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Revision 0

POST-CLOSURE CORRECTIVE ACTION GROUNDWATER MONITORING REPORT FOR THE 300 AREA PROCESS TRENCHES: JULY - DECEMBER 2017

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

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P.O. Box 1600
Richland, Washington 99352

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Executive Summary

This is the second 2017 semiannual report on post-closure corrective action groundwater monitoring for the 300 Area Process Trenches. It fulfills the requirement of WAC 173-303-645(11)(g)[1] to report twice each year on the effectiveness of the corrective action program.

This report covers the period from July through December 2017. Environmental data used to generate this report are available from the U.S. Department of Energy (DOE) Environmental Dashboard Application (EDA) (https://ehs.hanford.gov/eda/) or the Pacific Northwest National Laboratory Hanford Online Environmental Information Exchange (PHOENIX) application (http://phoenix.pnnl.gov). Ongoing verification, technical review, and evaluation efforts may result in differences between the data used for this publication and those available via EDA or PHOENIX after publication of this report.

The final status groundwater monitoring plan for the 300 Area Process Trenches was incorporated into the Hanford Facility *Resource Conservation and Recovery Act of 1976*[2] (RCRA) Permit, Revision 8c, on May 24, 2017[3]. This new plan supersedes WHC-SD-EN-AP-185, *Groundwater Monitoring Plan for the 300 Area Process Trenches*[4]. The new plan monitors *cis*-1,2-dichloroethene, trichloroethene, and field parameters (pH, specific conductance, temperature, and turbidity). Sampling is conducted semiannually (two samples per year). In the new monitoring plan, the concentration limits for *cis*-1,2-dichloroethene and trichloroethene are 16 µg/L and 4 µg/L, respectively, consistent with the cleanup levels in the *Comprehensive Environmental*

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[1] WAC 173-303-645, "Dangerous Waste Regulations," "Releases from Regulated Units," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303-645.

[2] *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.

[3] WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Washington State Department of Ecology. Available at: https://fortress.wa.gov/ecy/nwp/permitting/hdwp/rev/8c/index.html.

[4] 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/arpir/index.cfm/viewDoc?accession=D196020117.
Modified by:
WHC-SD-EN-AP-185, 1996, *Groundwater Monitoring Plan for the 300 Area Process Trenches*, Rev. 0A, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196135178.

Response, Compensation, and Liability Act of 1980[5] (CERCLA) record of decision (EPA et al., 2013[6]).

During the reporting period, *cis*-1,2-dichloroethene remained above the 16 µg/L Hanford Facility RCRA Permit[3] concentration limit in one deep well (399-1-16B). Trichloroethene remained below the 4 µg/L Hanford Facility RCRA Permit[3] concentration limit in all of the wells.

A statistical evaluation was performed to compare the *cis*-1,2-dichloroethene and trichloroethene results to the concentration limits. The evaluation applies to results at individual point of compliance (downgradient) wells. The 95% upper confidence limit on the concentration mean is used for results that exceed concentration limits. A nonstatistical analysis is used for results that are less than concentration limits. The only 95% upper confidence limit that exceeded the Hanford Facility RCRA Permit[3] concentration limit in a downgradient well was for *cis*-1,2-dichloroethene in well 399-1-16B.

Corrective action is being accomplished through the CERCLA remedial action for groundwater, as documented in the CERCLA record of decision for the 300-FF-5 Operable Unit (EPA et al., 2013[6]), issued in November 2013. The remedy for *cis*-1,2-dichloroethene and trichloroethene in groundwater is monitored natural attenuation and institutional controls.

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[5] *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 U.S.C. 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: https://www.csu.edu/cerc/researchreports/documents/CERCLASummary1980.pdf.

[6] EPA, Ecology, and DOE, 2013, *Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0087180.

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Terms

CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
cis-1,2-DCE	*cis-1,2*-dichloroethene
DOE	U.S. Department of Energy
EDA	Environmental Dashboard Application
MDL	method detection limit
OU	operable unit
PHOENIX	Pacific Northwest National Laboratory Hanford Online Environmental Information Exchange
RCRA	*Resource Conservation and Recovery Act of 1976*
TCE	trichloroethene
UCL	upper confidence limit

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1 Introduction

This is the second semiannual report for 2017 regarding post-closure corrective action groundwater monitoring describing the effectiveness of corrective actions at the 300 Area Process Trenches (316-5 waste site). This report fulfills the requirement of WAC 173-303-645(11)(g), "Dangerous Waste Regulations," "Releases from Regulated Units," to report twice each year on the effectiveness of the corrective action program. This report covers the period from July through December 2017.

The final status groundwater monitoring plan for the 300 Area Process Trenches was incorporated into the Hanford Facility *Resource Conservation and Recovery Act of 1976* (RCRA) Permit, Revision 8c (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*), on May 24, 2017. This new plan supersedes WHC-SD-EN-AP-185, *Groundwater Monitoring Plan for the 300 Area Process Trenches*. The new plan monitors *cis*-1,2-dichloroethene (*cis*-1,2-DCE) and trichloroethene (TCE) semiannually (two samples per year). This second semiannual report for 2017 includes *cis*-1,2-DCE and TCE results for samples collected in October.

Environmental data used to generate this report are available from the U.S. Department of Energy (DOE) Environmental Dashboard Application (EDA) (https://ehs.hanford.gov/eda/) or the Pacific Northwest National Laboratory Hanford Online Environmental Information Exchange (PHOENIX) application (http://phoenix.pnnl.gov/). Ongoing data verification, technical review, and evaluation efforts by DOE contractors could result in differences between the data used for this publication and those available via the EDA or PHOENIX after publication of this report.

2 Site Description

The 300 Area Process Trenches are permitted as a RCRA treatment, storage, and disposal unit that is currently in post-closure corrective action monitoring. From 1975 through 1985, the trenches received effluent discharges of dangerous mixed waste from fuel fabrication and research laboratories in the 300 Area, followed by continued discharge of clean effluent until December 1994. The site was remediated through removal of contaminated soil in the 1990s.

The 300 Area Process Trenches were closed under a modified closure/post-closure plan (DOE/RL-93-73, *300 Area Process Trenches Modified Closure/Postclosure Plan*) and remain in the groundwater corrective action program because groundwater contamination continues to exceed *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial action objectives and Hanford Facility RCRA Permit concentration limits. Groundwater monitoring is conducted in accordance with WAC 173-303-645(11) and the Hanford Facility RCRA Permit, Part VI, Post-Closure Unit 1. The closure plan (DOE/RL-93-73) indicates that groundwater corrective action will be addressed as part of remediation for the CERCLA 300-FF-5 Operable Unit (OU).

3 RCRA Groundwater Monitoring Program

Table 1 provides the Hanford Facility RCRA Permit concentration limits established for dangerous waste constituents *cis*-1,2-DCE and TCE at the 300 Area Process Trenches. RCRA corrective action monitoring for dangerous waste constituents *cis*-1,2-DCE and TCE will continue to evaluate analytical results relative to Hanford Facility RCRA Permit concentration limits.

Table 1. WAC 173-303-645(5) Concentration Limits for the 300 Area Process Trenches

Dangerous Waste Constituents	Hanford Facility RCRA Permit Concentration Limit[a]	CERCLA Cleanup Level[b]
cis-1,2-Dichloroethene	16 µg/L (CERCLA Cleanup Level)[b]	16 µg/L (risk assessment for drinking water)
Trichloroethene	4 µg/L (CERCLA Cleanup Level)[b]	4 µg/L (risk assessment for drinking water)

Reference: WAC 173-303-645, "Dangerous Waste Regulations," "Releases from Regulated Units."

a. WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Part VI ("Unit Specific Conditions for Units in Post-Closure," "300 Area Process Trenches (PCU 1)," "Chapter 3.0, Groundwater Monitoring," modification 8C.2017.1F).

b. EPA et al., 2013, *Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1.*

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*

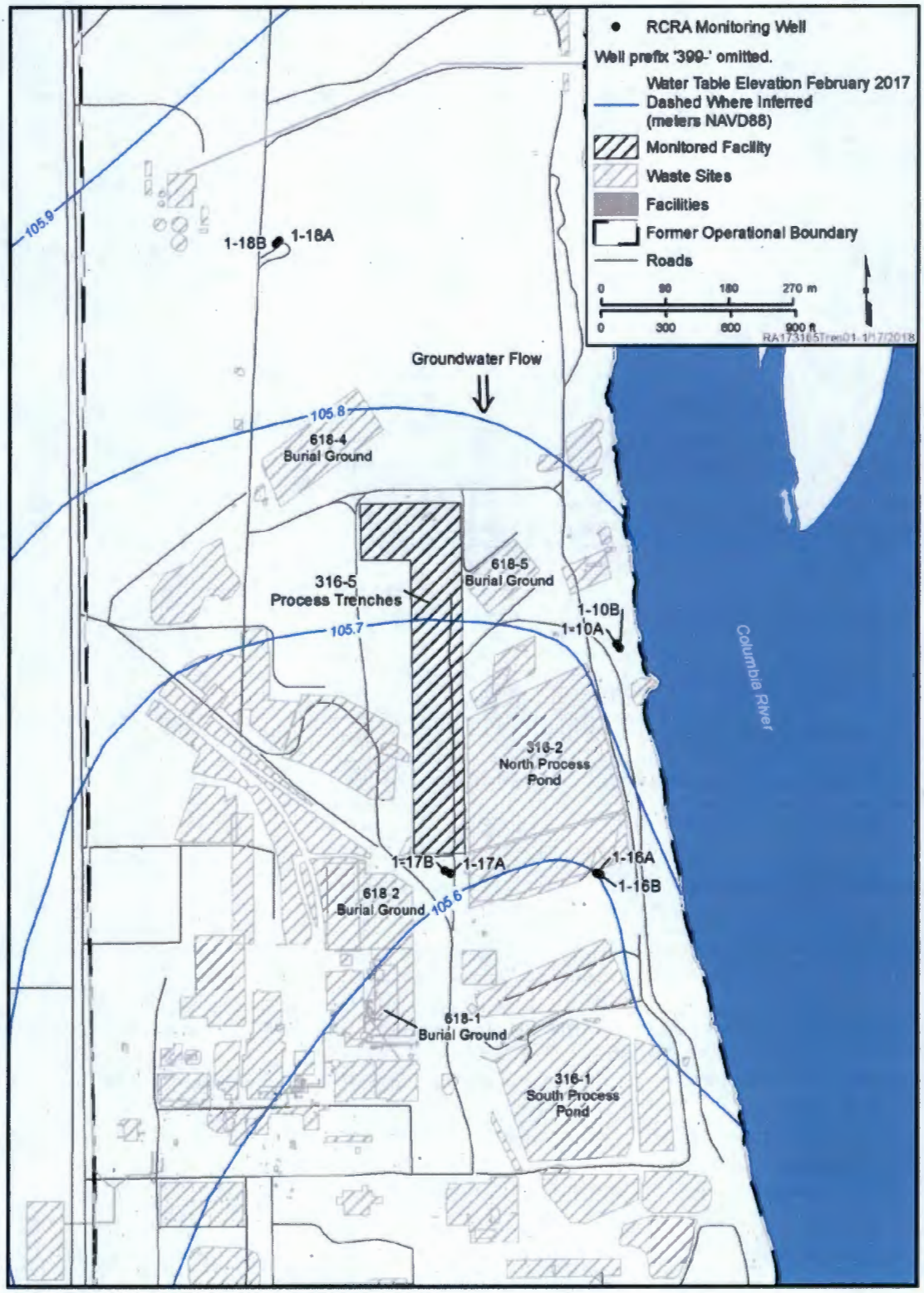
RCRA = *Resource Conservation and Recovery Act of 1976*

The new final status groundwater monitoring plan monitors dangerous waste constituents *cis*-1,2-DCE and TCE semiannually, with collection scheduled during low river stage (typically September to November) and high river stage (typically May through June). Semiannual sampling consists of a single sample per sampling event (i.e., two samples per year). Field parameters (pH, specific conductance, temperature, and turbidity) also are sampled semiannually. Water-level measurements at each monitoring well are determined each time a sample is obtained.

Under the previous groundwater monitoring plan (WHC-SD-EN-AP-185), the wells were sampled four times (at monthly intervals) during each semiannual sampling event in order to collect the required number of independent samples. As a result, the wells were sampled in December, January, February, and March; and in June, July, August, and September. During the July through December 2017 reporting period, the 300 Area Process Trenches monitoring wells were sampled in October under the new plan.

In the new monitoring plan, the concentration limits for *cis*-1,2-DCE and TCE are 16 µg/L and 4 µg/L, respectively, which are the cleanup levels identified in the CERCLA record of decision (EPA et al., 2013, *Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1*). Because of the previous exceedances of the concentration limits for *cis*-1,2-DCE and TCE and the ongoing remedial action, any concentration limit exceedances at the point of compliance during the remediation period do not require additional action (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Part VI ("Unit Specific Conditions for Units in Post-Closure," "300 Area Process Trenches (PCU 1)," "Chapter 3.0, Groundwater Monitoring").

The groundwater monitoring network for the 300 Area Process Trenches consists of four well pairs (Figure 1). Each well pair has one shallow and one deep well. The shallow wells (well numbers ending in "A") are screened near the water table, and the deep wells (well numbers ending in "B") are screened in the lower portion of the unconfined aquifer (above the lacustrine and overbank deposits of the Ringold Formation lower mud unit). One well pair is upgradient, and the other three pairs are downgradient of the process trenches.



Reference: NAVD88, *North American Vertical Datum of 1988.*

Figure 1. Monitoring Well Locations for the 300 Area Process Trenches

The point of compliance for the 300 Area Process Trenches is downgradient monitoring wells 399-1-10A, 399-1-10B, 399-1-16A, 399-1-16B, 399-1-17A, and 399-1-17B. The point of compliance wells are monitored to assess the progress of the corrective action (CERCLA remedial action). Concentrations of *cis*-1,2-DCE and TCE in these wells are evaluated relative to the concentration limits, in accordance with Section 3.3.2 of the new monitoring plan in the Hanford Facility RCRA permit. Results of the evaluation are provided in Chapter 5 of this report.

4 Contaminant Data

This chapter discusses concentration of dangerous waste constituents *cis*-1,2-DCE and TCE measured during the July through December 2017 reporting period. Table 2 lists the analytical results for *cis*-1,2-DCE and TCE measured in each well.

Table 2. Groundwater Data for 300 Area Process Trenches, July Through December 2017

Well	Date	Sampling Purpose	Dangerous Waste Constituents			
			cis-1,2-Dichloroethene (µg/L)		Trichloroethene (µg/L)	
Hanford Facility RCRA Permit Concentration Limits*			*16*		*4*	
399-1-10A	10/24/2017	RCRA	0.3	U	0.3	U
399-1-10B	10/22/2017	RCRA	0.1	U	0.25	U
399-1-16A	10/24/2017	RCRA	0.1	U	0.25	U
399-1-16B	10/24/2017	RCRA	**160**	D	1.20	
399-1-17A	10/24/2017	RCRA	0.3	U	0.3	U
	10/24/2017	RCRA	0.3	U	0.3	U
399-1-17B	10/24/2017	RCRA	1.2		0.25	U
399-1-18A	10/22/2017	RCRA	0.15	U	0.16	U
399-1-18B	10/22/2017	RCRA	0.3	U	0.3	U

Reference: WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended.

Notes: *Italics* indicate Hanford Facility RCRA Permit concentration limits. The Hanford Facility RCRA Permit concentration limits for dangerous waste constituents were revised on May 24, 2017 with incorporation of the final status groundwater monitoring plan into the Hanford Facility RCRA Permit, Revision 8c.

Bold emphasis is added where the result exceeded the Hanford Facility RCRA Permit concentration limit for dangerous waste constituents.

*Dangerous waste constituent concentration limits are defined in the Hanford Facility RCRA Permit, Part VI, Post-Closure Unit 1.

D = analyte reported at a secondary dilution factor

RCRA = *Resource Conservation and Recovery Act of 1976*

U = below detection limit

In the 300 Area Process Trenches network, *cis*-1,2-DCE continued to be detected in two deep wells (399-1-16B and 399-1-17B) during the reporting period. Only well 399-1-16B had concentrations that exceeded the 16 µg/L Hanford Facility RCRA Permit concentration limit. The concentration in well 399-1-16B was 160 µg/L, which is comparable to concentrations in the previous reporting period (Figure 2). At well 399-1-17B, the concentration of *cis*-1,2-DCE was 1.2 µg/L. The method detection limit (MDL) varied from 0.1 to 0.3 µg/L.

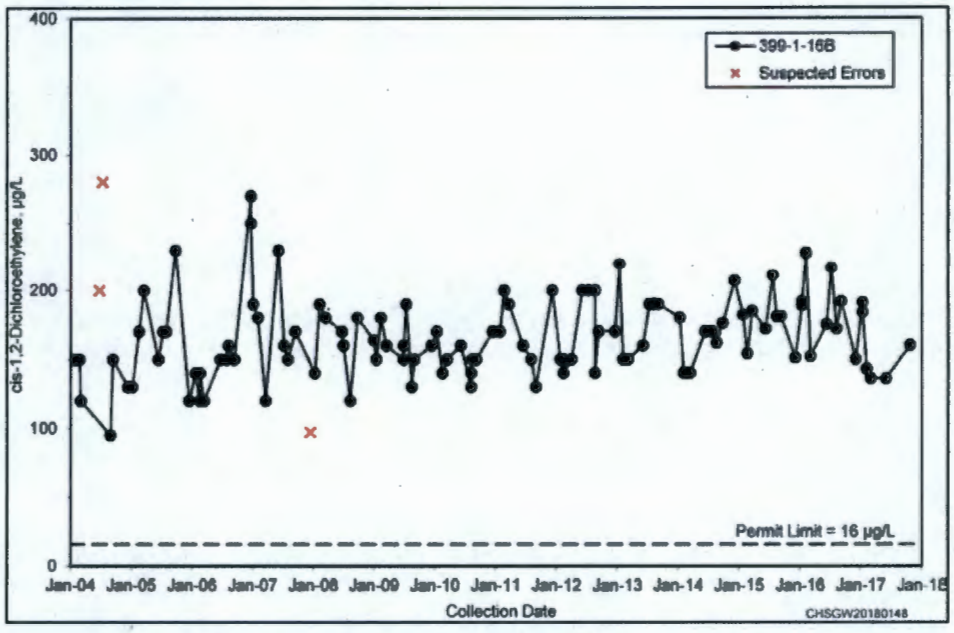


Figure 2. Concentrations of *cis*-1,2-DCE in Well 399-1-16B

During the reporting period, TCE was detected only in well 399-1-16B. The concentration, 1.2 µg/L, did not exceed the 4 µg/L Hanford Facility RCRA Permit concentration limit. The MDL ranged from 0.16 to 0.3 µg/L.

5 Statistical Evaluation

In accordance with Section 3.3.2 of the final status groundwater monitoring plan, a statistical evaluation was performed to compare the dangerous waste constituent results to the Hanford Facility RCRA Permit concentration limits. The evaluation applies to results at individual point of compliance (downgradient) wells. The 95% upper confidence limit (UCL) on the mean, hereinafter referred to as the 95% UCL, is used for results that exceed concentration limits. A nonstatistical analysis is used for results that are less than concentration limits. The 95% UCL was calculated using EPA, 1995, ProUCL, Version 5.1.

The 95% UCL statistical evaluation for dangerous waste constituents monitored in the six downgradient wells is documented in ECF-HANFORD-18-0005, *Calculation of Upper Confidence Limits for RCRA Monitoring at the 183-H Solar Evaporation Basins and the 300 Area Process Trenches to Support the July – December 2017 RCRA Semiannual Reports,* which is provided as Appendix A of this report. The data for the last 10 monitoring events were used for the calculation: the last 8 events monitored under the old plan (June 2016 through March 2017) and the first 2 events monitored under the new plan (June and October 2017). The only 95% UCL for a dangerous waste constituent that exceeded the Hanford Facility RCRA Permit concentration limit in a downgradient well was for *cis*-1,2-DCE in well 399-1-16B (Table 3).

Table 3. Statistical Evaluation of 300 Area Process Trenches Dangerous Waste Constituents

Well	2017 Semiannual Period	cis-1,2-Dichloroethene (µg/L)		Trichloroethene (µg/L)	
		95% UCL	Concentration Limit	95% UCL	Concentration Limit
399-1-10A	July-December	Not applicable*	16	Not applicable*	4
399-1-10B	July-December	Not applicable*	16	Not applicable*	4
399-1-16A	July-December	Not applicable*	16	Not applicable*	4
399-1-16B	July-December	182.4	16	Not applicable*	4
399-1-17A	July-December	Not applicable*	16	Not applicable*	4
399-1-17B	July-December	Not applicable*	16	Not applicable*	4

Sources: ECF-HANFORD-18-0005, *Calculation of Upper Confidence Limits for RCRA Monitoring at the 183-H Solar Evaporation Basins and the 300 Area Process Trenches to Support the July – December 2017 RCRA Semiannual Reports* (Appendix A of this report).

*No results exceeded the concentration limit.

UCL = upper confidence limit

Each result for *cis*-1,2-DCE in the data sets for the other five downgradient wells was less than the 16 µg/L concentration limit. Each result for TCE in the data sets for all six downgradient wells was less than the 4 µg/L concentration limit. For these data sets, a nonstatistical analysis of the data is appropriate. Time-series plots for all wells and constituents in the data sets are shown in ECF-HANFORD-18-0005, *Calculation of Upper Confidence Limits for RCRA Monitoring at the 183-H Solar Evaporation Basins and the 300 Area Process Trenches to Support the July – December 2017 RCRA Semiannual Reports* (Appendix A of this report).

6 Conclusions

The concentration of *cis*-1,2-DCE remained above the Hanford Facility RCRA Permit concentration limit (16 µg/L) in well 399-1-16B, which is screened near the bottom of the unconfined aquifer. Concentrations in this well are not affected by river stage, as shown in SGW-52135, *First Semiannual Report for 2011 Post-Closure Corrective Action Groundwater Monitoring at the 183-H Solar Evaporation Basins and 300 Area Process Trenches: January – June 2011*. Concentration of *cis*-1,2-DCE remained below the Hanford Facility RCRA Permit concentration limit in the other wells.

TCE concentrations remained below the Hanford Facility RCRA Permit concentration limit (4 µg/L) during the reporting period. However, monitoring of this constituent will continue in compliance with the final status groundwater monitoring plan (WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Part VI ("Unit Specific Conditions for Units in Post-Closure," "300 Area Process Trenches (PCU 1)," "Chapter 3.0, Groundwater Monitoring").

Corrective action is being accomplished through the CERCLA remedial action for groundwater, as documented in the CERCLA record of decision for the 300-FF-5 OU (EPA et al., 2013), issued in November 2013. The remedy for *cis*-1,2-DCE and TCE in groundwater is monitored natural attenuation and institutional controls.

7 References

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: https://www.csu.edu/cerc/researchreports/documents/CERCLASummary1980.pdf.

DOE/RL-93-73, 1997, *300 Area Process Trenches Modified Closure/Postclosure Plan*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1309100642.

EPA, 2015, ProUCL, Version 5.1, U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.epa.gov/land-research/proucl-software.

EPA, Ecology, and DOE, 2013, *Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0087180.

NAVD88, 1988, *North American Vertical Datum of 1988*, as revised, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland. Available at: http://www.ngs.noaa.gov/.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: https://www.epa.gov/rcra.

SGW-52135, 2012, *First Semiannual Report for 2011 Post-Closure Corrective Action Groundwater Monitoring at the 183-H Solar Evaporation Basins and 300 Area Process Trenches: January – June 2011*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093013.

WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Washington State Department of Ecology. Available at: https://fortress.wa.gov/ecy/nwp/permitting/hdwp/rev/8c/index.html

WAC 173-303-645, "Dangerous Waste Regulations," "Release from Regulated Units," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303-645.

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Appendix A

ECF-HANFORD-18-0005, REV. 0

Calculation of Upper Confidence Limits for RCRA Monitoring at the 183-H Solar Evaporation Basins and the 300 Area Process Trenches to Support the July – December 2017 RCRA Semiannual Reports

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Revision 0

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Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
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Section 1: Completed by the Responsible Manager

Project: RCRA Monitoring

Date:

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RELEASE / ISSUE

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Section 4: Document Review & Approval

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Checker:	L Scantlebury/SStaffHydro (SSP&A)	[illegible]	3/13/2018
Senior Reviewer:	P Humphreys (CHPRC)	[illegible]	3-20-18
Responsible Manager:	W.R. Faught (CHPRC)	[illegible]	3-27-18

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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Integration Lead			

Safety Software Approved:

	Name /Position	Signature	Date
Integration Lead			

CALCULATION APPROVED:

	Name /Position	Signature	Date
Risk/Modeling Integration Manager:			

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Terms

CHPRC	CH2M HILL Plateau Remediation Company
cis-1,2-DCE	*cis*-1,2-dichloroethylene
ECF	environmental calculation file
EPA	U.S. Environmental Protection Agency
HEIS	Hanford Environmental Information System
KM	Kaplan-Meier
MDL	method detection limit
OU	operable unit
RCRA	*Resource Conservation and Recovery Act of 1976*
TCE	trichloroethene
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 filtered total chromium and nitrate at the 183-H Solar Evaporation Basins *Resource Conservation and Recovery Act of 1976* (RCRA) site and 95% UCLs on the mean for *cis*-1,2-dichloroethylene (*cis*-1,2-DCE) and trichloroethene (TCE) at the 300 Area Process Trenches RCRA site. The 95% UCLs are compared to the applicable concentration limits in the *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 groundwater samples collected through December 2017.

2 Background

The 183-H Solar Evaporation Basins are located within the 100-H Operable Unit (OU) (Figure 1) and were used to evaporate various liquid waste streams from 300 Area fuel fabrication facilities. The final status groundwater monitoring plan was incorporated into the Hanford Facility RCRA Permit, Revision 8c, on May 24, 2017. The new plan supersedes PNNL-11573, *Groundwater Monitoring Plan for the 183-H Solar Evaporation Basins*. The new corrective action monitoring plan requires calculation of the 95% UCLs on the mean for nitrate and filtered total chromium based on the last eight (8) to ten (10) independent samples and comparison of the 95% UCLs to the concentration limits established in the Hanford Facility RCRA Permit.

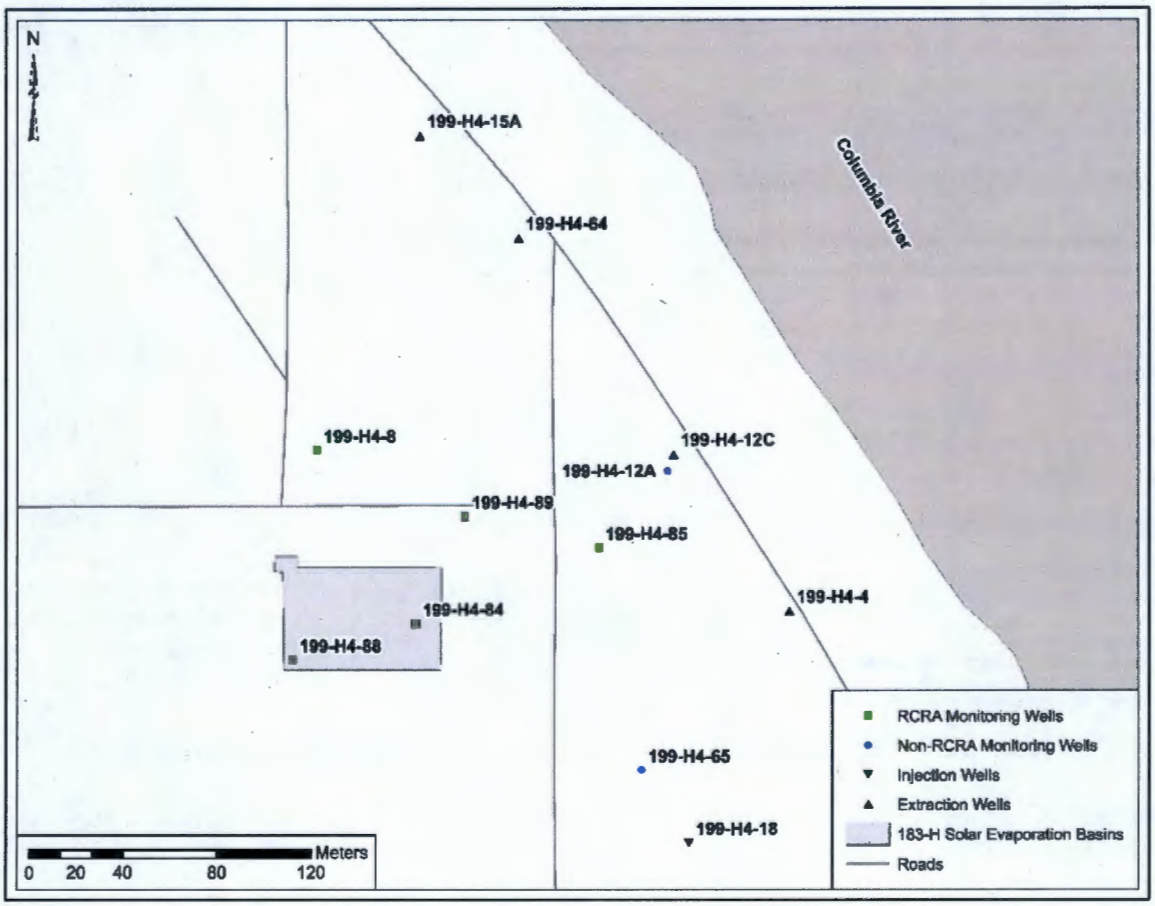

Figure 1. 183-H Solar Evaporation Basins and Associated Monitoring Wells

The 300 Area Process Trenches are located within the 300-FF-1 OU (Figure 2) 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. This new plan supersedes WHC-SD-EN-AP-185, *Groundwater Monitoring Plan for the 300 Area Process Trenches.* The new corrective action monitoring plan requires calculation of the 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 plus any samples collected under the new plan, and comparison of the 95% UCLs to the concentration limits established in the Hanford Facility RCRA Permit. For the 300 Area Process Trenches, the calculation of 95% UCLs only is required for the six downgradient RCRA wells (Figure 2).

For both the 183-H Solar Evaporation Basins and the 300 Area Process Trenches, when all data are non-detects, all data are less than the exceedance level, or there are less than the required number of samples, calculation of the 95% UCL on the mean is not required and the data are evaluated visually to ensure compliance.

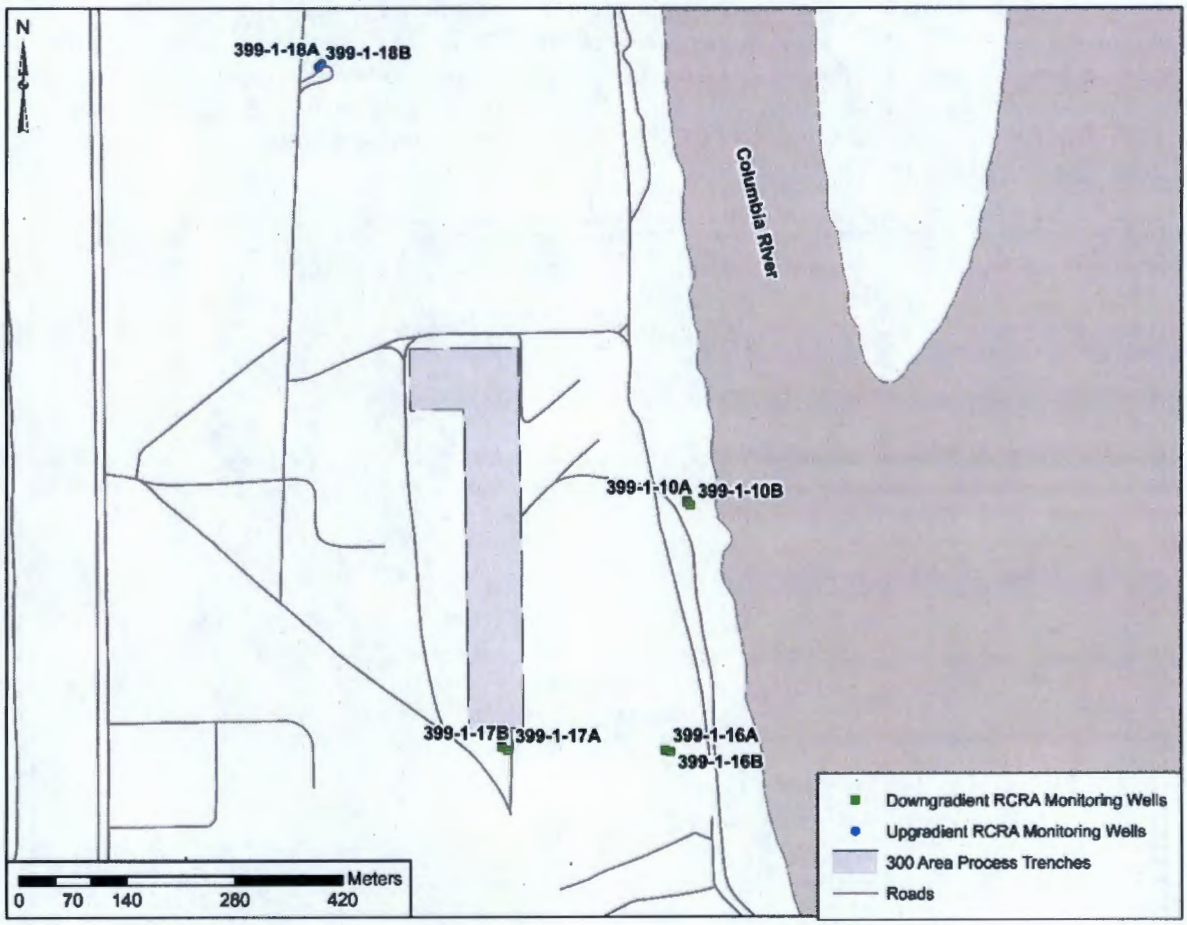

Figure 2. 300 Area Process Trenches and Associated Downgradient Monitoring Wells

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 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 (CHPRC), and exported into a Microsoft Access® database (named HEIS_CHEM_01082018.accdb). The data for this analysis were downloaded from the HEIS database on January 8, 2018. 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.

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

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

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3.1.2 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 non-detect, the highest detection limit was used for the daily value. For daily duplicates where only one of the samples was non-detect, the detected value was used for the daily value. Duplicate daily measurements and the calculated daily average are presented in Table 2.

Table 2. Duplicate Daily Measurements and Calculated Daily Averages

Area	Well Name	Constituent	Sample Date	Measured Concentration	Calculated Daily Average
183-H Solar Evaporation Basins	199-H4-84	Filtered Total Chromium	6/7/2017	7.2 µg/L 7.5 µg/L	7.35 µg/L
183-H Solar Evaporation Basins	199-H4-85	Filtered Total Chromium	2/21/2014	21.7 µg/L 21.9 µg/L	21.8 µg/L
183-H Solar Evaporation Basins	199-H4-85	Filtered Total Chromium	8/14/2015	18.4 µg/L 18.3 µg/L	18.35 µg/L
183-H Solar Evaporation Basins	199-H4-89	Filtered Total Chromium	3/30/2016	2.22 µg/L 2U µg/L	2.22[a] µg/L
183-H Solar Evaporation Basins	199-H4-85	Nitrate	8/14/2015	30.1 mg/L 30.5 mg/L	30.3 mg/L
300 Area Process Trenches	399-1-16A	*cis*-1,2-DCE	9/6/2016	0.32 µg/L 0.28 µg/L	0.3 µg/L
300 Area Process Trenches	399-1-16B	*cis*-1,2-DCE	1/12/2017	191 µg/L 184 µg/L	187.5 µg/L
300 Area Process Trenches	399-1-17A	*cis*-1,2-DCE	6/8/2016	0.15U µg/L 0.3U µg/L	0.3U[b] µg/L
300 Area Process Trenches	399-1-17A	*cis*-1,2-DCE	7/6/2016	0.15U µg/L 0.3U µg/L	0.3U[b] µg/L
300 Area Process Trenches	399-1-17A	*cis*-1,2-DCE	10/24/2017	0.3U µg/L 0.3U µg/L	0.3U[b] µg/L
300 Area Process Trenches	399-1-17B	*cis*-1,2-DCE	8/9/2016	1.3 µg/L 1.3 µg/L	1.3 µg/L
300 Area Process Trenches	399-1-17B	*cis*-1,2-DCE	9/6/2016	1.72 µg/L 2 µg/L	1.85 µg/L

Table 2. Duplicate Daily Measurements and Calculated Daily Averages

Area	Well Name	Constituent	Sample Date	Measured Concentration	Calculated Daily Average
300 Area Process Trenches	399-1-16A	TCE	9/6/2016	0.31 µg/L 0.25U µg/L	0.31[a] µg/L
300 Area Process Trenches	399-1-16B	TCE	8/9/2016	1.79 µg/L 1.77 µg/L	1.78 µg/L
300 Area Process Trenches	399-1-16B	TCE	1/12/2017	1.84 µg/L 1.99 µg/L	1.915 µg/L
300 Area Process Trenches	399-1-17A	TCE	6/8/2016	0.16U µg/L 0.3U µg/L	0.3U[b] µg/L
300 Area Process Trenches	399-1-17A	TCE	7/6/2016	0.16U µg/L 0.3U µg/L	0.3U[b] µg/L
300 Area Process Trenches	399-1-17A	TCE	10/24/2017	0.3U µg/L 0.3U µg/L	0.3U[b] µg/L
300 Area Process Trenches	399-1-17B	TCE	8/9/2016	0.16U µg/L 0.25U µg/L	0.25U[b] µg/L
300 Area Process Trenches	399-1-17B	TCE	9/6/2016	0.16U µg/L 0.25U µg/L	0.25U[b] µg/L

[a]Detected value used for daily value.

[b]Highest detection limit used for daily value.

cis-1,2-DCE = *cis*-1,2-dichloroethylene

TCE = trichloroethene

U = Constituent not detected at the detection limit shown.

3.1.3 Identifying Non-Detects

Non-detects in the chemistry data set were identified using the laboratory qualifier (LAB_QUALIFIER = U). The method detection limit (MDL) was substituted for concentration measurements when identified as a non-detect based on the laboratory qualifier. 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.

3.1.4 Wells and Constituents

The list of wells and constituents for this analysis was based on the groundwater monitoring plans incorporated on May 24, 2017 into the Hanford Facility RCRA Permit (WA7890008967), as listed in Table 3.

Table 3. Wells and Constituents

Area	Well Name	Constituent
183-H Solar Evaporation Basins	199-H4-8	Filtered Total Chromium, Nitrate
183-H Solar Evaporation Basins	199-H4-84	Filtered Total Chromium, Nitrate
183-H Solar Evaporation Basins	199-H4-85	Filtered Total Chromium, Nitrate
183-H Solar Evaporation Basins	199-H4-88	Filtered Total Chromium, Nitrate
183-H Solar Evaporation Basins	199-H4-89	Filtered Total Chromium, Nitrate
300 Area Process Trenches	399-1-10A	*cis*-1,2-Dichloroethylene, Trichloroethene
300 Area Process Trenches	399-1-10B	*cis*-1,2-Dichloroethylene, Trichloroethene
300 Area Process Trenches	399-1-16A	*cis*-1,2-Dichloroethylene, Trichloroethene
300 Area Process Trenches	399-1-16B	*cis*-1,2-Dichloroethylene, Trichloroethene
300 Area Process Trenches	399-1-17A	*cis*-1,2-Dichloroethylene, Trichloroethene
300 Area Process Trenches	399-1-17B	*cis*-1,2-Dichloroethylene, Trichloroethene

3.1.5 Time Period of Analysis

Datasets were selected based on the number of available samples and the sampling dates (Table 4). For the 183-H Solar Evaporation Basins, the last ten samples through the end of December 2017 were included in the datasets if available. For the 300 Area Process Trenches, all RCRA samples from June 2016 through December 2017 were included in the datasets. If fewer than eight samples were available, no statistical analysis was performed.

Table 4. Sampling Data

Area	Well Name	Analyte	Sampling Date Range	Number of Samples
183-H Solar Evaporation Basins	199-H4-8	Filtered Total Chromium	1/11/2010 – 11/10/2017	10
183-H Solar Evaporation Basins	199-H4-84	Filtered Total Chromium	11/15/2016 – 11/10/2017	10
183-H Solar Evaporation Basins	199-H4-85	Filtered Total Chromium	2/21/2014 – 5/22/2016	10
183-H Solar Evaporation Basins	199-H4-88	Filtered Total Chromium	4/4/2017 – 12/14/2017	10
183-H Solar Evaporation Basins	199-H4-89	Filtered Total Chromium	3/30/2016 – 11/10/2017	5
183-H Solar Evaporation Basins	199-H4-8	Nitrate	1/1/2010 – 11/10/2017	10
183-H Solar Evaporation Basins	199-H4-84	Nitrate	3/10/2017 – 12/14/2017	10
183-H Solar Evaporation Basins	199-H4-85	Nitrate	2/26/2015 – 5/25/2017	10
183-H Solar Evaporation Basins	199-H4-88	Nitrate	4/4/2017 – 12/14/2017	10
183-H Solar Evaporation Basins	199-H4-89	Nitrate	3/30/2016 – 11/10/2017	6
300 Area Process Trenches	399-1-10A	*cis*-1,2-DCE	6/7/2016 – 10/24/2017	10
300 Area Process Trenches	399-1-10B	*cis*-1,2-DCE	6/7/2016 – 10/22/2017	10
300 Area Process Trenches	399-1-16A	*cis*-1,2-DCE	6/8/2016 – 10/24/2017	10
300 Area Process Trenches	399-1-16B	*cis*-1,2-DCE	6/9/2016 – 10/24/2017	10
300 Area Process Trenches	399-1-17A	*cis*-1,2-DCE	6/8/2016 – 10/24/2017	10
300 Area Process Trenches	399-1-17B	*cis*-1,2-DCE	6/8/2016 – 10/24/2017	10

Table 4. Sampling Data

Area	Well Name	Analyte	Sampling Date Range	Number of Samples
300 Area Process Trenches	399-1-10A	TCE	6/7/2016 – 10/24/2017	10
300 Area Process Trenches	399-1-10B	TCE	6/7/2016 – 10/22/2017	10
300 Area Process Trenches	399-1-16A	TCE	6/8/2016 – 10/24/2017	10
300 Area Process Trenches	399-1-16B	TCE	6/9/2016 – 10/24/2017	10
300 Area Process Trenches	399-1-17A	TCE	6/8/2016 – 10/24/2017	10
300 Area Process Trenches	399-1-17B	TCE	6/8/2016 – 10/24/2017	10

cis-1,2-DCE = *cis*-1,2-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 new corrective action groundwater monitoring plans. ProUCL is available through the U.S. Environmental Protection Agency (EPA) and provides statistical methods and graphical tools that are commonly used in environmental assessments. ProUCL is capable of working with datasets where non-detects, 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 non-detects. For datasets with non-detects, ProUCL uses the Kaplan-Meier (KM) method, a non-parametric 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 eight samples and with at least one sample above the concentration limit. As shown in Table 5 below, only four datasets met these criteria – three of ten datasets in 183-H Solar Evaporation Basins area and one of twelve datasets in the 300 Area Process Trenches area. Calculation of 95% UCLs for the other datasets, including all TCE results, was not required.

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

Area	Analyte	Concentration Limit (µg/L)	Well Name	Number of Samples	Percent Non-Detect	Number of Samples Exceeding Concentration Limit	95% UCL Calculation Required
183-H Solar Evaporation Basins	Filtered total chromium	48	199-H4-8	10	20%	0	No
			199-H4-84	10	0%	2	**Yes**
			199-H4-85	10	0%	0	No
			199-H4-88	10	0%	0	No
			199-H4-89	5	20%	0	No
183-H Solar Evaporation Basins	Nitrate	45	199-H4-8	10	0%	0	No
			199-H4-84	10	0%	4	**Yes**
			199-H4-85	10	0%	0	No
			199-H4-88	10	0%	5	**Yes**
			199-H4-89	6	0%	1	No
300 Area Process Trenches	*cis*-1,2-DCE	16	399-1-10A	10	100%	0	No
			399-1-10B	10	100%	0	No
			399-1-16A	10	90%	0	No
			399-1-16B	10	0%	10	**Yes**
			399-1-17A	10	100%	0	No
			399-1-17B	10	0%	0	No
300 Area Process Trenches	TCE	4	399-1-10A	10	100%	0	No
			399-1-10B	10	100%	0	No
			399-1-16A	10	30%	0	No
			399-1-16B	10	0%	0	No
			399-1-17A	10	90%	0	No
			399-1-17B	10	100%	0	No

cis-1,2-DCE = *cis*-1,2-dichloroethylene
TCE = trichloroethene
UCL = upper confidence limit

4 Assumptions

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

- The MDL is independent of concentration.
- 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.
- 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_03052018.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 non-detects. 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 results are presented in Table 6. Results for nitrate were converted to milligrams per liter (mg/L) after processing with ProUCL. Timeseries plots for all wells and constituents are presented in Appendix B.

Table 6. Calculated 95% UCLs

Area	Well Name	Analyte	Conc. Limit	95% UCL	95% UCL Result Evaluation
183-H Solar Evaporation Basins	199-H4-84	Chromium[a]	48 µg/L	102[b] µg/L	Above Concentration Limit
	199-H4-84	Nitrate	45 mg/L	72.97[c] mg/L	Above Concentration Limit
	199-H4-88	Nitrate	45 mg/L	60.94[c] mg/L	Above Concentration Limit
300 Area Process Trenches	399-1-16B	*cis*-1,2-DCE	16 µg/L	182.4[c] µg/L	Above Concentration Limit

[a] Filtered total chromium

[b] ProUCL method: 95% Adjusted Gamma UCL

[c] ProUCL method: 95% Student's-t UCL

cis-1,2-DCE = *cis*-1,2-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.

PNNL-11573, 1997, *Groundwater Monitoring Plan for the 183-H Solar Evaporation Basins*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D1659822.

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.

WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste*, Revision 8c, as amended, Washington State Department of Ecology. Available at: http://www.ecy.wa.gov/programs/nwp/permitting/hdwp/rev/8c/index.html.

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/arpir/index.cfm/viewDoc?accession=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 183-H Solar Evaporation Basins

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Non-detect Identification*
199-H4-8	1/11/2010	Chromium	13	µg/L	U	0
199-H4-8	12/16/2010	Chromium	14	µg/L	U	0
199-H4-8	11/29/2011	Chromium	9.5	µg/L	B	1
199-H4-8	11/1/2012	Chromium	16.4	µg/L	B	1
199-H4-8	3/10/2014	Chromium	3.1	µg/L	D	1
199-H4-8	11/5/2014	Chromium	2.8	µg/L	B	1
199-H4-8	12/1/2015	Chromium	4	µg/L	B	1
199-H4-8	11/15/2016	Chromium	7.4	µg/L	B	1
199-H4-8	5/3/2017	Chromium	3.3	µg/L		1
199-H4-8	11/10/2017	Chromium	3	µg/L	BC	1
199-H4-84	11/15/2016	Chromium	46.5	µg/L	D	1
199-H4-84	2/8/2017	Chromium	33	µg/L		1
199-H4-84	3/10/2017	Chromium	37	µg/L		1
199-H4-84	4/4/2017	Chromium	150	µg/L	D	1
199-H4-84	5/3/2017	Chromium	8.1	µg/L		1
199-H4-84	6/7/2017	Chromium	7.35	µg/L	BD	1
199-H4-84	7/5/2017	Chromium	107	µg/L	D	1
199-H4-84	8/29/2017	Chromium	20	µg/L		1
199-H4-84	9/29/2017	Chromium	12.5	µg/L	D	1
199-H4-84	11/10/2017	Chromium	2.9	µg/L	BC	1
199-H4-85	2/21/2014	Chromium	21.8	µg/L	D	1
199-H4-85	5/5/2014	Chromium	21.5	µg/L		1
199-H4-85	8/25/2014	Chromium	31.5	µg/L		1
199-H4-85	10/31/2014	Chromium	23.3	µg/L		1
199-H4-85	2/26/2015	Chromium	19.6	µg/L		1
199-H4-85	5/19/2015	Chromium	17.1	µg/L		1
199-H4-85	8/14/2015	Chromium	18.35	µg/L		1
199-H4-85	11/19/2015	Chromium	18	µg/L		1
199-H4-85	2/10/2016	Chromium	16.1	µg/L		1
199-H4-85	5/22/2016	Chromium	6.76	µg/L	B	1
199-H4-88	4/4/2017	Chromium	9.5	µg/L	B	1
199-H4-88	5/3/2017	Chromium	36	µg/L		1
199-H4-88	6/7/2017	Chromium	30.9	µg/L		1
199-H4-88	6/14/2017	Chromium	41.7	µg/L		1
199-H4-88	7/5/2017	Chromium	20	µg/L		1
199-H4-88	8/29/2017	Chromium	19	µg/L		1

Table A-1

Dataset for 183-H Solar Evaporation Basins

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Non-detect Identification*
199-H4-88	9/29/2017	Chromium	17	µg/L		1
199-H4-88	10/20/2017	Chromium	17	µg/L	C	1
199-H4-88	11/10/2017	Chromium	11.6	µg/L		1
199-H4-88	12/14/2017	Chromium	9.6	µg/L	B	1
199-H4-89	3/30/2016	Chromium	2.22	µg/L		1
199-H4-89	11/22/2016	Chromium	2.9	µg/L	B	1
199-H4-89	6/14/2017	Chromium	3	µg/L	U	0
199-H4-89	8/29/2017	Chromium	3.4	µg/L		1
199-H4-89	11/10/2017	Chromium	1.2	µg/L	B	1
199-H4-8	1/11/2010	Nitrate	24600	µg/L	D	1
199-H4-8	12/16/2010	Nitrate	20300	µg/L	D	1
199-H4-8	11/29/2011	Nitrate	15100	µg/L	D	1
199-H4-8	11/1/2012	Nitrate	18800	µg/L	D	1
199-H4-8	3/10/2014	Nitrate	15300	µg/L		1
199-H4-8	11/5/2014	Nitrate	13700	µg/L	D	1
199-H4-8	12/1/2015	Nitrate	17700	µg/L	D	1
199-H4-8	11/15/2016	Nitrate	9300	µg/L	D	1
199-H4-8	5/3/2017	Nitrate	12400	µg/L		1
199-H4-8	11/10/2017	Nitrate	11100	µg/L	D	1
199-H4-84	3/10/2017	Nitrate	48700	µg/L	ZD	1
199-H4-84	4/4/2017	Nitrate	116000	µg/L	DX	1
199-H4-84	5/3/2017	Nitrate	13100	µg/L	D	1
199-H4-84	6/7/2017	Nitrate	13300	µg/L	D	1
199-H4-84	7/5/2017	Nitrate	124000	µg/L	D	1
199-H4-84	8/29/2017	Nitrate	42300	µg/L	D	1
199-H4-84	9/29/2017	Nitrate	35900	µg/L	D	1
199-H4-84	10/20/2017	Nitrate	21000	µg/L	DX	1
199-H4-84	11/10/2017	Nitrate	30500	µg/L	D	1
199-H4-84	12/14/2017	Nitrate	55800	µg/L	DX	1
199-H4-85	2/26/2015	Nitrate	25800	µg/L	D	1
199-H4-85	5/19/2015	Nitrate	25100	µg/L	D	1
199-H4-85	8/14/2015	Nitrate	30300	µg/L	D	1
199-H4-85	11/19/2015	Nitrate	26600	µg/L	D	1
199-H4-85	2/10/2016	Nitrate	20800	µg/L	D	1
199-H4-85	5/22/2016	Nitrate	6200	µg/L	D	1
199-H4-85	10/7/2016	Nitrate	16800	µg/L	D	1

Table A-1

Dataset for 183-H Solar Evaporation Basins

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Non-detect Identification*
199-H4-85	11/20/2016	Nitrate	4430	µg/L	D	1
199-H4-85	2/14/2017	Nitrate	2170	µg/L	D	1
199-H4-85	5/25/2017	Nitrate	6860	µg/L		1
199-H4-88	4/4/2017	Nitrate	19400	µg/L		1
199-H4-88	5/3/2017	Nitrate	40900	µg/L	D	1
199-H4-88	6/7/2017	Nitrate	75300	µg/L	D	1
199-H4-88	6/14/2017	Nitrate	57100	µg/L	D	1
199-H4-88	7/5/2017	Nitrate	76600	µg/L	D	1
199-H4-88	8/29/2017	Nitrate	54900	µg/L	D	1
199-H4-88	9/29/2017	Nitrate	57500	µg/L	D	1
199-H4-88	10/20/2017	Nitrate	44100	µg/L	DX	1
199-H4-88	11/10/2017	Nitrate	44300	µg/L	D	1
199-H4-88	12/14/2017	Nitrate	39600	µg/L	DX	1
199-H4-89	3/30/2016	Nitrate	12400	µg/L	D	1
199-H4-89	11/22/2016	Nitrate	10600	µg/L	D	1
199-H4-89	5/25/2017	Nitrate	13800	µg/L		1
199-H4-89	6/14/2017	Nitrate	10400	µg/L		1
199-H4-89	8/29/2017	Nitrate	19300	µg/L		1
199-H4-89	11/10/2017	Nitrate	48700	µg/L	D	1

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

Qualifier Definitions:

B = The analyte was detected at a value less than the contract required detection limit (RDL), but greater than or equal to the IDL/MIDL (as appropriate).

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

U = Analyzed for but not detected above limiting criteria.

X = The result-specific translation of this qualifier code is provided in the hardcopy data report and/or case narrative.

Z = Same as X if more than two flags are required.

Table A-2

Dataset for 300 Area Process Trenches

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Non-detect Identification*
399-1-10A	6/7/2016	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-10A	7/6/2016	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-10A	8/9/2016	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-10A	9/6/2016	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-10A	12/1/2016	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-10A	1/12/2017	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-10A	2/6/2017	cis-1,2-Dichloroethylene	0.3	µg/L	TU	0
399-1-10A	3/6/2017	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-10A	6/2/2017	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-10A	10/24/2017	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-10B	6/7/2016	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-10B	7/6/2016	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-10B	8/9/2016	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-10B	9/6/2016	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-10B	12/1/2016	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-10B	1/12/2017	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-10B	2/6/2017	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-10B	3/6/2017	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-10B	6/2/2017	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-10B	10/22/2017	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-16A	6/8/2016	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-16A	7/7/2016	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-16A	8/9/2016	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-16A	9/6/2016	cis-1,2-Dichloroethylene	0.3	µg/L	J	1
399-1-16A	12/1/2016	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-16A	1/12/2017	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-16A	2/6/2017	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-16A	3/3/2017	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-16A	6/2/2017	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-16A	10/24/2017	cis-1,2-Dichloroethylene	0.1	µg/L	U	0
399-1-16B	6/9/2016	cis-1,2-Dichloroethylene	175	µg/L	D	1
399-1-16B	7/7/2016	cis-1,2-Dichloroethylene	217	µg/L	D	1
399-1-16B	8/9/2016	cis-1,2-Dichloroethylene	172	µg/L	D	1
399-1-16B	9/6/2016	cis-1,2-Dichloroethylene	192	µg/L	D	1
399-1-16B	12/1/2016	cis-1,2-Dichloroethylene	150	µg/L		1
399-1-16B	1/12/2017	cis-1,2-Dichloroethylene	187.5	µg/L	D	1

Table A-2

Dataset for 300 Area Process Trenches

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Non-detect Identification*
399-1-16B	2/6/2017	cis-1,2-Dichloroethylene	143	µg/L	DT	1
399-1-16B	3/3/2017	cis-1,2-Dichloroethylene	136	µg/L	D	1
399-1-16B	6/2/2017	cis-1,2-Dichloroethylene	136	µg/L	D	1
399-1-16B	10/24/2017	cis-1,2-Dichloroethylene	160	µg/L	D	1
399-1-17A	6/8/2016	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-17A	7/6/2016	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-17A	8/9/2016	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-17A	9/6/2016	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-17A	12/1/2016	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-17A	1/12/2017	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-17A	2/6/2017	cis-1,2-Dichloroethylene	0.3	µg/L	TU	0
399-1-17A	3/3/2017	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-17A	6/2/2017	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-17A	10/24/2017	cis-1,2-Dichloroethylene	0.3	µg/L	U	0
399-1-17B	6/8/2016	cis-1,2-Dichloroethylene	1.3	µg/L		1
399-1-17B	7/6/2016	cis-1,2-Dichloroethylene	1.1	µg/L		1
399-1-17B	8/9/2016	cis-1,2-Dichloroethylene	1.3	µg/L		1
399-1-17B	9/6/2016	cis-1,2-Dichloroethylene	1.85	µg/L		1
399-1-17B	12/1/2016	cis-1,2-Dichloroethylene	0.83	µg/L	J	1
399-1-17B	1/12/2017	cis-1,2-Dichloroethylene	0.72	µg/L	J	1
399-1-17B	2/6/2017	cis-1,2-Dichloroethylene	1.3	µg/L		1
399-1-17B	3/3/2017	cis-1,2-Dichloroethylene	1.6	µg/L		1
399-1-17B	6/2/2017	cis-1,2-Dichloroethylene	1.9	µg/L		1
399-1-17B	10/24/2017	cis-1,2-Dichloroethylene	1.2	µg/L		1
399-1-10A	6/7/2016	Trichloroethene	0.3	µg/L	U	0
399-1-10A	7/6/2016	Trichloroethene	0.3	µg/L	U	0
399-1-10A	8/9/2016	Trichloroethene	0.3	µg/L	U	0
399-1-10A	9/6/2016	Trichloroethene	0.3	µg/L	U	0
399-1-10A	12/1/2016	Trichloroethene	0.3	µg/L	U	0
399-1-10A	1/12/2017	Trichloroethene	0.3	µg/L	U	0
399-1-10A	2/6/2017	Trichloroethene	0.3	µg/L	U	0
399-1-10A	3/6/2017	Trichloroethene	0.3	µg/L	U	0
399-1-10A	6/2/2017	Trichloroethene	0.3	µg/L	U	0
399-1-10A	10/24/2017	Trichloroethene	0.3	µg/L	U	0
399-1-10B	6/7/2016	Trichloroethene	0.25	µg/L	U	0
399-1-10B	7/6/2016	Trichloroethene	0.25	µg/L	U	0

Table A-2

Dataset for 300 Area Process Trenches

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Non-detect Identification*
399-1-10B	8/9/2016	Trichloroethene	0.25	µg/L	U	0
399-1-10B	9/6/2016	Trichloroethene	0.25	µg/L	U	0
399-1-10B	12/1/2016	Trichloroethene	0.25	µg/L	U	0
399-1-10B	1/12/2017	Trichloroethene	0.25	µg/L	U	0
399-1-10B	2/6/2017	Trichloroethene	0.25	µg/L	U	0
399-1-10B	3/6/2017	Trichloroethene	0.25	µg/L	U	0
399-1-10B	6/2/2017	Trichloroethene	0.25	µg/L	U	0
399-1-10B	10/22/2017	Trichloroethene	0.25	µg/L	U	0
399-1-16A	6/8/2016	Trichloroethene	0.4	µg/L	J	1
399-1-16A	7/7/2016	Trichloroethene	0.51	µg/L	J	1
399-1-16A	8/9/2016	Trichloroethene	0.34	µg/L	J	1
399-1-16A	9/6/2016	Trichloroethene	0.31	µg/L		1
399-1-16A	12/1/2016	Trichloroethene	0.42	µg/L	J	1
399-1-16A	1/12/2017	Trichloroethene	0.25	µg/L	U	0
399-1-16A	2/6/2017	Trichloroethene	0.31	µg/L	J	1
399-1-16A	3/3/2017	Trichloroethene	0.35	µg/L	J	1
399-1-16A	6/2/2017	Trichloroethene	0.25	µg/L	U	0
399-1-16A	10/24/2017	Trichloroethene	0.25	µg/L	U	0
399-1-16B	6/9/2016	Trichloroethene	1.97	µg/L	J	1
399-1-16B	7/7/2016	Trichloroethene	1.71	µg/L	J	1
399-1-16B	8/9/2016	Trichloroethene	1.78	µg/L	J	1
399-1-16B	9/6/2016	Trichloroethene	1.91	µg/L	J	1
399-1-16B	12/1/2016	Trichloroethene	1.3	µg/L		1
399-1-16B	1/12/2017	Trichloroethene	1.915	µg/L	J	1
399-1-16B	2/6/2017	Trichloroethene	1.56	µg/L	J	1
399-1-16B	3/3/2017	Trichloroethene	1.88	µg/L	DJ	1
399-1-16B	6/2/2017	Trichloroethene	1.73	µg/L	J	1
399-1-16B	10/24/2017	Trichloroethene	1.2	µg/L		1
399-1-17A	6/8/2016	Trichloroethene	0.3	µg/L	U	0
399-1-17A	7/6/2016	Trichloroethene	0.3	µg/L	U	0
399-1-17A	8/9/2016	Trichloroethene	0.3	µg/L	U	0
399-1-17A	9/6/2016	Trichloroethene	0.3	µg/L	U	0
399-1-17A	12/1/2016	Trichloroethene	0.3	µg/L	U	0
399-1-17A	1/12/2017	Trichloroethene	0.3	µg/L	U	0
399-1-17A	2/6/2017	Trichloroethene	0.3	µg/L	U	0
399-1-17A	3/3/2017	Trichloroethene	0.3	µg/L	U	0

Table A-2

Dataset for 300 Area Process Trenches

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Non-detect Identification*
399-1-17A	6/2/2017	Trichloroethene	0.32	µg/L	J	1
399-1-17A	10/24/2017	Trichloroethene	0.3	µg/L	U	0
399-1-17B	6/8/2016	Trichloroethene	0.25	µg/L	U	0
399-1-17B	7/6/2016	Trichloroethene	0.25	µg/L	U	0
399-1-17B	8/9/2016	Trichloroethene	0.25	µg/L	U	0
399-1-17B	9/6/2016	Trichloroethene	0.25	µg/L	U	0
399-1-17B	12/1/2016	Trichloroethene	0.25	µg/L	U	0
399-1-17B	1/12/2017	Trichloroethene	0.25	µg/L	U	0
399-1-17B	2/6/2017	Trichloroethene	0.25	µg/L	U	0
399-1-17B	3/3/2017	Trichloroethene	0.25	µg/L	U	0
399-1-17B	6/2/2017	Trichloroethene	0.25	µg/L	U	0
399-1-17B	10/24/2017	Trichloroethene	0.25	µg/L	U	0

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

Qualifier Definitions:

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

J = Estimated value; constituent detected at a level less than the RDL or PQL and greater than or equal to the MDL.

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

U = Analyzed for but not detected above limiting criteria.

183-H Solar Evaporation Basins ProUCL Chromium Results

	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 5.13/5/2018 3:03:28 PM							
5				From File	ProUCL_SolarEvap_Datasets_03052018_a.xls							
6				Full Precision	OFF							
7				Confidence Coefficient	95%							
8				Number of Bootstrap Operations	2000							
9												
10	VAL (199-H4-84)											
11												
12						General Statistics						
13					Total Number of Observations	10		Number of Distinct Observations				10
14								Number of Missing Observations				0
15					Minimum	2.9		Mean				42.44
16					Maximum	150		Median				26.5
17					SD	48.59		Std. Error of Mean				15.36
18					Coefficient of Variation	1.145		Skewness				1.61
19												
20						Normal GOF Test						
21					Shapiro Wilk Test Statistic	0.783		Shapiro Wilk GOF Test				
22					5% Shapiro Wilk Critical Value	0.842		Data Not Normal at 5% Significance Level				
23					Lilliefors Test Statistic	0.267		Lilliefors GOF Test				
24					5% Lilliefors Critical Value	0.262		Data Not Normal at 5% Significance Level				
25						Data Not 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	70.6		95% Adjusted-CLT UCL (Chen-1995)				76.06
30								95% Modified-t UCL (Johnson-1978)				71.9
31												
32						Gamma GOF Test						
33					A-D Test Statistic	0.267		Anderson-Darling Gamma GOF Test				
34					5% A-D Critical Value	0.75		Detected data appear Gamma Distributed at 5% Significance Level				
35					K-S Test Statistic	0.132		Kolmogorov-Smirnov Gamma GOF Test				
36					5% K-S Critical Value	0.274		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)	0.941		k star (bias corrected MLE)				0.726
41					Theta hat (MLE)	45.08		Theta star (bias corrected MLE)				58.49
42					nu hat (MLE)	18.83		nu star (bias corrected)				14.51
43					MLE Mean (bias corrected)	42.44		MLE Sd (bias corrected)				49.82
44								Approximate Chi Square Value (0.05)				6.923
45					Adjusted Level of Significance	0.0267		Adjusted Chi Square Value				6.035

	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)	88.95					95% Adjusted Gamma UCL (use when n<50)	102
49												
50						**Lognormal GOF Test**						
51					Shapiro Wilk Test Statistic	0.977			**Shapiro Wilk Lognormal GOF Test**			
52					5% Shapiro Wilk Critical Value	0.842			Data appear Lognormal at 5% Significance Level			
53					Lilliefors Test Statistic	0.116			**Lilliefors Lognormal GOF Test**			
54					5% Lilliefors Critical Value	0.262			Data appear Lognormal at 5% Significance Level			
55						**Data appear Lognormal at 5% Significance Level**						
56												
57						**Lognormal Statistics**						
58					Minimum of Logged Data	1.065					Mean of logged Data	3.13
59					Maximum of Logged Data	5.011					SD of logged Data	1.238
60												
61						**Assuming Lognormal Distribution**						
62					95% H-UCL	218.8					90% Chebyshev (MVUE) UCL	98.42
63					95% Chebyshev (MVUE) UCL	123.1					97.5% Chebyshev (MVUE) UCL	157.4
64					99% Chebyshev (MVUE) UCL	224.7						
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	67.71					95% Jackknife UCL	70.6
71					95% Standard Bootstrap UCL	65.99					95% Bootstrap-t UCL	108.3
72					95% Hall's Bootstrap UCL	214.9					95% Percentile Bootstrap UCL	68.42
73					95% BCA Bootstrap UCL	74.44						
74					90% Chebyshev(Mean, Sd) UCL	88.53					95% Chebyshev(Mean, Sd) UCL	109.4
75					97.5% Chebyshev(Mean, Sd) UCL	138.4					99% Chebyshev(Mean, Sd) UCL	195.3
76												
77						**Suggested UCL to Use**						
78					95% Adjusted Gamma UCL	102						
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.							

183-H Solar Evaporation Basins ProUCL Nitrate Results

	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 5.13/5/2018 3:03:51 PM							
5				From File	ProUCL_SolarEvap_Datasets_03052018_b.xls							
6				Full Precision	OFF							
7				Confidence Coefficient	95%							
8				Number of Bootstrap Operations	2000							
9												
10	VAL (199-H4-84)											
11												
12						General Statistics						
13					Total Number of Observations	10		Number of Distinct Observations				10
14								Number of Missing Observations				0
15					Minimum	13100		Mean				50060
16					Maximum	124000		Median				39100
17					SD	39518		Std. Error of Mean				12497
18					Coefficient of Variation	0.789		Skewness				1.25
19												
20						Normal GOF Test						
21					Shapiro Wilk Test Statistic	0.82		Shapiro Wilk GOF Test				
22					5% Shapiro Wilk Critical Value	0.842		Data Not Normal at 5% Significance Level				
23					Lilliefors Test Statistic	0.242		Lilliefors GOF Test				
24					5% Lilliefors Critical Value	0.262		Data appear Normal at 5% Significance Level				
25						Data appear Approximate 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	72968		95% Adjusted-CLT UCL (Chen-1995)				75896
30								95% Modified-t UCL (Johnson-1978)				73792
31												
32						Gamma GOF Test						
33					A-D Test Statistic	0.345		Anderson-Darling Gamma GOF Test				
34					5% A-D Critical Value	0.736		Detected data appear Gamma Distributed at 5% Significance Level				
35					K-S Test Statistic	0.147		Kolmogorov-Smirnov Gamma GOF Test				
36					5% K-S Critical Value	0.27		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)	2.001		k star (bias corrected MLE)				1.467
41					Theta hat (MLE)	25022		Theta star (bias corrected MLE)				34122
42					nu hat (MLE)	40.01		nu star (bias corrected)				29.34
43					MLE Mean (bias corrected)	50060		MLE Sd (bias corrected)				41330
44								Approximate Chi Square Value (0.05)				17.98
45					Adjusted Level of Significance	0.0267		Adjusted Chi Square Value				16.45

	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))	81711				95% Adjusted Gamma UCL (use when n<50)		89309
49												
50						**Lognormal GOF Test**						
51					Shapiro Wilk Test Statistic	0.941				**Shapiro Wilk Lognormal GOF Test**		
52					5% Shapiro Wilk Critical Value	0.842				Data appear Lognormal at 5% Significance Level		
53					Lilliefors Test Statistic	0.122				**Lilliefors Lognormal GOF Test**		
54					5% Lilliefors Critical Value	0.262				Data appear Lognormal at 5% Significance Level		
55						**Data appear Lognormal at 5% Significance Level**						
56												
57						**Lognormal Statistics**						
58					Minimum of Logged Data	9.48				Mean of logged Data		10.55
59					Maximum of Logged Data	11.73				SD of logged Data		0.782
60												
61						**Assuming Lognormal Distribution**						
62					95% H-UCL	104226				90% Chebyshev (MVUE) UCL		88407
63					95% Chebyshev (MVUE) UCL	105813				97.5% Chebyshev (MVUE) UCL		129971
64					99% Chebyshev (MVUE) UCL	177426						
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	70615				95% Jackknife UCL		72968
71					95% Standard Bootstrap UCL	70050				95% Bootstrap-t UCL		95234
72					95% Hall's Bootstrap UCL	212837				95% Percentile Bootstrap UCL		69930
73					95% BCA Bootstrap UCL	73640						
74					90% Chebyshev(Mean, Sd) UCL	87550				95% Chebyshev(Mean, Sd) UCL		104532
75					97.5% Chebyshev(Mean, Sd) UCL	128102				99% Chebyshev(Mean, Sd) UCL		174401
76												
77						**Suggested UCL to Use**						
78					95% Student's-t UCL	72968						
79												
80	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
81	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
82												
83	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
84	Recommendations are based upon data size, data distribution, and skewness.											
85	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
86	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
87												
88												
89	**VAL (199-H4-88)**											
90												

	A	B	C	D	E	F	G	H	I	J	K	L
91						General Statistics						
92					Total Number of Observations	10					Number of Distinct Observations	10
93											Number of Missing Observations	0
94					Minimum	19400					Mean	50970
95					Maximum	76600					Median	49600
96					SD	17203					Std. Error of Mean	5440
97					Coefficient of Variation	0.338					Skewness	-0.0755
98												
99						Normal GOF Test						
100					Shapiro Wilk Test Statistic	0.944			Shapiro Wilk GOF Test			
101					5% Shapiro Wilk Critical Value	0.842			Data appear Normal at 5% Significance Level			
102					Lilliefors Test Statistic	0.154			Lilliefors GOF Test			
103					5% Lilliefors Critical Value	0.262			Data appear Normal at 5% Significance Level			
104						Data appear Normal at 5% Significance Level						
105												
106						Assuming Normal Distribution						
107					95% Normal UCL				95% UCLs (Adjusted for Skewness)			
108					95% Student's-t UCL	60942			95% Adjusted-CLT UCL (Chen-1995)			59779
109									95% Modified-t UCL (Johnson-1978)			60921
110												
111						Gamma GOF Test						
112					A-D Test Statistic	0.385			Anderson-Darling Gamma GOF Test			
113					5% A-D Critical Value	0.727			Detected data appear Gamma Distributed at 5% Significance Level			
114					K-S Test Statistic	0.182			Kolmogorov-Smirnov Gamma GOF Test			
115					5% K-S Critical Value	0.267			Detected data appear Gamma Distributed at 5% Significance Level			
116						Detected data appear Gamma Distributed at 5% Significance Level						
117												
118						Gamma Statistics						
119					k hat (MLE)	8.26			k star (bias corrected MLE)			5.849
120					Theta hat (MLE)	6171			Theta star (bias corrected MLE)			8715
121					nu hat (MLE)	165.2			nu star (bias corrected)			117
122					MLE Mean (bias corrected)	50970			MLE Sd (bias corrected)			21076
123									Approximate Chi Square Value (0.05)			93
124					Adjusted Level of Significance	0.0267			Adjusted Chi Square Value			89.29
125												
126						Assuming Gamma Distribution						
127					95% Approximate Gamma UCL (use when n>=50))	64107			95% Adjusted Gamma UCL (use when n<50)			66771
128												
129						Lognormal GOF Test						
130					Shapiro Wilk Test Statistic	0.885			Shapiro Wilk Lognormal GOF Test			
131					5% Shapiro Wilk Critical Value	0.842			Data appear Lognormal at 5% Significance Level			
132					Lilliefors Test Statistic	0.214			Lilliefors Lognormal GOF Test			
133					5% Lilliefors Critical Value	0.262			Data appear Lognormal at 5% Significance Level			
134						Data appear Lognormal at 5% Significance Level						
135												

	A	B	C	D	E	F	G	H	I	J	K	L
136						Lognormal Statistics						
137					Minimum of Logged Data	9.873					Mean of logged Data	10.78
138					Maximum of Logged Data	11.25					SD of logged Data	0.394
139												
140						Assuming Lognormal Distribution						
141					95% H-UCL	68090					90% Chebyshev (MVUE) UCL	70804
142					95% Chebyshev (MVUE) UCL	79608					97.5% Chebyshev (MVUE) UCL	91829
143					99% Chebyshev (MVUE) UCL	115833						
144												
145						Nonparametric Distribution Free UCL Statistics						
146						Data appear to follow a Discernible Distribution at 5% Significance Level						
147												
148						Nonparametric Distribution Free UCLs						
149					95% CLT UCL	59918					95% Jackknife UCL	60942
150					95% Standard Bootstrap UCL	59481					95% Bootstrap-t UCL	61581
151					95% Hall's Bootstrap UCL	61437					95% Percentile Bootstrap UCL	58980
152					95% BCA Bootstrap UCL	59230						
153					90% Chebyshev(Mean, Sd) UCL	67290					95% Chebyshev(Mean, Sd) UCL	74683
154					97.5% Chebyshev(Mean, Sd) UCL	84944					99% Chebyshev(Mean, Sd) UCL	105099
155												
156						Suggested UCL to Use						
157					95% Student's-t UCL	60942						
158												
159					Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.							
160					Recommendations are based upon data size, data distribution, and skewness.							
161					These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).							
162					However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.							
163												
164					Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be							
165					reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.							
166												
167												

300 Area Process Trenches ProUCL cis-1,2-DCE Results

	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 5.13/5/2018 3:10:58 PM							
5				From File	ProUCL_300Area_Datasets_03052018_a.xls							
6				Full Precision	OFF							
7				Confidence Coefficient	95%							
8				Number of Bootstrap Operations	2000							
9												
10												
11	VAL (399-1-16B)											
12												
13						General Statistics						
14					Total Number of Observations	10		Number of Distinct Observations				9
15								Number of Missing Observations				0
16					Minimum	136		Mean				166.9
17					Maximum	217		Median				166
18					SD	26.81		Std. Error of Mean				8.479
19					Coefficient of Variation	0.161		Skewness				0.534
20												
21						Normal GOF Test						
22					Shapiro Wilk Test Statistic	0.94		Shapiro Wilk GOF Test				
23					5% Shapiro Wilk Critical Value	0.842		Data appear Normal at 5% Significance Level				
24					Lilliefors Test Statistic	0.135		Lilliefors GOF Test				
25					5% Lilliefors Critical Value	0.262		Data appear Normal at 5% Significance Level				
26						Data appear Normal at 5% Significance Level						
27												
28						Assuming Normal Distribution						
29					95% Normal UCL			95% UCLs (Adjusted for Skewness)				
30					95% Student's-t UCL	182.4		95% Adjusted-CLT UCL (Chen-1995)				182.3
31								95% Modified-t UCL (Johnson-1978)				182.6
32												
33						Gamma GOF Test						
34					A-D Test Statistic	0.257		Anderson-Darling Gamma GOF Test				
35					5% A-D Critical Value	0.724		Detected data appear Gamma Distributed at 5% Significance Level				
36					K-S Test Statistic	0.14		Kolmogorov-Smirnov Gamma GOF Test				
37					5% K-S Critical Value	0.266		Detected data appear Gamma Distributed at 5% Significance Level				
38						Detected data appear Gamma Distributed at 5% Significance Level						
39												
40						Gamma Statistics						
41					k hat (MLE)	44.2		k star (bias corrected MLE)				31.01
42					Theta hat (MLE)	3.774		Theta star (bias corrected MLE)				5.381
43					nu hat (MLE)	884.1		nu star (bias corrected)				620.2
44					MLE Mean (bias corrected)	166.9		MLE Sd (bias corrected)				29.96
45								Approximate Chi Square Value (0.05)				563.4

	A	B	C	D	E	F	G	H	I	J	K	L
46					Adjusted Level of Significance	0.0267					Adjusted Chi Square Value	554
47												
48					**Assuming Gamma Distribution**							
49				95% Approximate Gamma UCL (use when n>=50))		183.7				95% Adjusted Gamma UCL (use when n<50)		186.8
50												
51					**Lognormal GOF Test**							
52					Shapiro Wilk Test Statistic	0.947		**Shapiro Wilk Lognormal GOF Test**				
53					5% Shapiro Wilk Critical Value	0.842		Data appear Lognormal at 5% Significance Level				
54					Lilliefors Test Statistic	0.126		**Lilliefors Lognormal GOF Test**				
55					5% Lilliefors Critical Value	0.262		Data appear Lognormal at 5% Significance Level				
56					**Data appear Lognormal at 5% Significance Level**							
57												
58					**Lognormal Statistics**							
59					Minimum of Logged Data	4.913				Mean of logged Data		5.106
60					Maximum of Logged Data	5.38				SD of logged Data		0.158
61												
62					**Assuming Lognormal Distribution**							
63					95% H-UCL	184.1				90% Chebyshev (MVUE) UCL		191.9
64					95% Chebyshev (MVUE) UCL	203.2				97.5% Chebyshev (MVUE) UCL		219
65					99% Chebyshev (MVUE) UCL	250						
66												
67					**Nonparametric Distribution Free UCL Statistics**							
68					**Data appear to follow a Discernible Distribution at 5% Significance Level**							
69												
70					**Nonparametric Distribution Free UCLs**							
71					95% CLT UCL	180.8				95% Jackknife UCL		182.4
72					95% Standard Bootstrap UCL	180.4				95% Bootstrap-t UCL		184.9
73					95% Hall's Bootstrap UCL	182.4				95% Percentile Bootstrap UCL		180.6
74					95% BCA Bootstrap UCL	180.7						
75					90% Chebyshev(Mean, Sd) UCL	192.3				95% Chebyshev(Mean, Sd) UCL		203.8
76					97.5% Chebyshev(Mean, Sd) UCL	219.8				99% Chebyshev(Mean, Sd) UCL		251.2
77												
78					**Suggested UCL to Use**							
79					95% Student's-t UCL	182.4						
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												
86												

Appendix B

Timeseries Plots

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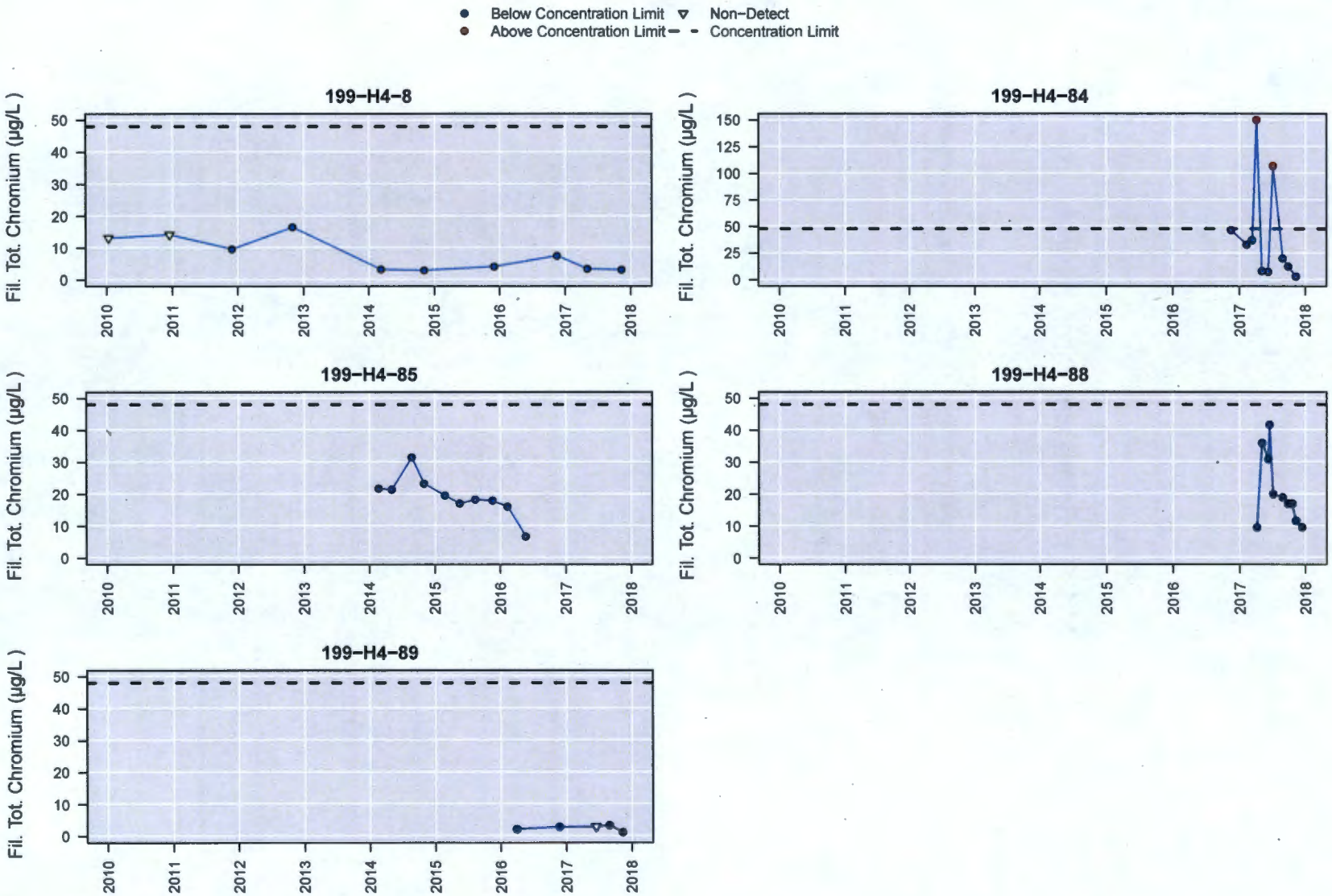
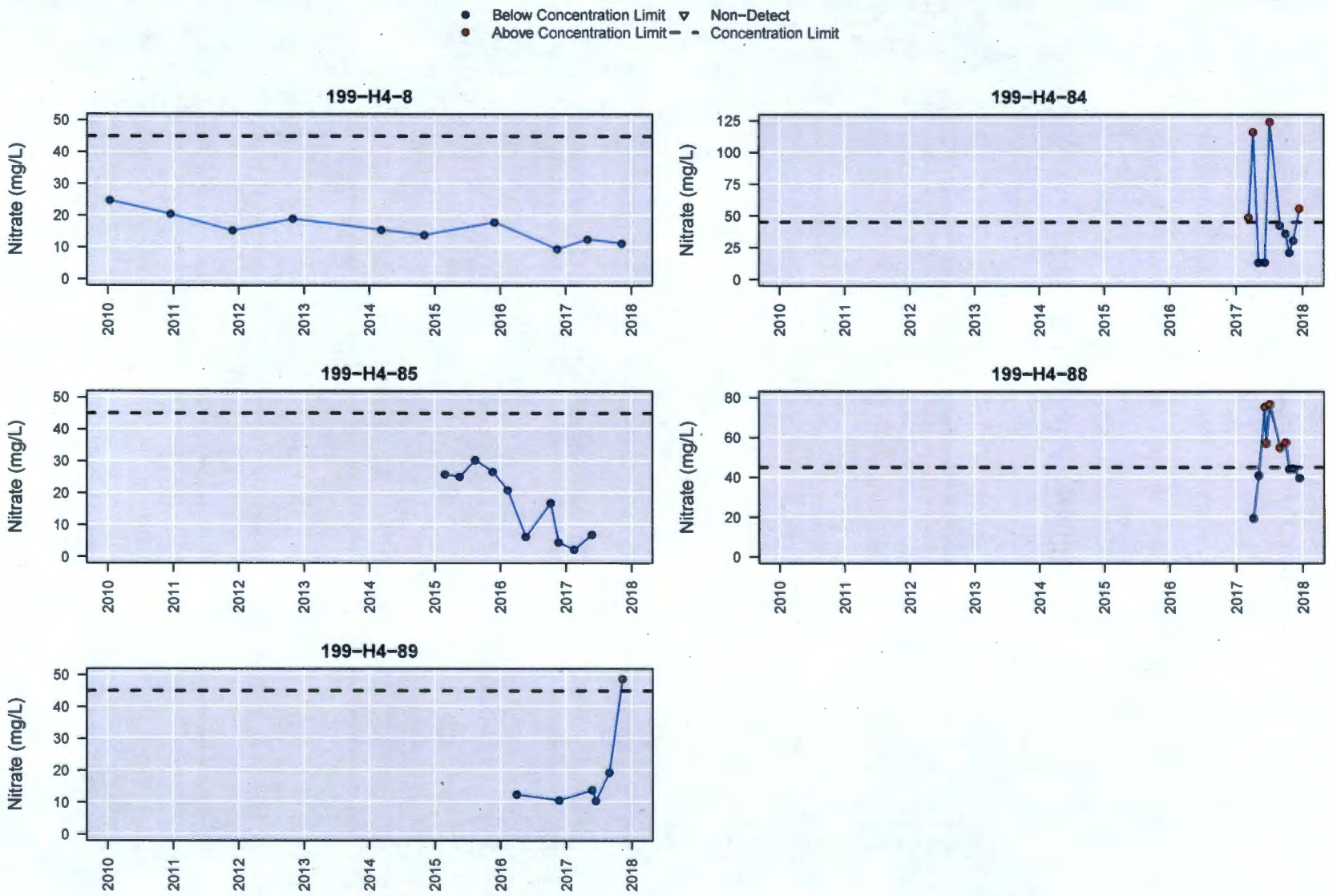
183-H Solar Evaporation Basins

Filtered Total Chromium

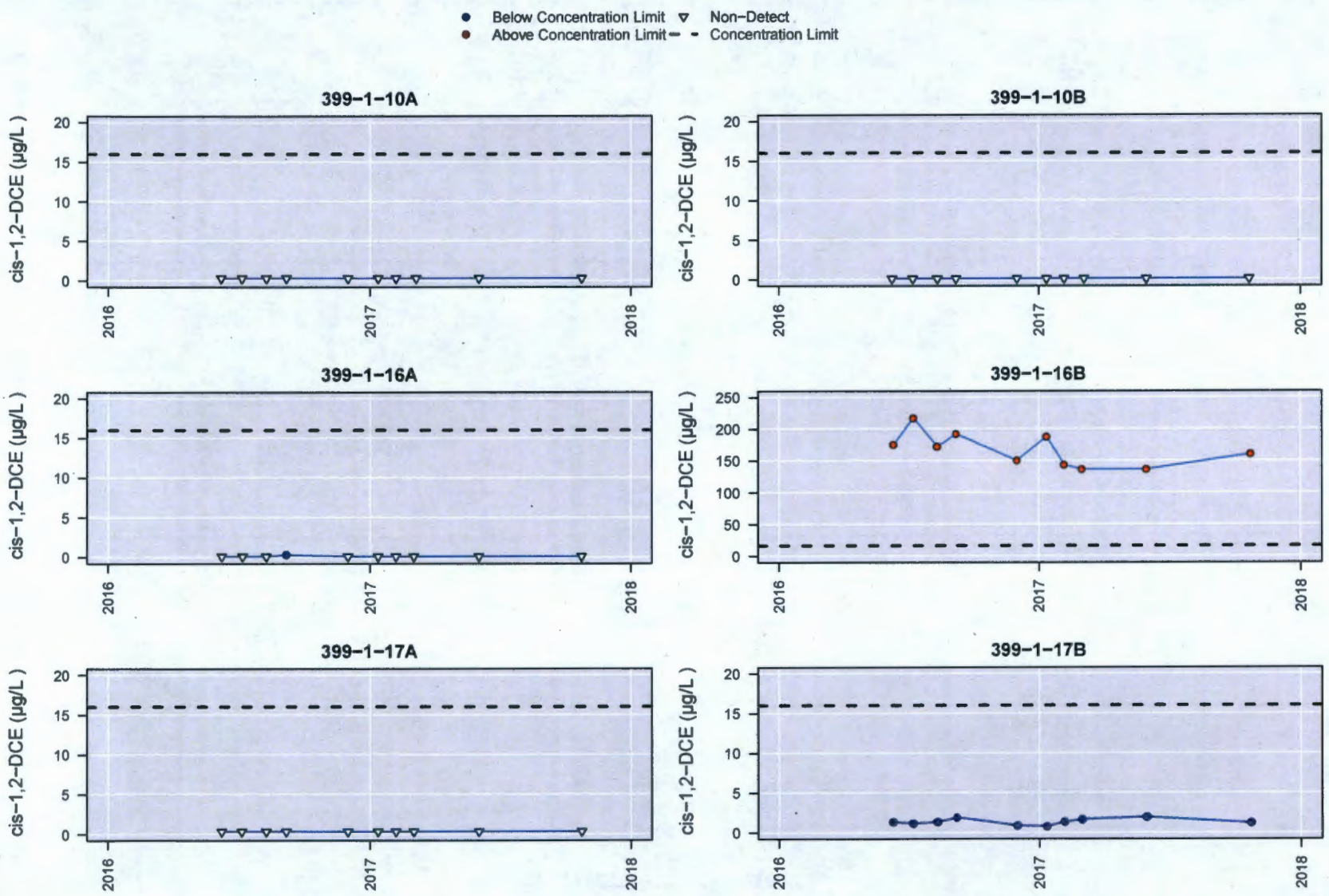
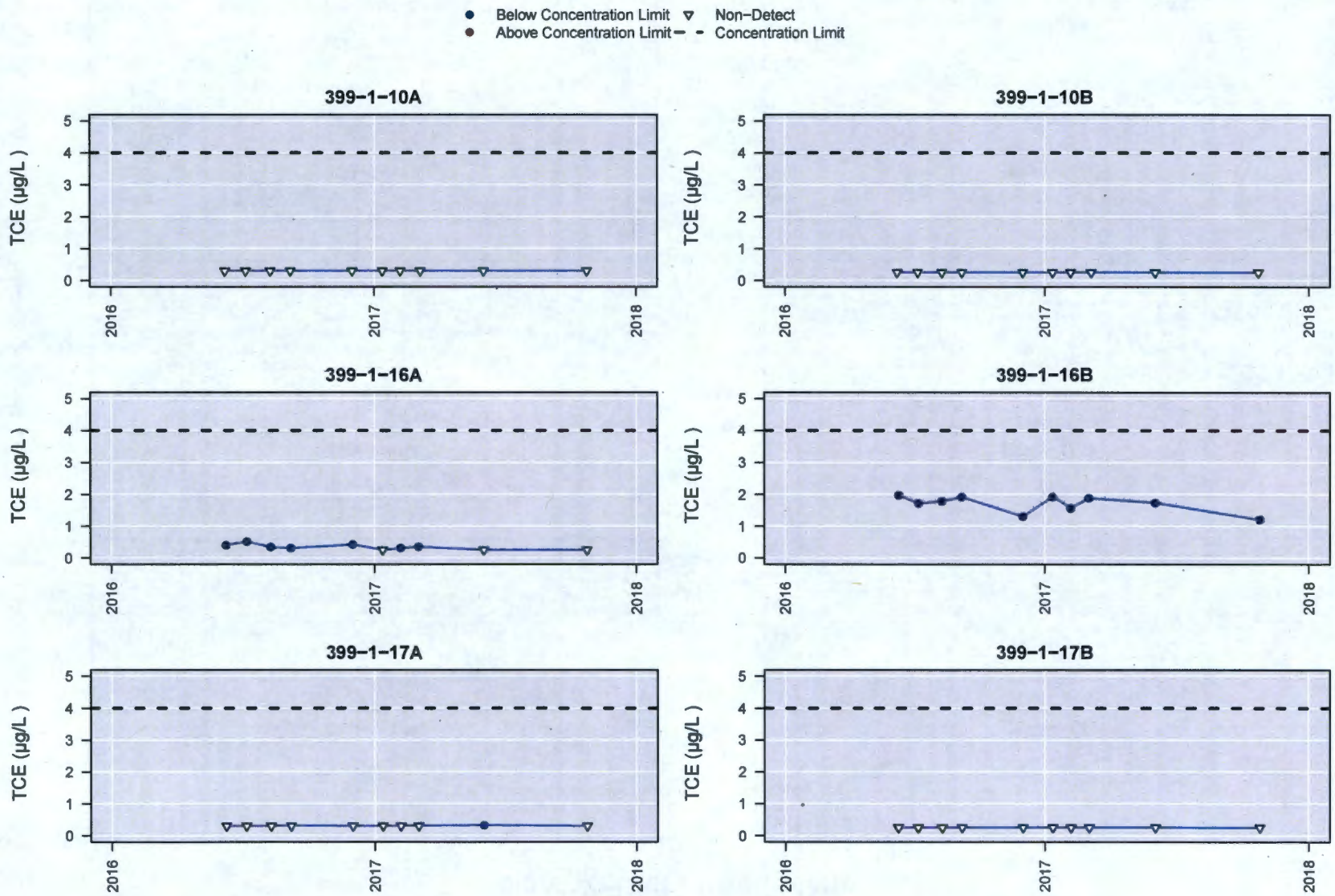


Nitrate


Below Concentration Limit
Above Concentration Limit
Non-Detect
Concentration Limit
199-H4-8
199-H4-84
199-H4-85
199-H4-88
199-H4-89
Nitrate (mg/L)
2010
2011
2012
2013
2014
2015
2016
2017
2018

300 Area Process Trenches

cis−1,2−Dichloroethylene



Trichloroethene