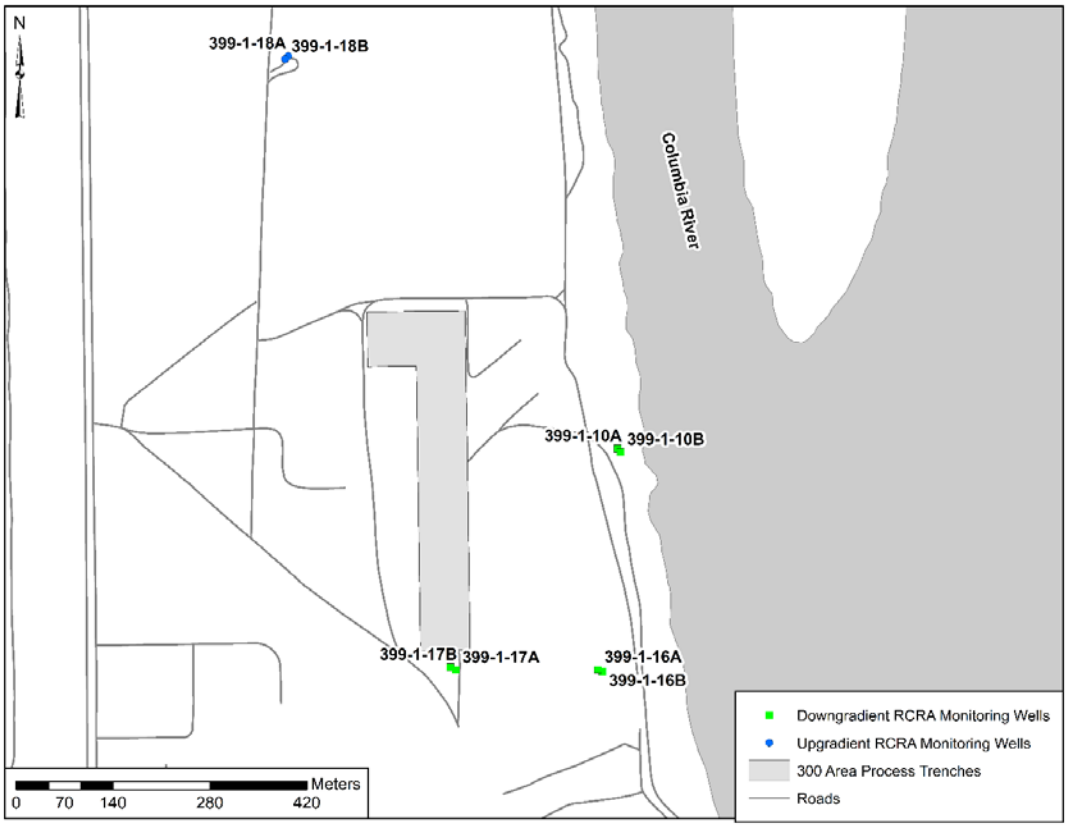

Figure 1. 300 Area Process Trenches and Associated Monitoring Wells

3 Methodology

This section discusses the data and methods used to complete the calculations presented in this document.

3.1 Data Acquisition and Processing Prior to 95% UCL Calculation

This section discusses the acquisition and processing of data prior to the 95% UCL calculation.

3.1.1 Chemistry Data Acquisition

Groundwater chemistry data were downloaded from the Hanford Environmental Information System (HEIS) database, which is maintained by CH2M HILL Plateau Remediation Company, and exported into a Microsoft Access® database (named HEIS_CHEM_08082019.accdb). The data for this analysis were downloaded from the HEIS database on August 8, 2019. The HEIS database contains one table (HEIS_ADM_PNLGW_STD_RESULT_MV), which contains information on groundwater samples, including laboratory and review data qualifiers, sample medium, sample collection purpose, analytical method, and reporting limits. The fields extracted from the HEIS database for use in calculations described in this document are presented in Table 1.

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Table 1. HEIS Database Fields for Chemistry Data

Field Extracted*	Definition
WELL_NAME	Location Identification
SAMP_DATE_TIME	Sampling Date
STD_CON_LONG_NAME	Analyte Name
STD_VALUE_RPTD	Reported Concentration
STD_ANAL_UNITS_RPTD	Units for Concentration Measurement
LAB_QUALIFIER	Laboratory Data Qualifier
REVIEW_QUALIFIER	Review Data Qualifier
COLLECTION_PURPOSE	Primary Reason for Sample Collection
VALIDATION_QUALIFIER	Validation Qualifier
MEDIA	Sample Medium
METHOD_NAME	Analytical Method
REPORTING_LIMIT	Reporting Limit

*Field codes are defined in HNF-38155, *HEIS Sample, Result, and Sampling Site Data Dictionary*.

HEIS = Hanford Environmental Information System

3.1.2 Data Qualifiers

Non-detects in the chemistry data set were identified using the laboratory qualifier (LAB_QUALIFIER = U). All estimated data (LAB_QUALIFIER = B or J) were treated as detected values. Rejected (“R”-flagged) data in the HEIS database were not included for statistical evaluation.

3.1.3 Wells and Constituents

The list of wells and constituents for this analysis was based on the groundwater monitoring plan incorporated on May 24, 2017, into the Hanford Facility RCRA Permit (WA7890008967), Modification 8C.2018.Q1, as listed in Table 2.

Table 2. Wells and Constituents

Well Name	Constituent
399-1-10A	*cis*-1,2-dichloroethylene, trichloroethene
399-1-10B	*cis*-1,2-dichloroethylene, trichloroethene
399-1-16A	*cis*-1,2-dichloroethylene, trichloroethene
399-1-16B	*cis*-1,2-dichloroethylene, trichloroethene
399-1-17A	*cis*-1,2-dichloroethylene, trichloroethene
399-1-17B	*cis*-1,2-dichloroethylene, trichloroethene

3.1.4 Daily Averaging

A daily average was calculated for chemistry data with multiple measurements on the same day. When all measurements on the same day were nondetect, the highest detection limit was used for the daily value. For daily duplicates where only one of the samples was nondetect, the detected value was used for the daily value. Duplicate daily measurements and the calculated daily average are presented in Table 3.

Table 3. Duplicate Daily Measurements and Calculated Daily Averages

Well Name	Constituent	Sample Date	Measured Concentration	Calculated Daily Average
399-1-16A	*cis*-1,2-DCE	9/6/2016	0.32J µg/L 0.28J µg/L	0.30J µg/L
399-1-16B	*cis*-1,2-DCE	8/9/2016	172D µg/L 172D µg/L	172D µg/L
399-1-16B	*cis*-1,2-DCE	1/12/2017	191D µg/L 184D µg/L	187.5D µg/L
399-1-17A	*cis*-1,2-DCE	6/8/2016	0.15U µg/L 0.3U µg/L	0.3U [a] µg/L
399-1-17A	*cis*-1,2-DCE	7/6/2016	0.15U µg/L 0.3U µg/L	0.3U [a] µg/L
399-1-17A	*cis*-1,2-DCE	10/24/2017	0.3U µg/L 0.3U µg/L	0.3U µg/L

Table 3. Duplicate Daily Measurements and Calculated Daily Averages

Well Name	Constituent	Sample Date	Measured Concentration	Calculated Daily Average
399-1-17A	*cis*-1,2-DCE	9/4/2018	0.3U µg/L 0.3U µg/L	0.3U µg/L
399-1-17B	*cis*-1,2-DCE	8/9/2016	1.3 µg/L 1.3 µg/L	1.3 µg/L
399-1-17B	*cis*-1,2-DCE	9/6/2016	1.72 µg/L 2 µg/L	1.86 µg/L
399-1-16A	TCE	9/6/2016	0.31J µg/L 0.25U µg/L	0.31J [b] µg/L
399-1-16B	TCE	8/9/2016	1.79J µg/L 1.77J µg/L	1.78J µg/L
399-1-16B	TCE	1/12/2017	1.84J µg/L 1.99J µg/L	1.915J µg/L
399-1-17A	TCE	6/8/2016	0.16U µg/L 0.3U µg/L	0.3U [a] µg/L
399-1-17A	TCE	7/6/2016	0.16U µg/L 0.3U µg/L	0.3U [a] µg/L
399-1-17A	TCE	10/24/2017	0.3U µg/L 0.3U µg/L	0.3U µg/L
399-1-17A	TCE	9/4/2018	0.3U µg/L 0.3U µg/L	0.3U µg/L
399-1-17B	TCE	8/9/2016	0.16U µg/L 0.25U µg/L	0.25U [a] µg/L
399-1-17B	TCE	9/6/2016	0.16U µg/L 0.25U µg/L	0.25U [a] µg/L

a. Highest detection limit used for daily value.

b. Detected value used for daily value.

D = Analyte was reported at a secondary dilution factor (DF), typically DF > 1.

DCE = dichloroethylene

J = Estimated value; constituent detected at a level less than the reporting detection limit or practical quantitation limit and greater than or equal to the method detection limit.

TCE = trichloroethene

U = Constituent not detected at the detection limit shown.

µg/L = micrograms per liter

3.1.5 Time Period of Analysis

Datasets were selected in accordance with the groundwater monitoring plan incorporated into the Hanford Facility RCRA Permit. The data for the last 13 RCRA monitoring events were used for the calculation: the last 8 events monitored under the previous plan (June 2016 through March 2017) and the first five events monitored under the current groundwater monitoring plan (June 2017 through June 2019) (Table 4).

Table 4. Sampling Data

Well Name	Analyte	Sampling Date Range	Number of Samples
399-1-10A	*cis*-1,2-DCE	6/7/2016 – 6/17/2019	13
399-1-10B	*cis*-1,2-DCE	6/7/2016 – 6/17/2019	13
399-1-16A	*cis*-1,2-DCE	6/8/2016 – 6/18/2019	13
399-1-16B	*cis*-1,2-DCE	6/9/2016 – 6/18/2019	13
399-1-17A	*cis*-1,2-DCE	6/8/2016 – 6/18/2019	13
399-1-17B	*cis*-1,2-DCE	6/8/2016 – 6/17/2019	13
399-1-10A	TCE	6/7/2016 – 6/17/2019	13
399-1-10B	TCE	6/7/2016 – 6/17/2019	13
399-1-16A	TCE	6/8/2016 – 6/18/2019	13
399-1-16B	TCE	6/9/2016 – 6/18/2019	13
399-1-17A	TCE	6/8/2016 – 6/18/2019	13
399-1-17B	TCE	6/8/2016 – 6/17/2019	13

DCE = dichloroethylene
TCE = trichloroethene

3.1.6 Outliers

The data sets were evaluated for outliers through visual inspection of timeseries plots. No outliers were identified in the datasets used in this analysis.

3.2 Calculated 95% UCLs on the Mean

A statistical software package, ProUCL version 5.1, was used to calculate the 95% UCL on the mean, in accordance with the groundwater monitoring plan. ProUCL is available through the U.S. Environmental Protection Agency and provides statistical methods and graphical tools that are commonly used in environmental assessments. ProUCL is capable of working with datasets where nondetects, samples with concentrations less than the reporting limit, are present. There are several methods available in ProUCL for calculating 95% UCLs on the mean. These methods account for the underlying distribution of the data

and the presence of nondetects. For datasets with nondetects, ProUCL uses the Kaplan-Meier method, a nonparametric method, for calculating the mean and standard deviation. ProUCL highlights a recommended method in its output file; however, it is important to assess all the methods available and independently verify the most appropriate method through visual inspection of the data, evaluation of the number of available data points, and the data distribution.

The 95% UCL calculations were performed on datasets with at least one sample above the concentration limit. As shown in Table 5, only one dataset met this criterion. Calculation of 95% UCLs for the other datasets was not required.

Table 5. Dataset Summary and Criteria to Calculate 95% UCL

Analyte	Concentration Limit	Well Name	Number of Samples	Percent NonDetect	Number of Samples Exceeding Concentration Limit	95% UCL Calculation Required
cis-1,2-DCE	16 µg/L	399-1-10A	13	100%	0	No
		399-1-10B	13	100%	0	No
		399-1-16A	13	92%	0	No
		399-1-16B	13	0%	13	**Yes**
		399-1-17A	13	100%	0	No
		399-1-17B	13	8%	0	No
TCE	4 µg/L	399-1-10A	13	100%	0	No
		399-1-10B	13	100%	0	No
		399-1-16A	13	38%	0	No
		399-1-16B	13	0%	0	No
		399-1-17A	13	92%	0	No
		399-1-17B	13	100%	0	No

DCE = dichloroethylene
TCE = trichloroethene
UCL = upper confidence limit

4 Assumptions

The following is a summary of assumptions made in this analysis:

- Concentrations observed at a well are not significantly affected by active remediation activities at the site for the period over which calculations are made.
- There are no concentration trends with time for the datasets used to calculate 95% UCLs. ProUCL does not explicitly test for concentration trends when calculating 95% UCLs. In the presence of a concentration trend, ProUCL will calculate a wider confidence interval on the mean.

- All of the data for a well/analyte pair are from the same statistical distribution.

5 Software Applications

95% UCL calculations were performed using ProUCL version 5.1.

6 Calculation

The following input files were used in the implementation of this analysis:

- *qryChemHeis1.txt* and *qryChemHeis2.txt*: Concentration data from the HEIS database
- *ProUCL_Datasets_08082019.xlsx*: datasets for use in ProUCL

Datasets were imported into the ProUCL software and 95% UCLs were calculated using all available methods and accounting for the presence of nondetects. The reported 95% UCL was selected based on the ProUCL results, including evaluation of the data distribution and sample size.

7 Results

The datasets evaluated for 95% UCL calculation and the output files from ProUCL are presented in Appendix A, and the 95% UCL result is presented in Table 6. Timeseries plots for all wells and constituents are presented in Appendix B.

Table 6. Calculated 95% UCLs

Well Name	Analyte	Concentration Limit	95% UCL	95% UCL Result Evaluation
399-1-16B	*cis*-1,2-DCE	16 µg/L	175.1* µg/L	Above Concentration Limit

*ProUCL method: 95% Student's-t UCL

DCE = dichloroethylene

UCL = upper confidence limit

8 References

HNF-38155, 2011, *HEIS Sample, Result, and Sampling Site Data Dictionary*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/0082589H.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: https://elr.info/sites/default/files/docs/statutes/full/rcra.pdf.

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WHC-SD-EN-AP-185, 1995, *Groundwater Monitoring Plan for the 300 Area Process Trenches*, Rev.0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/document/D196020117.

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Appendix A

Upper Confidence Limit (UCL) Datasets and ProUCL Output Results

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Table A-1

Dataset for 300 Area Process Trenches

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Non-detect Identification[a]
399-1-10A	6/7/2016	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-10A	7/6/2016	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-10A	8/9/2016	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-10A	9/6/2016	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-10A	12/1/2016	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-10A	1/12/2017	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-10A	2/6/2017	cis-1,2-Dichloroethylene	0.3	ug/L	TU	0
399-1-10A	3/6/2017	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-10A	6/2/2017	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-10A	10/24/2017	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-10A	6/6/2018	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10A	9/5/2018	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10A	6/17/2019	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-10B	6/7/2016	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10B	7/6/2016	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10B	8/9/2016	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10B	9/6/2016	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10B	12/1/2016	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10B	1/12/2017	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10B	2/6/2017	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10B	3/6/2017	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10B	6/2/2017	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10B	10/22/2017	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10B	6/6/2018	cis-1,2-Dichloroethylene	0.15	ug/L	U	0
399-1-10B	9/5/2018	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10B	6/17/2019	cis-1,2-Dichloroethylene	0.23	ug/L	U	0
399-1-16A	6/8/2016	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-16A	7/7/2016	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-16A	8/9/2016	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-16A	9/6/2016	cis-1,2-Dichloroethylene	0.3	ug/L	J	1
399-1-16A	12/1/2016	cis-1,2-Dichloroethylene	0.1	ug/L	U	0

Table A-1

Dataset for 300 Area Process Trenches

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Non-detect Identification[a]
399-1-16A	1/12/2017	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-16A	2/6/2017	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-16A	3/3/2017	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-16A	6/2/2017	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-16A	10/24/2017	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-16A	6/6/2018	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-16A	9/6/2018	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-16A	6/18/2019	cis-1,2-Dichloroethylene	0.23	ug/L	U	0
399-1-16B	6/9/2016	cis-1,2-Dichloroethylene	175	ug/L	D	1
399-1-16B	7/7/2016	cis-1,2-Dichloroethylene	217	ug/L	D	1
399-1-16B	8/9/2016	cis-1,2-Dichloroethylene	172	ug/L	D	1
399-1-16B	9/6/2016	cis-1,2-Dichloroethylene	192	ug/L	D	1
399-1-16B	12/1/2016	cis-1,2-Dichloroethylene	150	ug/L		1
399-1-16B	1/12/2017	cis-1,2-Dichloroethylene	187.5	ug/L	D	1
399-1-16B	2/6/2017	cis-1,2-Dichloroethylene	143	ug/L	DT	1
399-1-16B	3/3/2017	cis-1,2-Dichloroethylene	136	ug/L	D	1
399-1-16B	6/2/2017	cis-1,2-Dichloroethylene	136	ug/L	D	1
399-1-16B	10/24/2017	cis-1,2-Dichloroethylene	160	ug/L	D	1
399-1-16B	6/6/2018	cis-1,2-Dichloroethylene	130	ug/L	D	1
399-1-16B	9/6/2018	cis-1,2-Dichloroethylene	140	ug/L	D	1
399-1-16B	6/18/2019	cis-1,2-Dichloroethylene	169	ug/L	DX	1
399-1-17A	6/8/2016	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17A	7/6/2016	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17A	8/9/2016	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17A	9/6/2016	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17A	12/1/2016	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17A	1/12/2017	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17A	2/6/2017	cis-1,2-Dichloroethylene	0.3	ug/L	TU	0
399-1-17A	3/3/2017	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17A	6/2/2017	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17A	10/24/2017	cis-1,2-Dichloroethylene	0.3	ug/L	U	0

Table A-1

Dataset for 300 Area Process Trenches

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Non-detect Identification[a]
399-1-17A	6/6/2018	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17A	9/4/2018	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17A	6/18/2019	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17B	6/8/2016	cis-1,2-Dichloroethylene	1.3	ug/L		1
399-1-17B	7/6/2016	cis-1,2-Dichloroethylene	1.1	ug/L		1
399-1-17B	8/9/2016	cis-1,2-Dichloroethylene	1.3	ug/L		1
399-1-17B	9/6/2016	cis-1,2-Dichloroethylene	1.85	ug/L		1
399-1-17B	12/1/2016	cis-1,2-Dichloroethylene	0.83	ug/L	J	1
399-1-17B	1/12/2017	cis-1,2-Dichloroethylene	0.72	ug/L	J	1
399-1-17B	2/6/2017	cis-1,2-Dichloroethylene	1.3	ug/L		1
399-1-17B	3/3/2017	cis-1,2-Dichloroethylene	1.6	ug/L		1
399-1-17B	6/2/2017	cis-1,2-Dichloroethylene	1.9	ug/L		1
399-1-17B	10/24/2017	cis-1,2-Dichloroethylene	1.2	ug/L		1
399-1-17B	6/6/2018	cis-1,2-Dichloroethylene	1	ug/L		1
399-1-17B	9/6/2018	cis-1,2-Dichloroethylene	0.82	ug/L	J	1
399-1-17B	6/17/2019	cis-1,2-Dichloroethylene	0.23	ug/L	U	0
399-1-10A	6/7/2016	Trichloroethene	0.3	ug/L	U	0
399-1-10A	7/6/2016	Trichloroethene	0.3	ug/L	U	0
399-1-10A	8/9/2016	Trichloroethene	0.3	ug/L	U	0
399-1-10A	9/6/2016	Trichloroethene	0.3	ug/L	U	0
399-1-10A	12/1/2016	Trichloroethene	0.3	ug/L	U	0
399-1-10A	1/12/2017	Trichloroethene	0.3	ug/L	U	0
399-1-10A	2/6/2017	Trichloroethene	0.3	ug/L	U	0
399-1-10A	3/6/2017	Trichloroethene	0.3	ug/L	U	0
399-1-10A	6/2/2017	Trichloroethene	0.3	ug/L	U	0
399-1-10A	10/24/2017	Trichloroethene	0.3	ug/L	U	0
399-1-10A	6/6/2018	Trichloroethene	0.25	ug/L	U	0
399-1-10A	9/5/2018	Trichloroethene	0.25	ug/L	U	0
399-1-10A	6/17/2019	Trichloroethene	0.3	ug/L	U	0
399-1-10B	6/7/2016	Trichloroethene	0.25	ug/L	U	0
399-1-10B	7/6/2016	Trichloroethene	0.25	ug/L	U	0

Table A-1

Dataset for 300 Area Process Trenches

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Non-detect Identification[a]
399-1-10B	8/9/2016	Trichloroethene	0.25	ug/L	U	0
399-1-10B	9/6/2016	Trichloroethene	0.25	ug/L	U	0
399-1-10B	12/1/2016	Trichloroethene	0.25	ug/L	U	0
399-1-10B	1/12/2017	Trichloroethene	0.25	ug/L	U	0
399-1-10B	2/6/2017	Trichloroethene	0.25	ug/L	U	0
399-1-10B	3/6/2017	Trichloroethene	0.25	ug/L	U	0
399-1-10B	6/2/2017	Trichloroethene	0.25	ug/L	U	0
399-1-10B	10/22/2017	Trichloroethene	0.25	ug/L	U	0
399-1-10B	6/6/2018	Trichloroethene	0.16	ug/L	U	0
399-1-10B	9/5/2018	Trichloroethene	0.25	ug/L	U	0
399-1-10B	6/17/2019	Trichloroethene	0.31	ug/L	U	0
399-1-16A	6/8/2016	Trichloroethene	0.4	ug/L	J	1
399-1-16A	7/7/2016	Trichloroethene	0.51	ug/L	J	1
399-1-16A	8/9/2016	Trichloroethene	0.34	ug/L	J	1
399-1-16A	9/6/2016	Trichloroethene	0.31	ug/L	J	1
399-1-16A	12/1/2016	Trichloroethene	0.42	ug/L	J	1
399-1-16A	1/12/2017	Trichloroethene	0.25	ug/L	U	0
399-1-16A	2/6/2017	Trichloroethene	0.31	ug/L	J	1
399-1-16A	3/3/2017	Trichloroethene	0.35	ug/L	J	1
399-1-16A	6/2/2017	Trichloroethene	0.25	ug/L	U	0
399-1-16A	10/24/2017	Trichloroethene	0.25	ug/L	U	0
399-1-16A	6/6/2018	Trichloroethene	0.35	ug/L	J	1
399-1-16A	9/6/2018	Trichloroethene	0.25	ug/L	U	0
399-1-16A	6/18/2019	Trichloroethene	0.31	ug/L	U	0
399-1-16B	6/9/2016	Trichloroethene	1.97	ug/L	J	1
399-1-16B	7/7/2016	Trichloroethene	1.71	ug/L	J	1
399-1-16B	8/9/2016	Trichloroethene	1.78	ug/L	J	1
399-1-16B	9/6/2016	Trichloroethene	1.91	ug/L	J	1
399-1-16B	12/1/2016	Trichloroethene	1.3	ug/L		1
399-1-16B	1/12/2017	Trichloroethene	1.915	ug/L	J	1
399-1-16B	2/6/2017	Trichloroethene	1.56	ug/L	J	1

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Dataset for 300 Area Process Trenches

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Non-detect Identification[a]
399-1-16B	3/3/2017	Trichloroethene	1.88	ug/L	DJ	1
399-1-16B	6/2/2017	Trichloroethene	1.73	ug/L	J	1
399-1-16B	10/24/2017	Trichloroethene	1.2	ug/L		1
399-1-16B	6/6/2018	Trichloroethene	1.5	ug/L		1
399-1-16B	9/6/2018	Trichloroethene	1.3	ug/L		1
399-1-16B	6/18/2019	Trichloroethene	1.57	ug/L	J	1
399-1-17A	6/8/2016	Trichloroethene	0.3	ug/L	U	0
399-1-17A	7/6/2016	Trichloroethene	0.3	ug/L	U	0
399-1-17A	8/9/2016	Trichloroethene	0.3	ug/L	U	0
399-1-17A	9/6/2016	Trichloroethene	0.3	ug/L	U	0
399-1-17A	12/1/2016	Trichloroethene	0.3	ug/L	U	0
399-1-17A	1/12/2017	Trichloroethene	0.3	ug/L	U	0
399-1-17A	2/6/2017	Trichloroethene	0.3	ug/L	U	0
399-1-17A	3/3/2017	Trichloroethene	0.3	ug/L	U	0
399-1-17A	6/2/2017	Trichloroethene	0.32	ug/L	J	1
399-1-17A	10/24/2017	Trichloroethene	0.3	ug/L	U	0
399-1-17A	6/6/2018	Trichloroethene	0.3	ug/L	U	0
399-1-17A	9/4/2018	Trichloroethene	0.3	ug/L	U	0
399-1-17A	6/18/2019	Trichloroethene	0.5	ug/L	U	0
399-1-17B	6/8/2016	Trichloroethene	0.25	ug/L	U	0
399-1-17B	7/6/2016	Trichloroethene	0.25	ug/L	U	0
399-1-17B	8/9/2016	Trichloroethene	0.25	ug/L	U	0
399-1-17B	9/6/2016	Trichloroethene	0.25	ug/L	U	0
399-1-17B	12/1/2016	Trichloroethene	0.25	ug/L	U	0
399-1-17B	1/12/2017	Trichloroethene	0.25	ug/L	U	0
399-1-17B	2/6/2017	Trichloroethene	0.25	ug/L	U	0
399-1-17B	3/3/2017	Trichloroethene	0.25	ug/L	U	0
399-1-17B	6/2/2017	Trichloroethene	0.25	ug/L	U	0
399-1-17B	10/24/2017	Trichloroethene	0.25	ug/L	U	0
399-1-17B	6/6/2018	Trichloroethene	0.16	ug/L	U	0
399-1-17B	9/6/2018	Trichloroethene	0.25	ug/L	U	0

Table A-1

Dataset for 300 Area Process Trenches

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Non-detect Identification[a]
399-1-17B	6/17/2019	Trichloroethene	0.31	ug/L	U	0

[a]Value used in ProUCL to identify non-detects (0) and detected values (1).

Qualifier Definitions:

D = Analyte was reported at a secondary dilution factor (DF), typically DF > 1.

J = Estimated value; constituent detected at a level less than the report detection limit (RDL) or practical quantitation limit (PQL) and greater than or equal to the method detection limit (MDL).

T = Spike and/or spike duplicate sample recovery is outside control limits.

X = ALL - The result-specific translation of this qualifier code is provided in the hardcopy data report and/or case narrative. Additional result-specific translation information may also be found in the RESULT COMMENT field for this record.

U = Analyzed for but not detected above limiting criteria.

	A	B	C	D	E	F	G	H	I	J	K	L
1						UCL Statistics for Data Sets with Non-Detects						
2												
3				User Selected Options								
4				Date/Time of Computation		ProUCL 5.18/9/2019 3:01:24 PM						
5				From File		ProUCL_Datasets_08082019_a.xls						
6				Full Precision		OFF						
7				Confidence Coefficient		95%						
8				Number of Bootstrap Operations		2000						
9												
10	VAL (399-1-16B)											
11												
12						General Statistics						
13					Total Number of Observations	13		Number of Distinct Observations				12
14								Number of Missing Observations				0
15					Minimum	130		Mean				162.1
16					Maximum	217		Median				160
17					SD	26.24		Std. Error of Mean				7.278
18					Coefficient of Variation	0.162		Skewness				0.673
19												
20						Normal GOF Test						
21					Shapiro Wilk Test Statistic	0.934		Shapiro Wilk GOF Test				
22					5% Shapiro Wilk Critical Value	0.866		Data appear Normal at 5% Significance Level				
23					Lilliefors Test Statistic	0.151		Lilliefors GOF Test				
24					5% Lilliefors Critical Value	0.234		Data appear Normal at 5% Significance Level				
25						Data appear Normal at 5% Significance Level						
26												
27						Assuming Normal Distribution						
28					95% Normal UCL			95% UCLs (Adjusted for Skewness)				
29					95% Student's-t UCL	175.1		95% Adjusted-CLT UCL (Chen-1995)				175.5
30								95% Modified-t UCL (Johnson-1978)				175.3
31												
32						Gamma GOF Test						
33					A-D Test Statistic	0.325		Anderson-Darling Gamma GOF Test				
34					5% A-D Critical Value	0.733		Detected data appear Gamma Distributed at 5% Significance Level				
35					K-S Test Statistic	0.16		Kolmogorov-Smirnov Gamma GOF Test				
36					5% K-S Critical Value	0.236		Detected data appear Gamma Distributed at 5% Significance Level				
37						Detected data appear Gamma Distributed at 5% Significance Level						
38												
39						Gamma Statistics						
40					k hat (MLE)	43.07		k star (bias corrected MLE)				33.18
41					Theta hat (MLE)	3.764		Theta star (bias corrected MLE)				4.886
42					nu hat (MLE)	1120		nu star (bias corrected)				862.6
43					MLE Mean (bias corrected)	162.1		MLE Sd (bias corrected)				28.14
44								Approximate Chi Square Value (0.05)				795.5
45					Adjusted Level of Significance	0.0301		Adjusted Chi Square Value				786.3

	A	B	C	D	E	F	G	H	I	J	K	L
46												
47	**Assuming Gamma Distribution**											
48	95% Approximate Gamma UCL (use when n>=50))					175.8	95% Adjusted Gamma UCL (use when n<50)					177.9
49												
50	**Lognormal GOF Test**											
51	Shapiro Wilk Test Statistic					0.948	**Shapiro Wilk Lognormal GOF Test**					
52	5% Shapiro Wilk Critical Value					0.866	Data appear Lognormal at 5% Significance Level					
53	Lilliefors Test Statistic					0.15	**Lilliefors Lognormal GOF Test**					
54	5% Lilliefors Critical Value					0.234	Data appear Lognormal at 5% Significance Level					
55	**Data appear Lognormal at 5% Significance Level**											
56												
57	**Lognormal Statistics**											
58	Minimum of Logged Data					4.868	Mean of logged Data					5.077
59	Maximum of Logged Data					5.38	SD of logged Data					0.158
60												
61	**Assuming Lognormal Distribution**											
62	95% H-UCL					176.1	90% Chebyshev (MVUE) UCL					183.4
63	95% Chebyshev (MVUE) UCL					193.1	97.5% Chebyshev (MVUE) UCL					206.5
64	99% Chebyshev (MVUE) UCL					232.8						
65												
66	**Nonparametric Distribution Free UCL Statistics**											
67	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
68												
69	**Nonparametric Distribution Free UCLs**											
70	95% CLT UCL					174.1	95% Jackknife UCL					175.1
71	95% Standard Bootstrap UCL					173.5	95% Bootstrap-t UCL					177.6
72	95% Hall's Bootstrap UCL					176.3	95% Percentile Bootstrap UCL					174.5
73	95% BCA Bootstrap UCL					175.5						
74	90% Chebyshev(Mean, Sd) UCL					183.9	95% Chebyshev(Mean, Sd) UCL					193.8
75	97.5% Chebyshev(Mean, Sd) UCL					207.6	99% Chebyshev(Mean, Sd) UCL					234.5
76												
77	**Suggested UCL to Use**											
78	95% Student's-t UCL					175.1						
79												
80	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
81	Recommendations are based upon data size, data distribution, and skewness.											
82	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
83	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
84												

Appendix B

Time Series Plots

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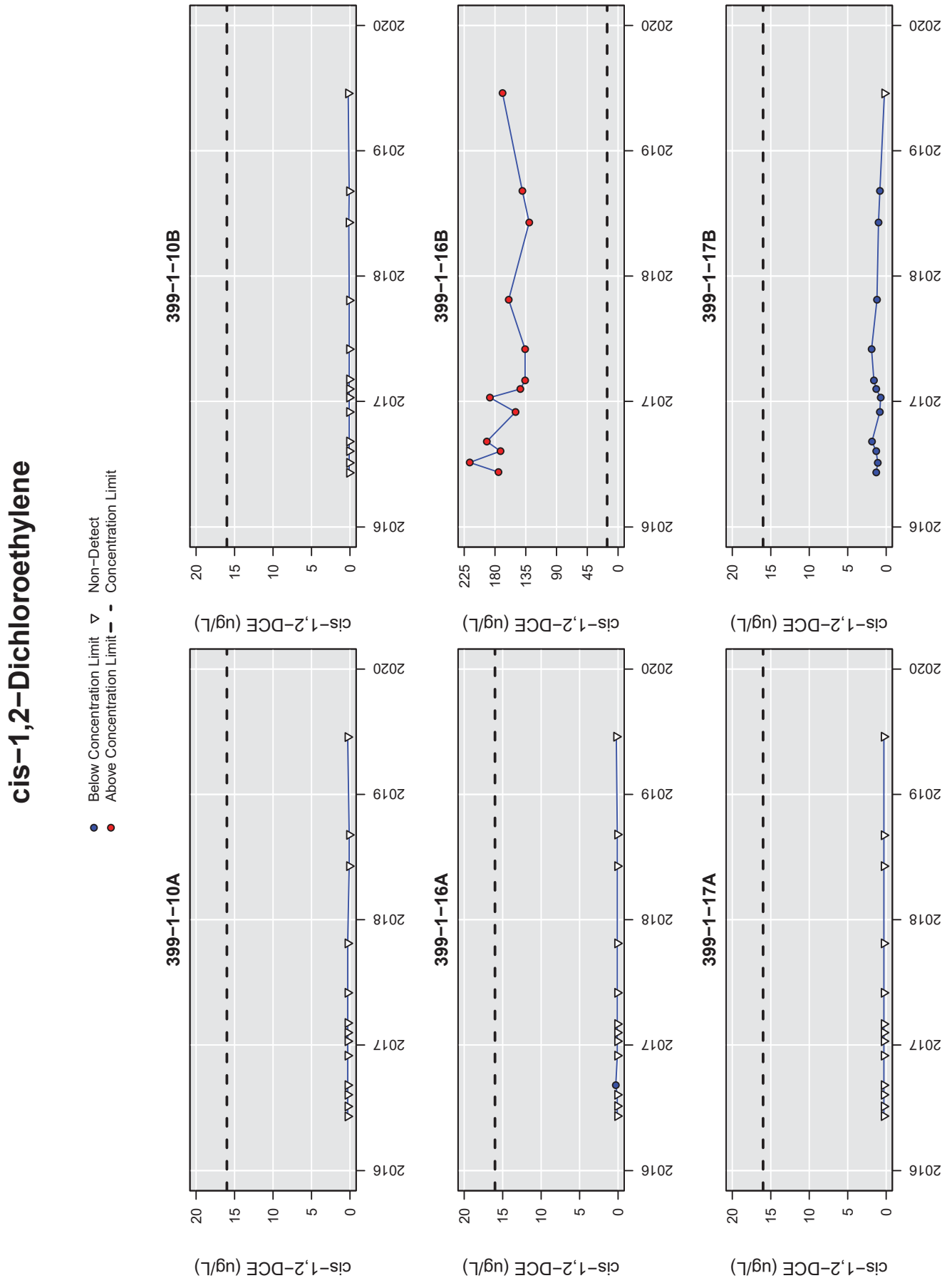
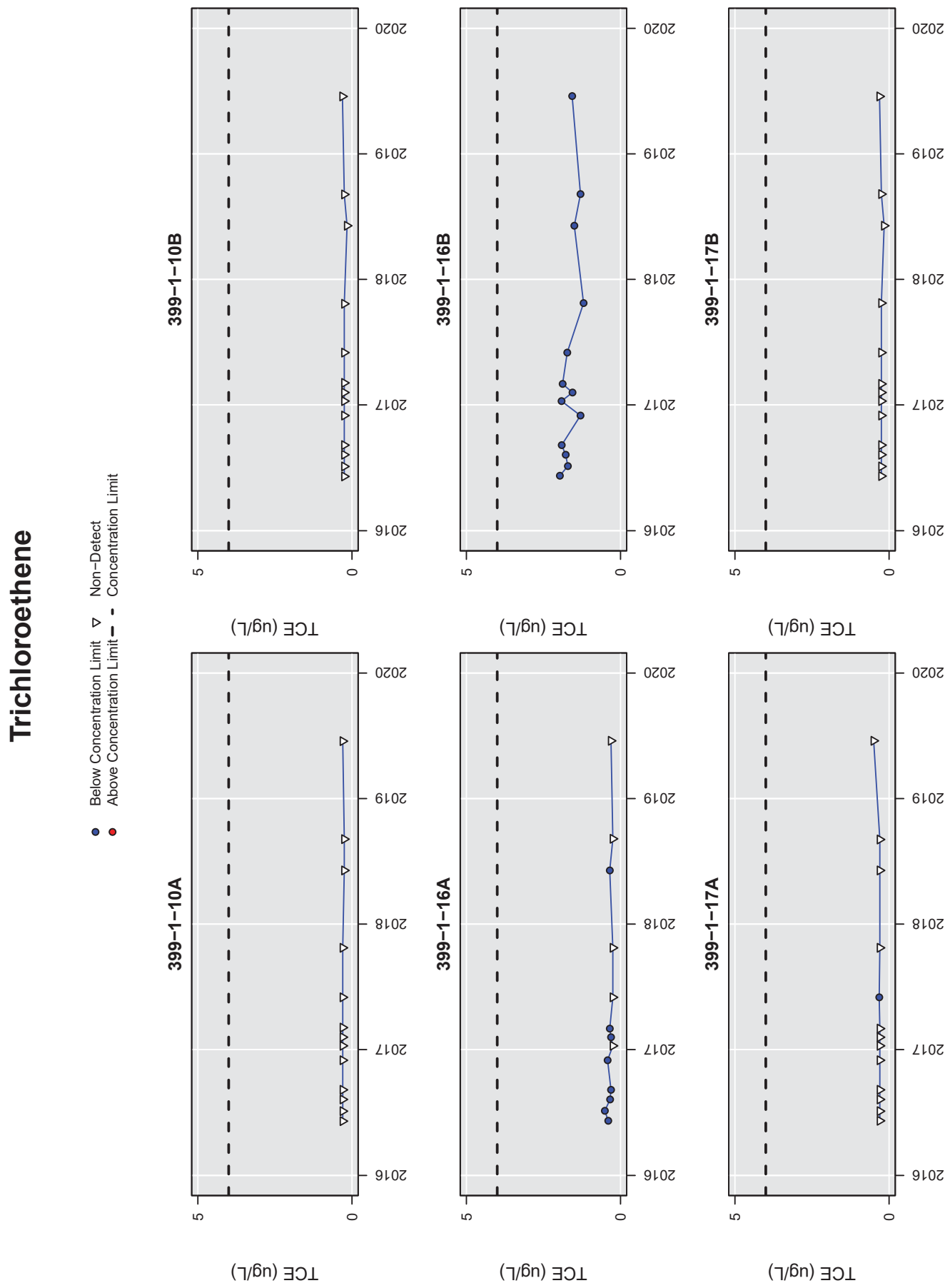

cis−1,2−Dichloroethylene
Below Concentration Limit
Above Concentration Limit
Non−Detect
Concentration Limit
399−1−10A
399−1−10B
399−1−16A
399−1−16B
399−1−17A
399−1−17B
cis−1,2−DCE (ug/L)
2016
2017
2018
2019
2020


Trichloroethene
Below Concentration Limit
Above Concentration Limit
Non−Detect
Concentration Limit
399−1−10A
399−1−10B
399−1−16A
399−1−16B
399−1−17A
399−1−17B
TCE (ug/L)
5
0
2016
2017
2018
2019
2020