1249955

[0064872H]

ECF-200UP1-18-0017
Revision 0

Calculation of the 95th Percentile Upper Confidence Limit on Plume Monitoring Data for the 200-UP-1 Groundwater Operable Unit through Calendar Year 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

CH2MHILL
Plateau Remediation Company

P.O. Box 1600
Richland, Washington 99352

RECEIVED
AUG 27 2018
EDMC

Approved for Public Release;
Further Dissemination Unlimited

ECF-200UP1-18-0017
Revision 0

Calculation of the 95th Percentile Upper Confidence Limit on Plume Monitoring Data for the 200-UP-1 Groundwater Operable Unit through Calendar Year 2017

Document Type: ENV Program/Project: EP&SP

J. P. McDonald
INTERA, Inc.

Date Published
August 2018

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
By Mary P. Curry at 3:10 pm, Aug 07, 2018

Release Approval Date

Approved for Public Release;
Further Dissemination Unlimited

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by tradename, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

ENVIRONMENTAL CALCULATION COVER PAGE

SECTION 1 - Completed by the Responsible Manager

Project: 200-UP-1	**RELEASE / ISSUE**
Date: 04/05/2018	DATE: Aug 07, 2018 HANFORD RELEASE
Calculation Title and Description: Calculation of the 95th Percentile Upper Confidence Limit on Plume Monitoring Data for the 200-UP-1 Groundwater Operable Unit through Calendar Year 2017	

Qualifications Summary

Preparer(s):

Name: John McDonald

Degree, Major, Institution, Year: BS, Geology, Eastern Washington University, 1993
AS, General Studies, Columbia Basin College, 1989
AAS, Computer Science, Columbia Basin College, 1985

Professional Licenses:

Brief Narrative of Experience: John McDonald brings experience in soil and groundwater remediation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA). He specializes in groundwater sampling, water-level monitoring, groundwater sample representativeness, hydraulic gradient determinations by trend-surface analyses, flow dynamics in high transmissivity aquifers, barometric corrections by multiple regression/deconvolution, analyses of automated water-level data, hydrologic testing data analysis, and statistical analyses. His experience includes implementation of remedial actions, conceptual model development, multimedia/risk assessment modeling, groundwater sample data interpretation, water level data interpretation, and reporting. He also has experience in taking hydraulic head measurements, operating continuous water-level recording equipment, generating potentiometric surface maps, conducting hydrologic tests, collecting water samples, and generating contaminant plume maps.

ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

Checker(s):

Name: Randy Dockter

Degree, Major, Institution, Year: Graduate Coursework, Physics/Computer Science, University of Nevada, 1980 - 1985
BS, Applied Physics, University of Nevada, 1977

Professional Licenses:

Brief Narrative of Experience: Randy Dockter's professional experience is focused in the areas of experimental testing; acquisition, processing and analysis of experimental data; applied physics modeling; software design and configuration management; embedded systems programming; systems administration; disaster recovery planning; and management and mentoring of technical staff. His experience includes programming on numerous types of computers and operating system platforms using a variety of programming languages. In addition to his programming experience, Randy participated in underground nuclear weapons testing experiments. He is author or co-author of a number of technical reports, manuals, and software documents.

Senior Reviewer(s):

Name: Greg Ruskauff

Degree, Major, Institution, Year: MS, Petroleum Engineering, New Mexico Institute of Mining and Technology, 1985
BS, Petroleum Engineering, New Mexico Institute of Mining and Technology, 1983

Professional Licenses:

Brief Narrative of Experience: Greg Ruskauff's professional experience has focused on the areas of performance assessment of both near-surface and geological radioactive waste repositories, regulatory development, dose assessment for residual contamination of soils and buildings, toxic materials risk assessment, and mixed waste issues. His experience includes performing, planning, and managing site investigations and groundwater modeling on various types of projects. He brings expertise in coordinating teams of technical experts to perform activities necessary for the development of integrated interpretations of complex groundwater systems in order to meet or exceed regulatory-driven requirements. He led the analysis and modeling team for a large federal environmental restoration site, whose primary task was to characterize the complex subsurface environment and evaluate groundwater contamination from historical underground nuclear testing. Under Greg's leadership the activity passed, for the first time, a public peer review required by the regulatory agency advancing the first corrective action unit out of characterization and toward closure. The organizational approach was judged to be so successful that the preparation for the next peer review followed the same pattern. Greg's career has been marked by numerous promotions on important federal projects due to his reliable technical and regulatory leadership skills.

SECTION 2 - Completed by Preparer

Calculation Number: ECF-200UP1-18-0017	Revision Number: 0

ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

Revision History

Revision No.	Description	Date	Affected Pages
0	Initial issue		All

SECTION 3 - Completed by the Responsible Manager

Document Control:

Is the document intended to be controlled within the Document Management Control System (DMCS)? ◉ Yes ○ No

Does document contain scientific and technical information intended for public use? ◉ Yes ○ No

Does document contain controlled-use information? ○ Yes ◉ No

SECTION 4 - Document Review and Approval

Preparer(s):

Print First and Last Name	Position	Signature	Date
John McDonald	Hydrogeologist		7/17/2018

Checker(s):

Print First and Last Name	Position	Signature	Date
Randy Dockter	Prog Computer Engineer	Randy Dockter	7/30/2018

Senior Reviewer(s):

Print First and Last Name	Position	Signature	Date
Greg Ruskauff	Principal Hydrogeol.		7/30/18

Responsible Manager(s):

Print First and Last Name	Position	Signature	Date
Alaa Aly WE NICHOLS, ACTING	Risk & Model Integr Mgr		1 AUG 2018

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

Prior to Initiating Modeling:

Required training for modelers completed:
Integration Lead:

Print First and Last Name	Signature	Date
William Nichols NOT APPLICABLE		

Safety Software Approved:
Integration Lead:

Print First and Last Name	Signature	Date
William Nichols NOT APPLICABLE		

Calculation Approved:
Risk/Modeling Integration Manager:

Print First and Last Name	Signature	Date
Alaa Aly WE NICHOLS, ACTING		1 AUG 2018

Contents

1 Purpose **5**

2 Background **5**

3 Methodology **6**

4 Assumptions and Inputs **8**

5 Software Applications **11**

5.1 Exempt Software 11

5.2 Approved Software 11

6 Calculation **12**

7 Results/Conclusions **12**

8 References **17**

Figures

Figure 1. Technetium-99 UCL_{95} for WMA S-SX 14

Figure 2. Nitrate UCL_{95} for WMA S-SX 15

Figure 3. Chromium UCL_{95} for WMA S-SX 15

Figure 4. Uranium UCL_{95} for U Plant 16

Figure 5. Regional Nitrate UCL_{95} for 200-UP-1 16

Figure 6. Regional Tritium UCL_{95} for 200-UP-1 17

Tables

Table 1. Well Networks for the 200-UP-1 UCL_{95} Calculations 8

Table 2. Results of the 200-UP-1 UCL_{95} Calculations 12

Terms

CY	calendar year
ECF	environmental calculation file
EDA	Environmental Dashboard Application
HEIS	Hanford Environmental Information System
MNA	monitored natural attenuation
OU	operable unit
UCL_{95}	95 percent upper confidence limit
WMA	waste management area

1 Purpose

This environmental calculation file (ECF) documents the methodology and calculations for generating the upper one-sided 95 percent confidence limit (UCL_{95}) on mean concentrations of contaminants for operational cleanup remedies in the 200-UP-1 groundwater operable unit (OU). The UCL_{95} is a plume-wide statistic used to track remediation progress, DOE/RL-2015-14, *Performance Monitoring Plan for the 200-UP-1 Groundwater Operable Unit Remedial Action*. The calculations in this ECF support annual reporting for Calendar Year (CY) 2017.

2 Background

The following active, groundwater-restoration remedies were operating in 200-UP-1 during CY 2017:

1. Groundwater extraction at Waste Management Area (WMA) S-SX primarily for technetium-99, but chromium and nitrate are also recovered
2. Groundwater extraction in the U Plant area downgradient from the 216-U-1 and 216-U-2 Cribs for uranium, technetium-99, and nitrate

The following passive, groundwater-restoration remedies were operating in 200-UP-1 during CY 2017:

1. Monitored natural attenuation (MNA) for the regional tritium plume
2. MNA for the regional nitrate plume

The extraction wells at WMA S-SX and U Plant also remove carbon tetrachloride from the aquifer, but remediation of this plume is being implemented as part of remedial actions for the 200-ZP-1 OU. Thus, plume monitoring and evaluations of remediation progress for carbon tetrachloride are overseen as part of 200-ZP-1 OU activities.

Use of the UCL_{95} statistic is recommended for calculating groundwater plume exposure point concentrations in superfund risk assessment guidance (OSWER 9285.6-10, *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*), and it is calculated using sample results at monitoring wells. The advantage of the UCL_{95} is that it provides a comprehensive evaluation of plume concentrations in a single metric. It is used in 200-UP-1 to track remediation progress by evaluating the trend of the UCL_{95} values over time and by comparing the UCL_{95} values from monitoring data to values calculated from fate and transport modeling results.

Previous calculations of UCL_{95} values from monitoring data for the 200-UP-1 OU are documented in ECF-200UP1-16-0073, *Calculated Timeframes for Attainment of Cleanup Levels in the 200-UP-1 Operable Unit for Remedial Action based on 95th Percent Upper Confidence Limit Calculation for Groundwater Monitoring Data and Updated Simulated Future Groundwater Fate and Transport*. UCL_{95} values were calculated for the following constituents/areas in ECF-200UP1-16-0073:

1. Technetium-99 and nitrate for the groundwater extraction system at WMA S-SX
2. Uranium, technetium-99, and nitrate for the groundwater extraction system near U Plant
3. Tritium and nitrate for the regional MNA remedy

The calculations in ECF-200UP1-16-0073 used a minimum of 20 sample results per constituent to ensure a meaningful sample size when calculating the UCL_{95}. When less than 20 results were available for a given year, data from up to the previous 2 years were included, as needed (in accordance with DOE/RL-2015-14). The calculations used a result for each sample event during a given year. For instance, four

results would have been used for wells sampled quarterly, whereas a single result would have been used for wells sampled annually. UCL_{95} well networks are specified in DOE/RL-2015-14.

During 2017, the fate and transport modeling of the 200-UP-1 plume remedies was updated and UCL_{95} values were calculated from the modeling results for 2012 to the end of the 125-year cleanup timeframe for Central Plateau groundwater (year 2137), or a shorter timeframe as dictated by the model results. These calculations are documented in ECF-200UP1-17-0093, *Fate and Transport Analysis for U Plant Groundwater Plumes in the 200-UP-1 Operable Unit*, for uranium and technetium-99 at U Plant; ECF-200UP1-17-0094, *Fate and Transport Analysis for WMA S-SX Groundwater Plumes in the 200-UP-1 Operable Unit*, for technetium-99, chromium, and nitrate at WMA S-SX; and ECF-200ZP1-17-0095, *Fate and Transport Analysis for the Groundwater Plume Remedies in the 200-ZP-1 and 200-UP-1 Operable Units Using the Central Plateau Groundwater Model*, for the regional tritium and nitrate plumes. The calculations for any given year used results for that year and the previous 2 years (only 1 year was used for the 2012 calculations because the start date for the modeling was 1/1/2012; similarly, 2 years of model results were used for 2013).

The 200-UP-1 performance monitoring plan, DOE/RL-2015-14, is undergoing revision and two changes are being made to the methodology for calculating UCL_{95} values. First, the calculations will use only a single sample result for each well within a single year (the last sample in the year will be chosen), rather than use results for all sample events within the year. This will prevent the UCL_{95} values from being biased toward those wells that are sampled more frequently, thus providing for a more uniform spatial representation of mean plume concentrations. Second, to keep the statistical sample sizes relatively large, UCL_{95} values will be calculated using 3 years of sample results for each constituent (note that for the first year, only 1 year of data will be used; similarly, 2 years will be used for the second year). These changes will result in more compatibility with the UCL_{95} values calculated from the fate and transport modeling, which also used 3 years of results in each calculation and only a single result per well per year.

The new methodology is implemented in this ECF, and the UCL_{95} values for 2008 through 2015 presented in ECF-200UP1-16-0073 were recalculated. Other differences between the calculations in this ECF and ECF-200UP1-16-0073 are:

1. A UCL_{95} value for technetium-99 at the U Plant area was not calculated (and will no longer be required in the revision to DOE/RL-2015-14). With only three wells in the UCL_{95} network, this plume is small enough that it is more meaningful to monitor concentrations well-by-well.
2. The UCL_{95} values for the regional nitrate plume now include the wells at U Plant. Nitrate at U Plant is part of the regional nitrate plume and was simulated using the full Central Plateau groundwater model (rather than the local-scale model for U Plant), and the UCL_{95} values calculated from the modeling results included the U Plant area as part of the larger regional plume (ECF-200ZP1-17-0095).
3. UCL_{95} values for chromium at WMA S-SX were calculated as specified in DOE/RL-2015-14.

The remainder of this ECF presents the calculation methodology (Section 3), assumptions and inputs (Section 4), software used (Section 5), calculations (Section 6), and calculation results (Section 7).

3 Methodology

The one-sided UCL_{95} was calculated using Student's *t* distribution assuming normality (OSWER 9285.6-10):

$$UCL_{95} = \bar{X} + t_{\alpha,n-1}\frac{s}{\sqrt{n}} \tag{1}$$

where

$\bar{X}$ = arithmetic mean of the sample results

$t_{\alpha,n-1}$ = the 1-α^{th} quantile of Student's t distribution with n-1 degrees of freedom; for the 95th percentile, $\alpha = 0.95$ (one-tailed)

s = standard deviation of the sample results

n = number of samples.

The calculations were performed using the following procedure:

1. Identify the well networks for each constituent. These are specified in DOE/RL-2015-14. Include any additional wells within the plume for which concentrations have increased to above a cleanup level.
2. Obtain sample results for the monitoring wells from the Hanford Environmental Information System (HEIS) database using the Environmental Dashboard Application (EDA) (https://ehs.hanford.gov/eda/) for the period from 1/1/2008 through 12/31/2017. For chromium, obtain sample results for total chromium and hexavalent chromium.
3. To avoid issues of total chromium analyses being affected by turbidity, remove all unfiltered, total chromium results.
4. Remove all sample results flagged as suspect (REVIEW_QUALIFIER = 'Y') or reject (REVIEW_QUALIFIER = 'R').
5. Remove all characterization sample results (COLLECTION_PURPOSE = 'C'). These denote non-standard samples, such as those collected during well drilling for characterization purposes.
6. Remove all nondetect results (LAB_QUALIFIER = 'U').
7. Remove all results less than 1/10th the cleanup level. In accordance with DOE/RL-2015-14, when concentrations in a well decline to below 1/10th the cleanup level, it is removed from the UCL_{95} calculation. The 200-UP-1 cleanup levels are 900 pCi/L for technetium-99, 45 mg/L for nitrate, 48 µg/L for hexavalent chromium, 30 µg/L for uranium, and 20,000 pCi/L for tritium.
8. For any given sample event, retain only the maximum of duplicate sample results. For chromium, select the maximum of the filtered total chromium, filtered hexavalent chromium, and unfiltered hexavalent chromium results if two or more of these results are available for a given sample event.
9. For wells with multiple sample events within a given year, retain only the last sample result.
10. Calculate a UCL_{95} value for each year using Equation 1 for the following:
    a. Technetium-99 at WMA S-SX
    b. Chromium at WMA S-SX
    c. Nitrate at WMA S-SX
    d. Uranium at U Plant
    e. Tritium, regional plume
    f. Nitrate, regional plume

Use a single year of data for 2008, two years of data for 2009, and three years for 2010 and 2011. For 2012, use only a single year of data for compatibility with the UCL_{95} values calculated for the fate and transport modeling. Use two years of data for 2013 and three years of data thereafter.

4 Assumptions and Inputs

Input data to the UCL_{95} calculations consisted of the well networks specified in DOE/RL-2015-14 (Step 1 in Section 3) and sample results obtained from HEIS using EDA (Step 2 in Section 3). The well networks are listed in Table 1. Sample results obtained from EDA are in the spreadsheet used for these calculations which is archived as part of this ECF.

There were two main assumptions associated with these calculations. First, it was assumed that sample results for filtered total chromium are fully compatible with results for filtered and unfiltered hexavalent chromium in that all of these represent the dissolved (and therefore mobile) chromium concentration in the aquifer. This is consistent with plume mapping conventions used for Hanford Site annual groundwater monitoring reports. As stated in DOE/RL-2016-67, *Hanford Site Groundwater Monitoring Report for 2016*, "Dissolved chromium in Hanford Site groundwater is nearly all hexavalent (Chapter 7 of WHC-SD-EN-TI-302, *Speciation and Transport Characteristics of Chromium in the 100D/H Areas of the Hanford Site*; Appendix C of DOE/RL-2008-01, *Hanford Site Groundwater Monitoring for Fiscal Year 2007*), so filtered total chromium data effectively represent [hexavalent chromium] concentrations."

Second, the sample results used to calculate a UCL_{95} value were assumed to be normally distributed, an assumption necessary for Student's *t* distribution (Equation 1). Normality was not tested, but there is no real consequence if this assumption is violated. The UCL_{95} statistic is only being used to track cleanup progress and to compare with modeling results. It will not be used for risk assessment purposes.

Table 1. Well Networks for the 200-UP-1 UCL_{95} Calculations

Well Name	Constituent	Area	Comment
299-W22-44	Technetium-99	WMA S-SX	Dry, replaced by 299-W22-93
299-W22-45	Technetium-99	WMA S-SX	Dry, replaced by 299-W22-115
299-W22-49	Technetium-99	WMA S-SX	Dry, replaced by 299-W22-113
299-W22-50	Technetium-99	WMA S-SX	Dry, replaced by 299-W22-116
299-W22-82	Technetium-99	WMA S-SX	
299-W22-83	Technetium-99	WMA S-SX	
299-W22-86	Technetium-99	WMA S-SX	
299-W22-93	Technetium-99	WMA S-SX	Replacement for 299-W22-44
299-W22-96	Technetium-99	WMA S-SX	
299-W22-113	Technetium-99	WMA S-SX	Replacement for 299-W22-49
299-W22-115	Technetium-99	WMA S-SX	Replacement for 299-W22-45
299-W22-116	Technetium-99	WMA S-SX	Replacement for 299-W22-50
299-W23-19	Technetium-99	WMA S-SX	
299-W22-44	Nitrate	WMA S-SX	Dry, replaced by 299-W22-93

Table 1. Well Networks for the 200-UP-1 UCL_{95} Calculations

Well Name	Constituent	Area	Comment
299-W22-45	Nitrate	WMA S-SX	Dry, replaced by 299-W22-115
299-W22-49	Nitrate	WMA S-SX	Dry, replaced by 299-W22-113
299-W22-50	Nitrate	WMA S-SX	Dry, replaced by 299-W22-116
299-W22-83	Nitrate	WMA S-SX	
299-W22-86	Nitrate	WMA S-SX	
299-W22-93	Nitrate	WMA S-SX	Replacement for 299-W22-44
299-W22-95	Nitrate	WMA S-SX	Replacement for 299-W22-26
299-W22-113	Nitrate	WMA S-SX	Replacement for 299-W22-49
299-W22-115	Nitrate	WMA S-SX	Replacement for 299-W22-45
299-W22-116	Nitrate	WMA S-SX	Replacement for 299-W22-50
299-W23-19	Nitrate	WMA S-SX	
299-W23-21	Nitrate	WMA S-SX	
299-W22-44	Chromium	WMA S-SX	Dry, replaced by 299-W22-93
299-W22-47	Chromium	WMA S-SX	
299-W22-49	Chromium	WMA S-SX	Dry, replaced by 299-W22-113
299-W22-50	Chromium	WMA S-SX	Dry, replaced by 299-W22-116
299-W22-82	Chromium	WMA S-SX	
299-W22-83	Chromium	WMA S-SX	
299-W22-86	Chromium	WMA S-SX	
299-W22-93	Chromium	WMA S-SX	Replacement for 299-W22-44
299-W22-95	Chromium	WMA S-SX	Replacement for 299-W22-26
299-W22-113	Chromium	WMA S-SX	Replacement for 299-W22-49
299-W22-116	Chromium	WMA S-SX	Replacement for 299-W22-50
299-W23-19	Chromium	WMA S-SX	
299-W19-18	Uranium	U Plant	Dry, replaced by 299-W19-115
299-W19-36	Uranium	U Plant	
299-W19-39	Uranium	U Plant	
299-W19-43	Uranium	U Plant	
299-W19-46	Uranium	U Plant	
299-W19-48	Uranium	U Plant	
299-W19-49	Uranium	U Plant	
299-W19-101	Uranium	U Plant	

Table 1. Well Networks for the 200-UP-1 UCL_{95} Calculations

Well Name	Constituent	Area	Comment
299-W19-105	Uranium	U Plant	
299-W19-115	Uranium	U Plant	Replacement for 299-W19-18
299-W15-37	Nitrate	Regional	
299-W18-15	Nitrate	Regional	
299-W18-21	Nitrate	Regional	
299-W18-40	Nitrate	Regional	
299-W19-4	Nitrate	Regional	
299-W19-18	Nitrate	Regional	Dry, replaced by 299-W19-115
299-W19-39	Nitrate	Regional	
299-W19-43	Nitrate	Regional	
299-W19-44	Nitrate	Regional	
299-W19-45	Nitrate	Regional	
299-W19-47	Nitrate	Regional	
299-W19-48	Nitrate	Regional	
299-W19-101	Nitrate	Regional	
299-W19-107	Nitrate	Regional	
299-W19-115	Nitrate	Regional	Replacement for 299-W19-18
299-W19-116	Nitrate	Regional	Replacement for 699-38-70
699-36-66B	Nitrate	Regional	
699-36-70B	Nitrate	Regional	
699-37-66	Nitrate	Regional	
699-38-65	Nitrate	Regional	
699-38-68A	Nitrate	Regional	
699-38-70B	Nitrate	Regional	
699-38-70C	Nitrate	Regional	
699-40-62	Nitrate	Regional	
699-40-65	Nitrate	Regional	
299-W21-3	Tritium	Regional	Replacement for 699-35-70
299-W22-45	Tritium	Regional	Dry, replaced by 299-W22-115
299-W22-49	Tritium	Regional	Dry, replaced by 299-W22-113
299-W22-72	Tritium	Regional	
299-W22-96	Tritium	Regional	

Table 1. Well Networks for the 200-UP-1 UCL_{95} Calculations

Well Name	Constituent	Area	Comment
299-W22-113	Tritium	Regional	Replacement for 299-W22-49
299-W22-114	Tritium	Regional	Replacement for 299-W22-9
299-W22-115	Tritium	Regional	Replacement for 299-W22-45
299-W23-4	Tritium	Regional	
299-W23-19	Tritium	Regional	
299-W23-21	Tritium	Regional	
699-31-68	Tritium	Regional	
699-32-72A	Tritium	Regional	
699-34-72	Tritium	Regional	
699-35-66A	Tritium	Regional	
699-35-70	Tritium	Regional	Dry, replaced by 299-W21-3
699-36-61A	Tritium	Regional	
699-36-63B	Tritium	Regional	
699-36-66B	Tritium	Regional	
699-36-70A	Tritium	Regional	
699-37-66	Tritium	Regional	
699-38-61	Tritium	Regional	
699-38-65	Tritium	Regional	

5 Software Applications

All software used for this calculation was used in accordance with PRC-PRO-IRM-309, *Controlled Software Management*.

5.1 Exempt Software

Microsoft Excel®[1] is site-licensed software used as "flat file" spreadsheets that are wholly incorporated into this calculation and verified during the technical review of this report and is therefore rated as exempt software (PRC-PRO-IRM-309, Section 1.3, Exemptions). Spreadsheets were used to tabulate the groundwater data obtained from HEIS and calculate the UCL_{95} statistic using the methodology described in Section 3.

5.2 Approved Software

No utility calculation software, as defined in PRC-PRO-IRM-309, were used in these calculations

[1] Microsoft Excel is a registered product of the Microsoft Corporation in the United States and in other countries.

6 Calculation

Calculations of the UCL_{95} values were performed in a spreadsheet which is archived as part of this ECF. The spreadsheet also contains the sample results obtained from HEIS using EDA. The results of the calculations are provided in Section 7.

7 Results/Conclusions

Results of the UCL_{95} calculations are provided in Table 2, and charts of the results are provided in Figures 1 through 6.

Table 2. Results of the 200-UP-1 UCL_{95} Calculations

Area	Constituent	Year	Result
WMA S-SX	Technetium-99 (pCi/L)	2008	21771.40
WMA S-SX	Technetium-99 (pCi/L)	2009	21964.43
WMA S-SX	Technetium-99 (pCi/L)	2010	19968.00
WMA S-SX	Technetium-99 (pCi/L)	2011	19767.54
WMA S-SX	Technetium-99 (pCi/L)	2012	21300.51
WMA S-SX	Technetium-99 (pCi/L)	2013	15060.05
WMA S-SX	Technetium-99 (pCi/L)	2014	12295.55
WMA S-SX	Technetium-99 (pCi/L)	2015	8187.64
WMA S-SX	Technetium-99 (pCi/L)	2016	6690.25
WMA S-SX	Technetium-99 (pCi/L)	2017	5974.05
WMA S-SX	Nitrate (mg/L)	2008	189.95
WMA S-SX	Nitrate (mg/L)	2009	199.64
WMA S-SX	Nitrate (mg/L)	2010	188.44
WMA S-SX	Nitrate (mg/L)	2011	192.67
WMA S-SX	Nitrate (mg/L)	2012	208.47
WMA S-SX	Nitrate (mg/L)	2013	156.38
WMA S-SX	Nitrate (mg/L)	2014	130.47
WMA S-SX	Nitrate (mg/L)	2015	94.84
WMA S-SX	Nitrate (mg/L)	2016	78.80
WMA S-SX	Nitrate (mg/L)	2017	73.29
WMA S-SX	Chromium (µg/L)	2008	420.15
WMA S-SX	Chromium (µg/L)	2009	409.60
WMA S-SX	Chromium (µg/L)	2010	404.77

Table 2. Results of the 200-UP-1 UCL_{95} Calculations

Area	Constituent	Year	Result
WMA S-SX	Chromium (µg/L)	2011	419.00
WMA S-SX	Chromium (µg/L)	2012	545.55
WMA S-SX	Chromium (µg/L)	2013	381.39
WMA S-SX	Chromium (µg/L)	2014	288.42
WMA S-SX	Chromium (µg/L)	2015	179.38
WMA S-SX	Chromium (µg/L)	2016	130.38
WMA S-SX	Chromium (µg/L)	2017	107.84
U Plant	Uranium (µg/L)	2008	263.45
U Plant	Uranium (µg/L)	2009	234.17
U Plant	Uranium (µg/L)	2010	223.10
U Plant	Uranium (µg/L)	2011	220.02
U Plant	Uranium (µg/L)	2012	191.93
U Plant	Uranium (µg/L)	2013	182.69
U Plant	Uranium (µg/L)	2014	214.96
U Plant	Uranium (µg/L)	2015	317.45
U Plant	Uranium (µg/L)	2016	464.12
U Plant	Uranium (µg/L)	2017	844.25
Regional	Nitrate (mg/L)	2008	216.51
Regional	Nitrate (mg/L)	2009	174.29
Regional	Nitrate (mg/L)	2010	179.06
Regional	Nitrate (mg/L)	2011	160.14
Regional	Nitrate (mg/L)	2012	544.10
Regional	Nitrate (mg/L)	2013	451.23
Regional	Nitrate (mg/L)	2014	367.80
Regional	Nitrate (mg/L)	2015	352.96
Regional	Nitrate (mg/L)	2016	267.92
Regional	Nitrate (mg/L)	2017	226.34
Regional	Tritium (pCi/L)	2008	101127.18
Regional	Tritium (pCi/L)	2009	75501.23
Regional	Tritium (pCi/L)	2010	64676.72
Regional	Tritium (pCi/L)	2011	55060.04
Regional	Tritium (pCi/L)	2012	111057.10

Table 2. Results of the 200-UP-1 UCL_{95} Calculations

Area	Constituent	Year	Result
Regional	Tritium (pCi/L)	2013	95052.76
Regional	Tritium (pCi/L)	2014	87012.70
Regional	Tritium (pCi/L)	2015	78603.51
Regional	Tritium (pCi/L)	2016	70632.64
Regional	Tritium (pCi/L)	2017	62601.54

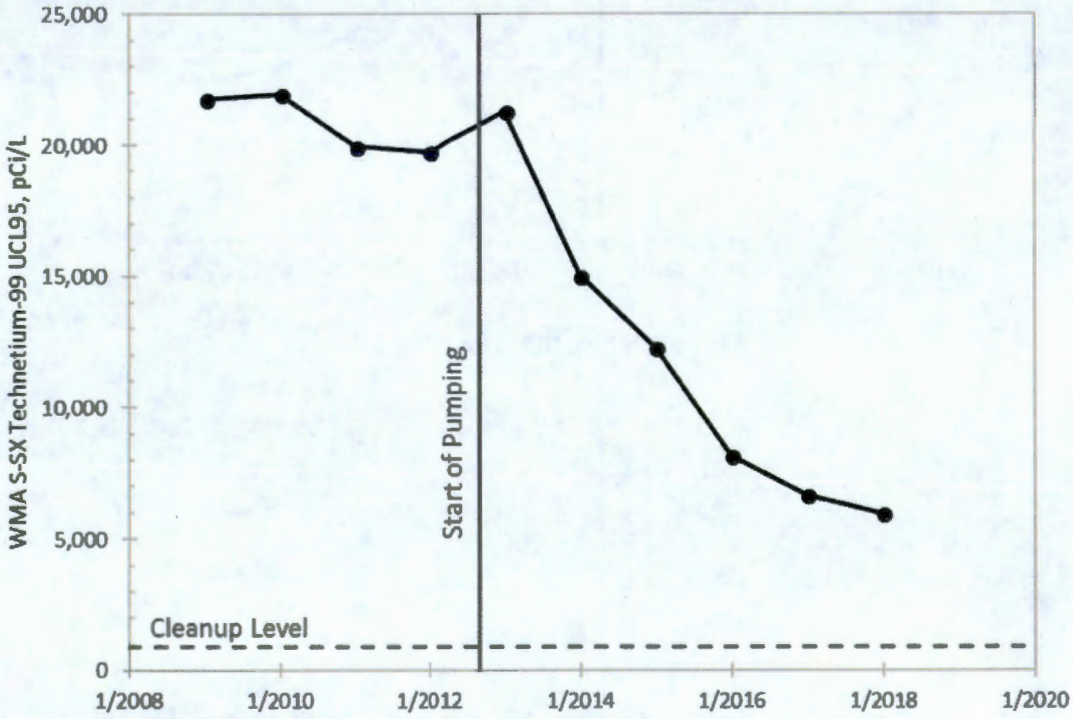

Figure 1. Technetium-99 UCL_{95} for WMA S-SX

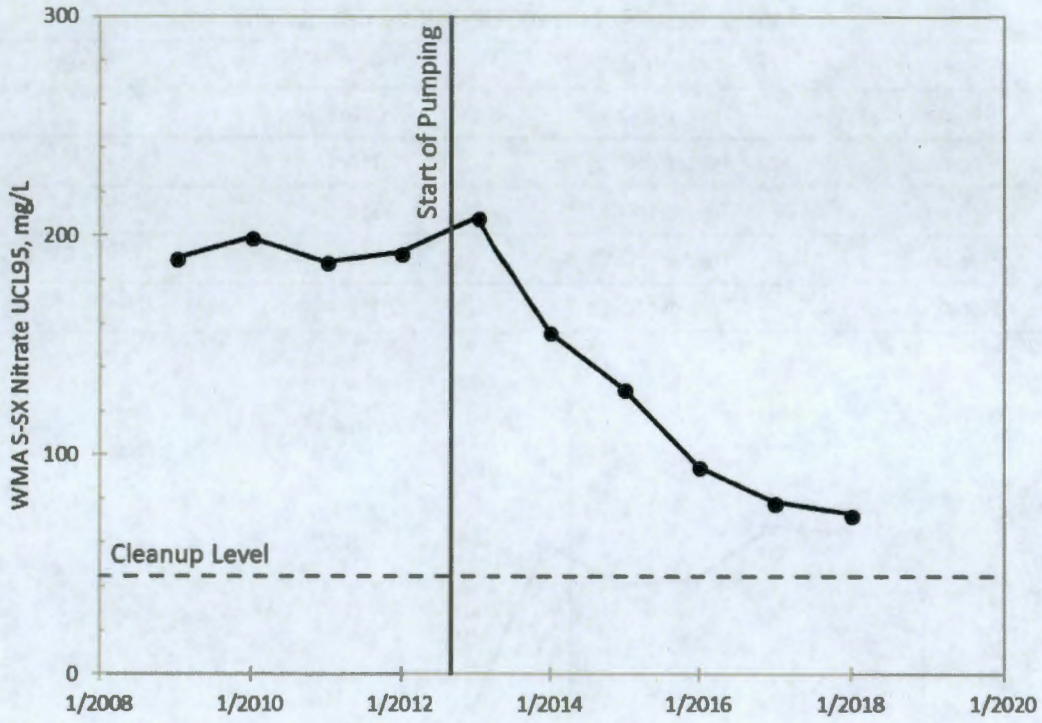

Figure 2. Nitrate UCL_{95} for WMA S-SX

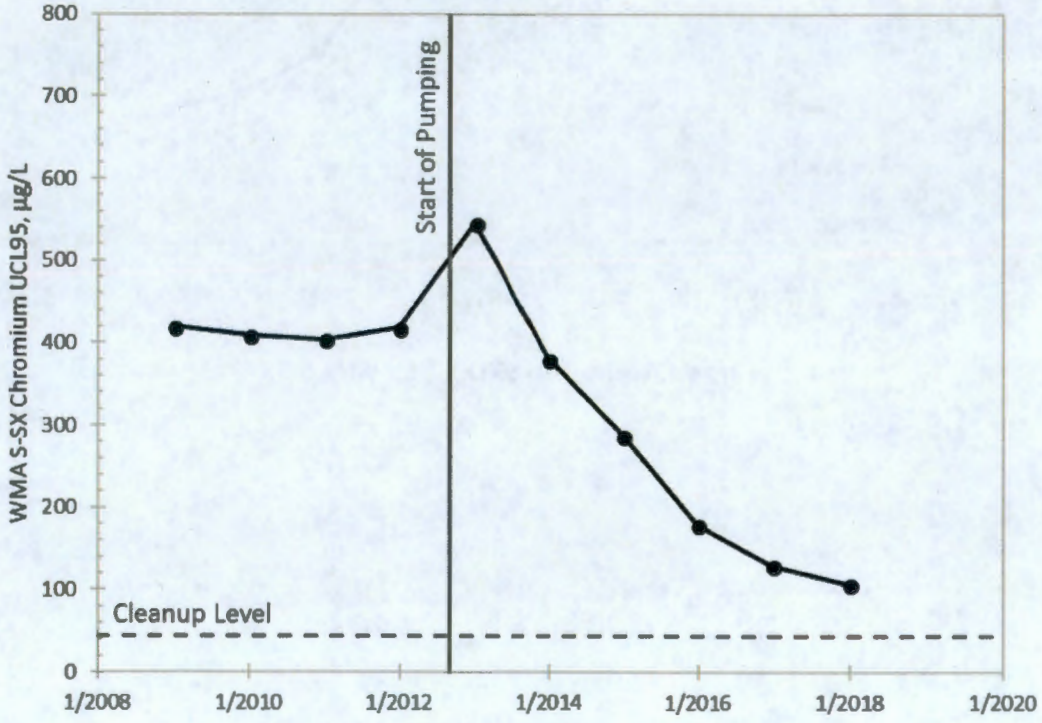

Figure 3. Chromium UCL_{95} for WMA S-SX

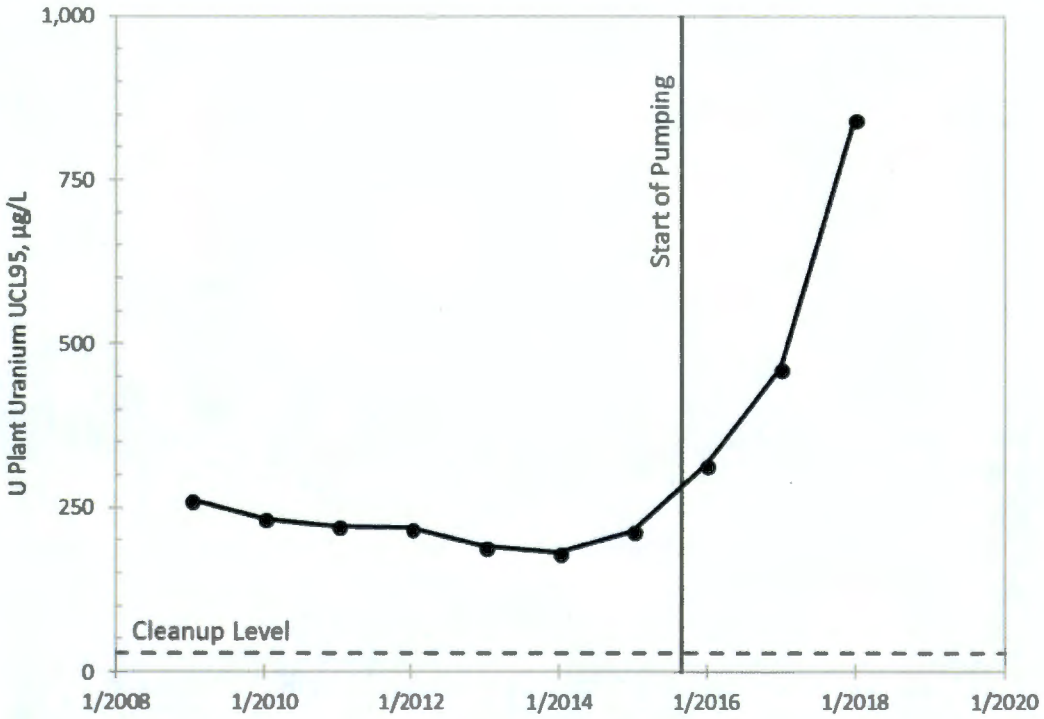

Figure 4. Uranium UCL_{95} for U Plant

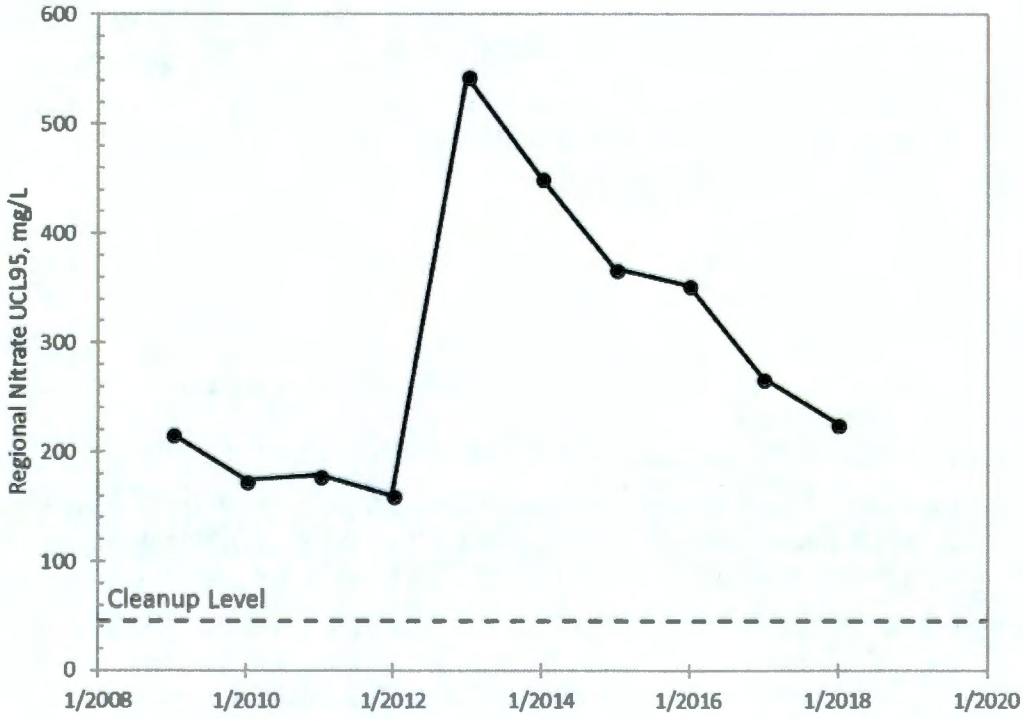

Figure 5. Regional Nitrate UCL_{95} for 200-UP-1

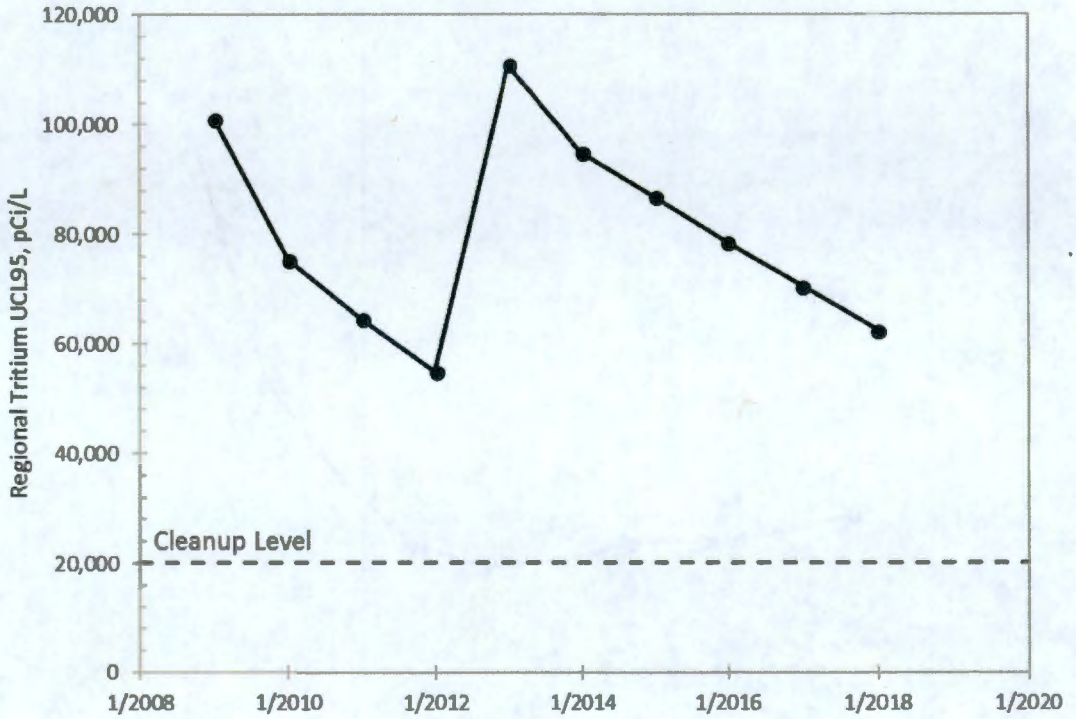

Figure 6. Regional Tritium UCL_{95} for 200-UP-1

8 References

DOE/RL-2008-01, 2008, *Hanford Site Groundwater Monitoring for Fiscal Year 2007*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=00098824.

DOE/RL-2013-07, 2013, *200-UP-1 Groundwater Operable Unit Remedial Design/Remedial Action Work Plan*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087671.

DOE/RL-2015-14, 2015, *Performance Monitoring Plan for the 200-UP-1 Groundwater Operable Unit Remedial Action*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080202H.

DOE/RL-2016-67, 2017, *Hanford Site Groundwater Monitoring Report for 2016*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://higrv.hanford.gov/Hanford_Reports_2016/Hanford_GW_Report/.

ECF-200UP1-16-0073, 2016, *Calculated Timeframes for Attainment of Cleanup Levels in the 200-UP-1 Operable Unit for Remedial Action based on 95th Percent Upper Confidence Limit Calculation for Groundwater Monitoring Data and Updated Simulated Future Groundwater Fate and Transport*, CH2M Hill Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0065732H.

ECF-200UP1-17-0093, 2017, *Fate and Transport Analysis for U Plant Groundwater Plumes in the 200-UP-1 Operable Unit*, CH2M Hill Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0066441H.

ECF-200UP1-17-0094, 2017, *Fate and Transport Analysis for WMA S-SX Groundwater Plumes in the 200-UP-1 Operable Unit*, CH2M Hill Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0066440H.

ECF-200ZP1-17-0095, 2017, *Fate and Transport Analysis for the Groundwater Plume Remedies in the 200-ZP-1 and 200-UP-1 Operable Units Using the Central Plateau Groundwater Model*, CH2M Hill Plateau Remediation Company, Richland, Washington.

OSWER 9285.6-10, 2002, *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

WHC-SD-EN-TI-302, 1995, *Speciation and Transport Characteristics of Chromium in the 100D/H Areas of the Hanford Site*, Westinghouse Hanford Company, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=1201050287.