

# 300-FF-5 OPERABLE UNIT REMEDIAL ACTION PERFORMANCE EVALUATION FOR 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**

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April 2019

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**CH2MHILL**  
Plateau Remediation Company  
P.O. Box 1600  
Richland, Washington 99352

**APPROVED**  
*By Janis D. Aardal at 3:53 pm, Apr 29, 2019*

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Release Approval

Date

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## Terms

<i>cis</i> -1,2-DCE	<i>cis</i> -1,2-dichloroethene
COC	contaminant of concern
CSM	conceptual site model
CUL	cleanup level
EA	enhanced attenuation
EPA	U.S. Environmental Protection Agency
LCL	lower confidence limit
MNA	monitored natural attenuation
OU	operable unit
ROD	record of decision
SAP	sampling and analysis plan
TCE	trichloroethene
UCL	upper confidence limit

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## 1 Introduction

Groundwater in the 300-FF-5 Operable Unit (OU) at the Hanford Site was contaminated by releases from waste sites associated with past operations of the 300 Area fuel fabrication facilities. The 300 Area record of decision (ROD) was issued in 2013 (EPA and DOE, 2013, *Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1*) and includes remedies for groundwater associated with the 300 Area Industrial Complex, the 618-10 Burial Ground and adjacent 316-4 Crib, and the 618-11 Burial Ground (Figure 1). The ROD specifies enhanced attenuation (EA), monitored natural attenuation (MNA), groundwater monitoring, and institutional controls to restrict groundwater use as the remedial actions for the 300-FF-5 OU. The contaminants of concern (COCs) in the groundwater are uranium, trichloroethene (TCE), *cis*-1,2-dichloroethene (*cis*-1,2-DCE), gross alpha, nitrate, and tritium.

Performance monitoring of these COCs is a component of the EA and MNA remedies and is implemented in accordance with DOE/RL-2014-42, *300-FF-5 Operable Unit Remedy Implementation Sampling and Analysis Plan* (SAP). The SAP specifies sampling frequencies for monitoring a network of groundwater wells for each COC. Performance monitoring will continue until COCs have attained, and are expected to continue to meet, the cleanup levels (CULs) specified in the ROD (EPA and DOE, 2013), and the U.S. Environmental Protection Agency (EPA) approves termination of the monitoring (Section 3.5.1.1 of the SAP).

Appendix B of the SAP (DOE/RL-2014-42) describes the methods to be used for evaluating remedy performance. These methods are plume mapping, water-level mapping and refining the conceptual site model (CSM), groundwater modeling, statistical analysis, and enhanced attenuation treatment performance (Appendix B, Chapter B2 of the SAP). The ROD (EPA and DOE, 2013) requires a statutory review of the selected remedies every 5 years. Annual evaluation of the remedies using the methods outlined in Appendix B of the SAP is not required by the ROD. However, statistical analysis is performed annually in accordance with Section B2.4 of the SAP to evaluate the remedy performance from year to year. The purpose of this performance evaluation is to provide the context in which to interpret the results of the statistical tests for 2017 in the absence of evaluation using the other methods outlined in Appendix B of the SAP.

## 2 Performance Monitoring Approach

As discussed in OSWER 9355.0-129, *Guidance for Evaluating Completion of Groundwater Restoration Remedial Actions*, performance monitoring consists of two phases: remediation monitoring and attainment monitoring. Remediation monitoring refers to the first phase of the remedy where remedial activities are being implemented to reach groundwater CULs. During this phase, groundwater sampling and monitoring data are collected to evaluate contaminant migration and changes in COC concentrations over time. Progress toward achieving the CULs is evaluated during the remediation phase on a well-by-well basis for each COC. Remediation monitoring for a specific monitoring well and COC pair is complete when the data evaluation demonstrates that the groundwater has reached the CUL for that COC at that well. For wells that are monitored for multiple COCs, conclusions may be made at any time during groundwater remediation to remove certain COCs from the monitoring program because the data indicate that they have met their CULs before other, more recalcitrant COCs monitored by the well (OSWER 9355.0-129; Section 3.5.1.1 of the SAP [DOE/RL-2014-42]).

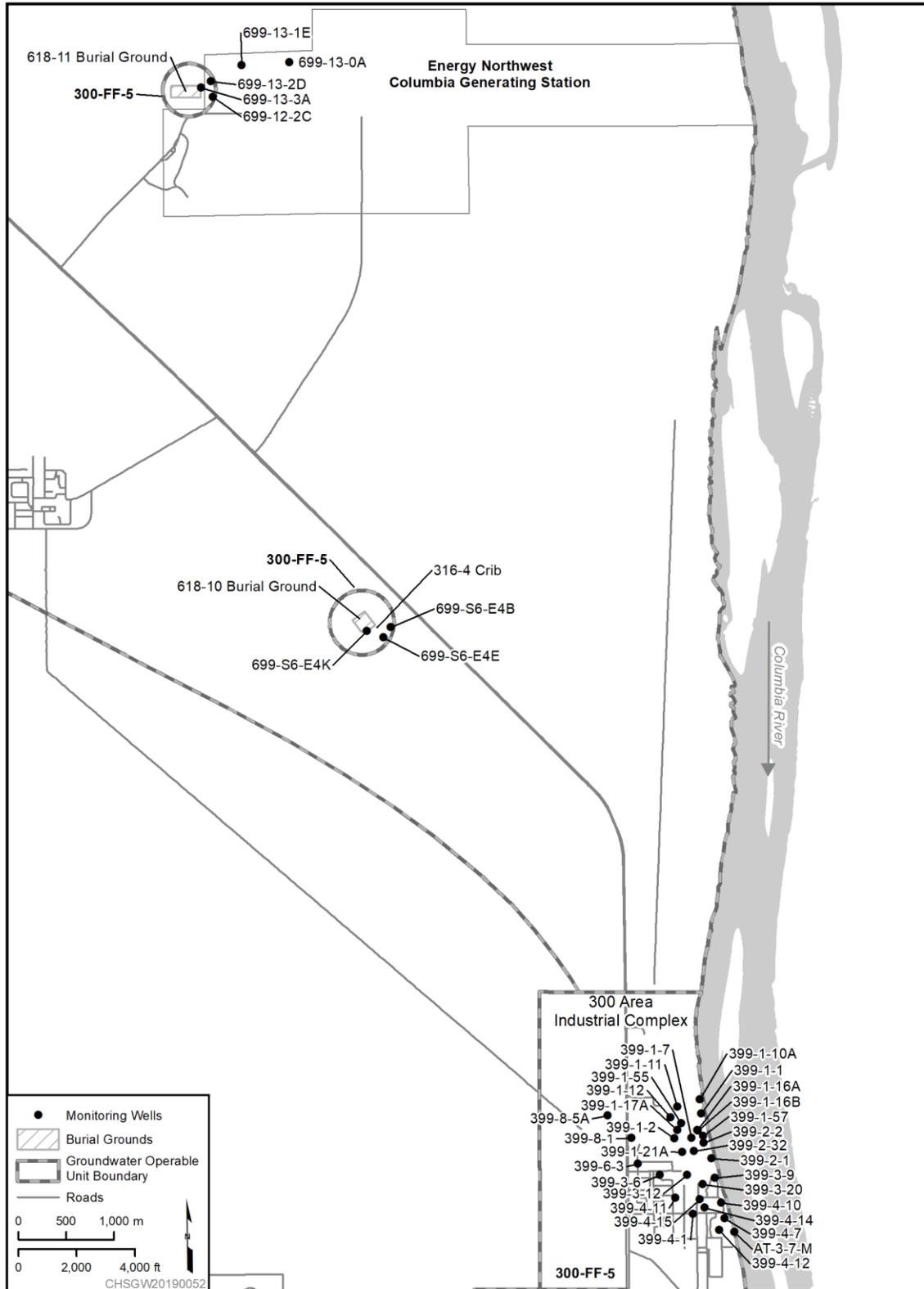


Figure 1. 2017 Monitoring Well Locations for the 300-FF-5 Operable Unit

The attainment monitoring phase occurs after the remediation monitoring phase is complete. Progress toward achieving attainment of the CULs is evaluated on a well-by-well basis for each COC. Once the groundwater concentration for a COC is observed to have reached the CUL at a well, data are collected and evaluated to confirm that attainment has been achieved. The attainment monitoring phase at a monitoring well is complete when the data support both of the following conclusions (Section 3.5.1.1 of the SAP [DOE/RL-2014-42]):

- The contaminant CUL for each COC has been met.
- Groundwater will continue to meet the contaminant CUL for each COC in the future (OSWER 9355.0-129).

## 2.1 Statistical Analysis

Appendix B of the SAP (DOE/RL-2014-42) outlines the key statistical tests, referred to as fundamental tests, to be used during the remediation monitoring and attainment monitoring phases. The fundamental tests are as follows:

- Trend test
- Mean test

A trend test evaluates the time-dependent sample concentration. The trend test requires calculation of the concentration slope and confidence limits around the slope. Appendix B of the SAP (DOE/RL-2014-42) identifies several methods that can be used to evaluate concentration trends. When trends are nonmonotonic or sample concentrations are influenced by factors other than the selected remedy, a parametric, multiple regression method may be applied by incorporating site-specific factors influencing the observed concentrations. At the 300 Area, groundwater levels and sample concentrations are influenced by changes in the river stage of the Columbia River. Therefore, a parametric, multiple regression method was applied as the trend test for the 300-FF-5 OU groundwater concentrations.

A mean test evaluates the yearly mean and variance of the contaminant concentration. The mean test requires calculation of the yearly mean contaminant concentration along with the upper confidence limit (UCL) and lower confidence limit (LCL) of the mean. When a trend is present, calculation of the mean needs to incorporate the underlying trend.

At a minimum, the statistical tests are performed for the 300-FF-5 OU groundwater well and COC pairs on an annual basis. Consistent with the recommendations of OSWER 9283.1-44, *Recommended Approach for Evaluating Completion of Groundwater Restoration Remedial Actions at a Groundwater Monitoring Well*, data obtained during the remediation monitoring phase are used to assess the status of the attainment of CULs. The attainment monitoring statistics are calculated simultaneously with the calculation of the remediation monitoring statistics because the statistics are calculated using the same, or similar, datasets. Calculation of the attainment statistics, in many cases, relies upon the results of the remediation monitoring statistical calculations (Appendix B, Section B2.4 of the SAP [DOE/RL-2014-42]).

As discussed in OSWER 9283.1-44, it may be appropriate to conclude that the remediation phase is complete at a monitoring well based on a nonstatistical or visual analysis of the data if the groundwater COC concentrations are all nondetect, or a combination of nondetect sampling results and all detected COC concentrations are below the CUL (Appendix B, Section B2.4 of the SAP [DOE/RL-2014-42]). The results presented herein are based only on statistical analysis of the sampled data. Nonstatistical or visual analysis should be included, when appropriate, during the 5-year review.

## 2.2 Remediation Monitoring

Both the trend and the mean tests should be used to evaluate EA and MNA progress toward, and potential attainment of, CULs during the remediation monitoring phase. If the trend and mean tests indicate that the well/COC pair has attained the CUL, then remediation monitoring is complete for this well/COC pair, and attainment monitoring can commence.

## 2.3 Attainment Monitoring

Similar to remediation monitoring, both the trend and mean tests are used for each COC and monitoring well pair to evaluate whether the CULs have been attained for the particular well/COC pair (Appendix B, Section B2.4.2 of the SAP [DOE/RL-2014-42]). Attainment monitoring for a specific well/COC pair is complete when both of these conditions are met:

- The UCL of the mean is at or below the CUL.
- The time-dependent trend is zero (not statistically significant) or has a statistically significant decreasing trend.

## 3 Performance Monitoring Results

The performance monitoring results presented in Appendix A of this performance evaluation (ECF-300FF5-18-0024, *Calculation of Concentration Trends, Means, and Confidence Limits for cis-1,2-Dichloroethene, Gross Alpha, Nitrate, Trichloroethene, Tritium, and Uranium in the 300-FF-5 Operable Unit through CY 2017*) are based on the application of statistical methods to sample datasets with varying numbers of sample results, numbers of nondetect results, historical periods for which data are available, and historical periods over which the statistical tests were applied. Estimates rely solely on calculated statistical trends (using the multiple regression method) and observed data and are not based on future projected plume migration patterns, groundwater modeling, or contaminant transport parameters (Chapter 4 in Appendix A). The results of the statistical tests conducted for the 300-FF-5 OU well/COC pairs are summarized in Tables 14 through 19 in Appendix A.

### 3.1 300 Area Industrial Complex

The 300 Area Industrial Complex is located along the Columbia River within the southeastern extent of the 300 Area. Monitoring wells located in this area are presented in Figure 1. Wells within the 300 Area Industrial Complex are monitored for TCE, *cis*-1,2-DCE, uranium, and gross alpha as part of performance monitoring for the 300-FF-5 OU.

Compliance and attainment monitoring for TCE was conducted only in well 399-4-14 in 2017 (Figure 2). The UCL of the mean TCE concentration in 2017 was 1.50 µg/L, which is below the CUL for TCE (4 µg/L), and there is no statistically significant trend (Table 17 in Appendix A).

Compliance and attainment monitoring for *cis*-1,2-DCE was performed in 2017 at two wells (399-1-16B and 399-1-57) screened in the lower portion of the unconfined aquifer (Figure 3). The UCLs of the mean *cis*-1,2-DCE concentrations in 2017 exceeded the CUL for *cis*-1,2-DCE (16 µg/L) in both wells (Table 14 in Appendix A). Well 399-1-57 had a statistically significant decreasing trend, and well 399-1-16B had a statistically significant increasing trend (Table 14 in Appendix A).

Compliance and attainment monitoring for uranium was performed in 26 wells and 1 aquifer tube in 2017 (Figure 4). The UCLs of the mean uranium concentrations in 2017 were below the CUL for uranium (30 µg/L) at eight wells and the one aquifer tube in the 300 Area Industrial Complex (wells 399-1-1,

399-1-2, 399-1-10A, 399-1-11, 399-1-12, 399-2-32, 399-4-1, and 399-4-15, and aquifer tube AT-3-7-M) (Table 19 in Appendix A). All nine monitoring locations had either decreasing trends or no statistically significant trends, indicating that uranium concentrations in these wells are likely to continue to fall below the CUL. Seven wells had UCLs of the mean uranium concentrations greater than the CUL in 2017 but also had statistically significant decreasing trends (wells 399-1-16A, 399-1-17A, 399-2-1, 399-2-2, 399-4-7, 399-8-1, and 399-8-5A). Two wells (399-1-7 and 399-1-55) had insufficient data to evaluate trends and calculate means and UCLs for 2017. At the remaining nine wells, UCLs of the mean uranium concentrations were above the CUL and there were no statistically significant trends.

Compliance and attainment monitoring for gross alpha activity, which is attributed to uranium isotopes, was performed in 26 wells and 1 aquifer tube in 2017 (Figure 5). The UCLs of the mean gross alpha activities in 2017 were below the CUL for gross alpha (15 pCi/L) for wells 399-1-1, 399-1-10A, 399-1-11, and 399-1-12. All four of these monitoring locations have statistically significant decreasing trends (Table 15 in Appendix A). Two wells (399-1-16A and 399-2-1) had UCLs of the mean gross alpha activities above the CUL in 2017 but did have statistically significant decreasing trends. Well 399-1-17A has insufficient gross alpha data to evaluate the trend, but it does have a statistically decreasing trend for uranium indicating likely decrease in gross alpha. Wells 399-1-7 and 399-1-55 had insufficient data for gross alpha and uranium to evaluate trends and to calculate means and UCLs for 2017. The remaining 18 monitoring locations had UCLs of the mean gross alpha activities above the CUL in 2017 and either increasing or no statistically significant trends.

### **3.2 618-10 Burial Ground and 316-4 Crib**

The 618-10 Burial Ground and adjacent 316-4 Crib are located northwest of the 300 Area Industrial Complex. Monitoring wells located in this area are presented in Figure 1. Wells within the 618-10 Burial Ground and 316-4 Crib area are monitored for uranium and gross alpha as part of performance monitoring for the 300-FF-5 OU.

Compliance and attainment monitoring for uranium was performed in three wells in 2017 (Figure 4). The UCLs of the mean uranium concentrations in 2017 were below the CUL for uranium (30 µg/L) at all three wells (699-S6-E4B, 699-S6-E4E, and 699-S6-E4K) (Table 19 in Appendix A). Well 699-S6-E4B had a statistically significant decreasing trend and well 699-S6-E4K had no statistically significant trend, indicating that these wells will likely continue to fall below the CUL. The trend was increasing at well 699-S6-E4E.

Compliance and attainment monitoring for gross alpha activity, which is attributed to uranium, was performed in three wells (Figure 5). The UCL of the mean gross alpha activity in 2017 was below the CUL for gross alpha (15 pCi/L) at well 699-S6-E4B (Table 15 in Appendix A). Although this well shows no statistically significant trend for gross alpha, it does have a statistically significant decreasing trend for uranium, indicating that this well will likely continue to fall below the CUL. The UCLs of the mean gross alpha activities at wells 699-S6-E4E and 699-S6-E4K were above the CUL in 2017 and had either increasing or no statistically significant trends.

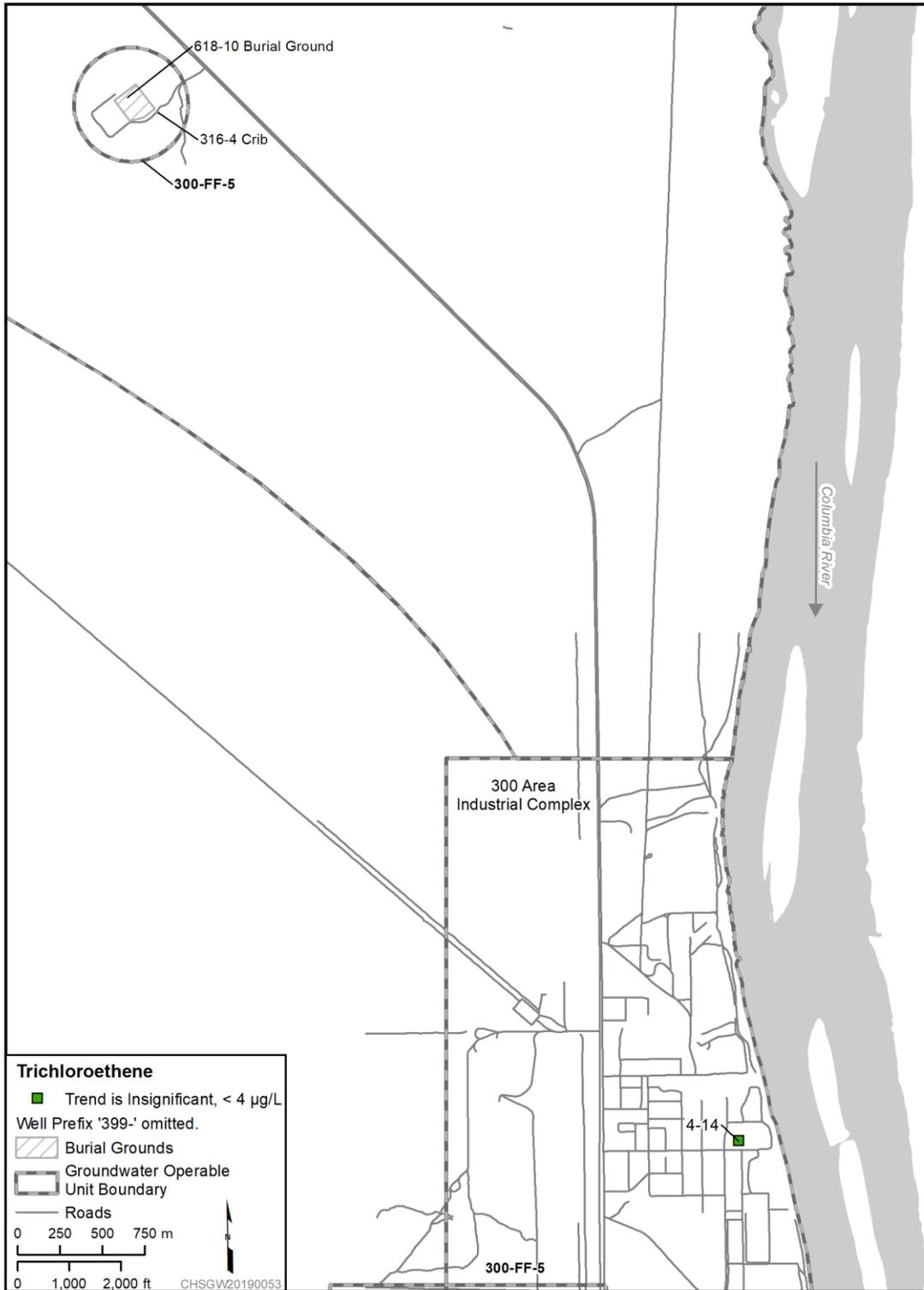


Figure 2. Summary of TCE Trend and Mean Concentration Test Results

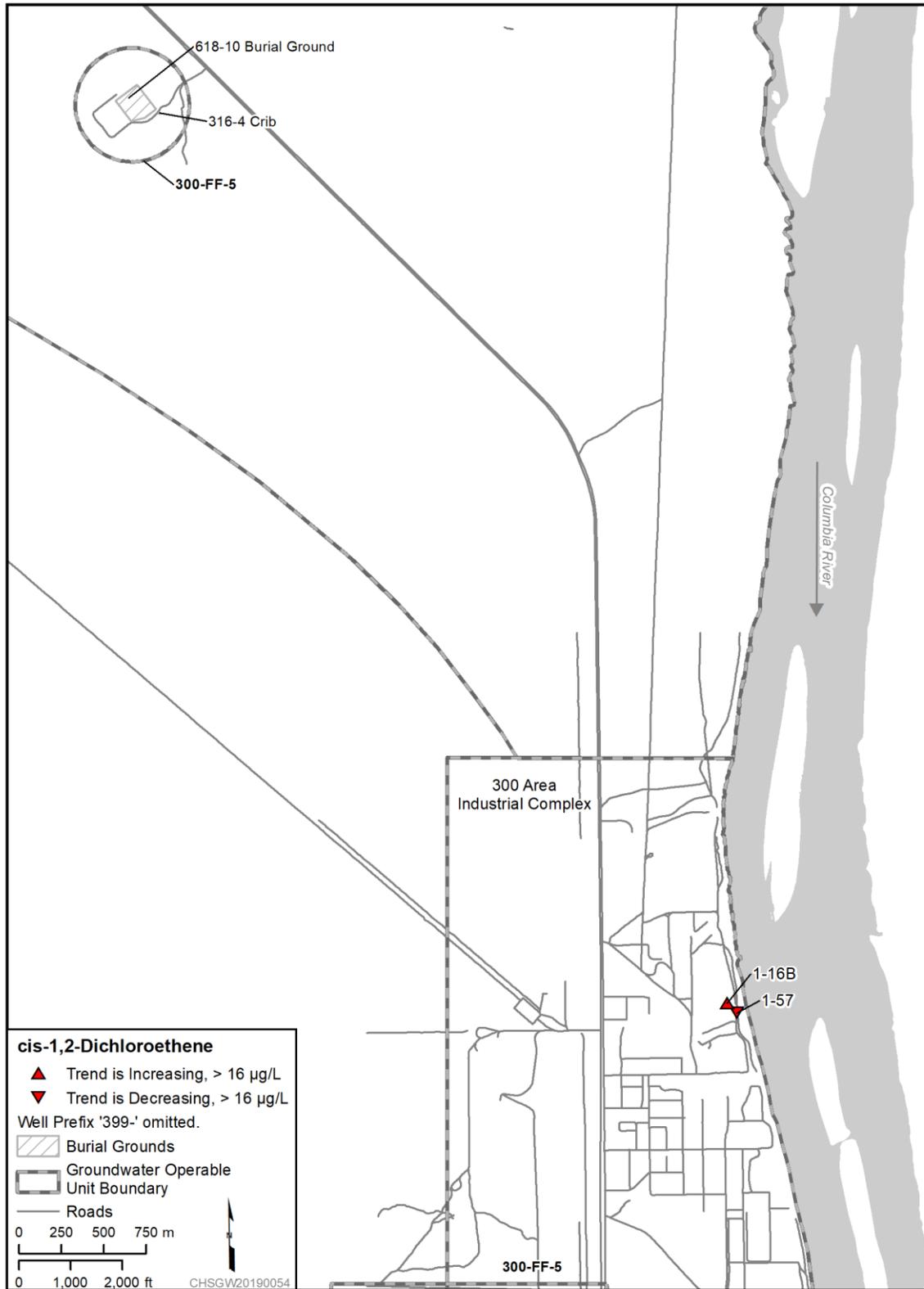


Figure 3. Summary of *cis*-1,2-DCE Trend and Mean Concentration Test Results



Figure 4. Summary of Uranium Trend and Mean Concentration Test Results



### 3.3 618-11 Burial Ground

The 618-11 Burial Ground is located near the northeastern extent of the 300 Area. Monitoring wells located in this area are presented in Figure 1. Wells within the 618-11 Burial Ground are monitored for nitrate and tritium as part of performance monitoring for the 300-FF-5 OU.

Compliance and attainment monitoring for nitrate was performed in four wells in 2017 (Figure 6). The UCLs of the mean nitrate concentrations in 2017 exceeded the CUL for nitrate (45 µg/L) in all four wells. Wells 699-12-2C and 699-13-2D had statistically significant decreasing trends (Table 16 in Appendix A). There were no statistically significant trends at wells 699-13-1E and 699-13-3A.

Compliance and attainment monitoring for tritium was performed in five wells in 2017 (Figure 7). The UCL of the mean tritium activity in 2017 was below the CUL for tritium (20,000 pCi/L) in one well (699-12-2C) and showed a statistically significant decreasing trend (Table 18 in Appendix A). The four remaining wells had UCLs of the mean tritium activities above the CUL and either decreasing or no statistically significant trends.

## 4 Summary

Table 1 provides a summary of the statistical results.

Wells that have a UCL of the mean COC concentration below the CUL and decreasing or no statistically significant trend are likely to continue to fall below the CUL and have, therefore, met the statistical criteria for achieving attainment. Monitoring for these well/COC pairs can be discontinued pending approval from EPA. An increasing trend may be caused by factors not considered in this statistical analysis, such as plume migration. Therefore, further review is required to evaluate remedy performance for these well/COC pairs.

Further review is required for two of the three wells in the 618-10 Burial Ground and 316-4 Crib area. Final remediation of the 316-4 Crib began in November 2016 and was completed in May 2017; contaminated soil was excavated to the groundwater interface (Section 4.1 of DOE/RL-2017-49, *Cleanup Verification Package for the 316-4 Liquid Waste Disposal Crib*). The 618-10 Burial Ground was remediated from March 2011 to September 2017. The deepest excavation was 13 m (43 ft) above the groundwater interface (DOE/RL-2017-61, *Cleanup Verification Package for the 618-10 Burial Ground*). Infiltration of dust-suppression water applied during the excavations may have mobilized uranium contamination to groundwater. The results of statistical tests for uranium concentrations after the source remediation, groundwater flow directions, and contaminant migration rates will be used to assess remedy performance as part of the 5-year review.

A three-dimensional flow and transport model is being developed to evaluate and predict the long-term uranium concentrations in the aquifer. The model will be used to evaluate the MNA remedy for the uranium plume in the 300 Area Industrial Complex (extending west to include the 618-7 Burial Ground) and to evaluate the enhanced attenuation remedy in the highest concentration portion of the uranium plume (including the southern portion of the 316-2 and 316-5 waste sites). The model will be calibrated using uranium concentrations from selected monitoring wells. The results of the statistical tests, model predictions, and plume maps will provide multiple lines of evidence to assess remedy performance as part of the 5-year review.

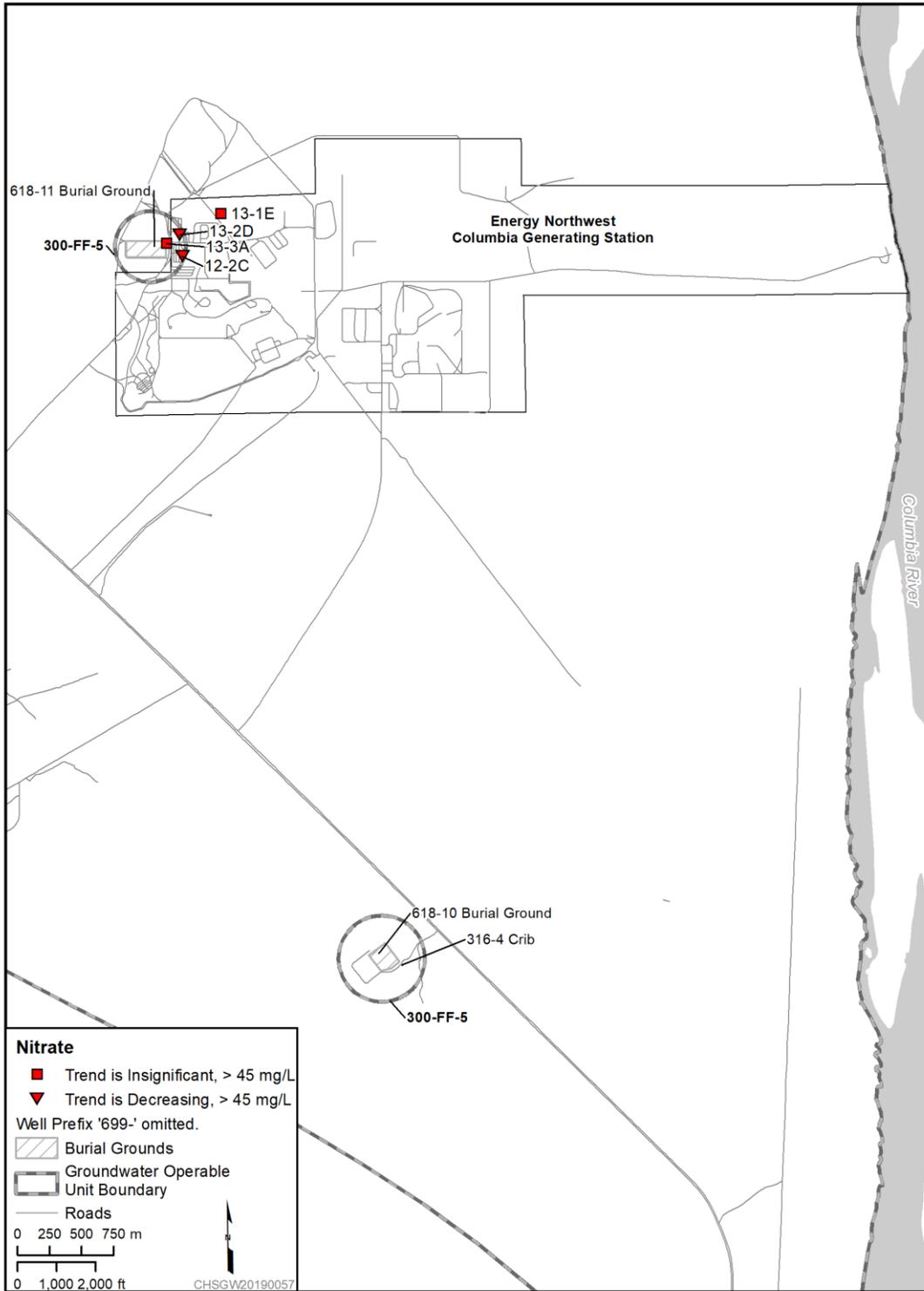


Figure 6. Summary of Nitrate Trend and Mean Concentration Test Results

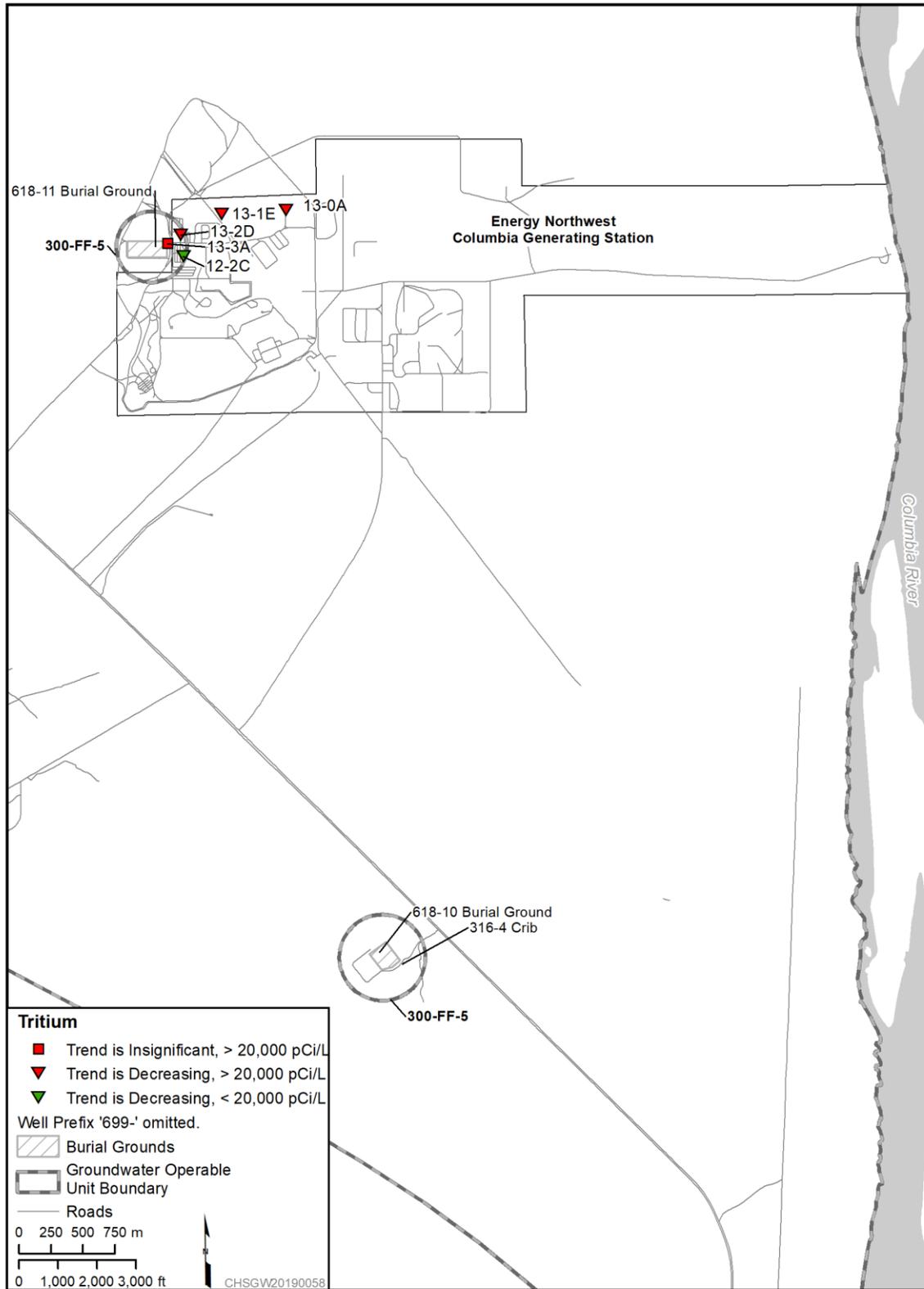


Figure 7. Summary of Tritium Trend and Mean Concentration Test Results

**Table 1. Summary of Statistical Results**

Well Name	cis-1,2-DCE	Gross Alpha*	Nitrate	TCE	Tritium	Uranium*	Summary of Statistical Results
<b>300 Area Industrial Complex</b>							
399-1-1	N/A	Below CUL Decreasing Trend	N/A	N/A	N/A	Below CUL Decreasing Trend	Achieved CUL, Candidate for Removal
399-1-2	N/A	Above CUL Increasing Trend	N/A	N/A	N/A	Below CUL No Trend	Further Review and Continued Monitoring
399-1-7	N/A	Insufficient Data	N/A	N/A	N/A	Insufficient Data	Further Review and Continued Monitoring
399-1-10A	N/A	Below CUL Decreasing Trend	N/A	N/A	N/A	Below CU Decreasing Trend	Achieved CUL, Candidate for Removal
399-1-11	N/A	Below CUL Decreasing Trend	N/A	N/A	N/A	Below CUL Decreasing Trend	Achieved CUL, Candidate for Removal
399-1-12	N/A	Below CUL Decreasing Trend	N/A	N/A	N/A	Below CUL Decreasing Trend	Achieved CUL, Candidate for Removal
399-1-16A	N/A	Above CUL Decreasing Trend	N/A	N/A	N/A	Above CUL Decreasing Trend	Further Review and Continued Monitoring
399-1-16B	Above CUL Increasing Trend	N/A	N/A	N/A	N/A	N/A	Further Review and Continued Monitoring
399-1-17A	N/A	Insufficient Data	N/A	N/A	N/A	Above CUL Decreasing Trend	Further Review and Continued Monitoring
399-1-21A	N/A	Above CUL No Trend	N/A	N/A	N/A	Above CUL No Trend	Further Review and Continued Monitoring

**Table 1. Summary of Statistical Results**

Well Name	cis-1,2-DCE	Gross Alpha*	Nitrate	TCE	Tritium	Uranium*	Summary of Statistical Results
399-1-55	N/A	Insufficient Data	N/A	N/A	N/A	Insufficient Data	Further Review and Continued Monitoring
399-1-57	Above CUL Decreasing Trend	N/A	N/A	N/A	N/A	N/A	Further Review and Continued Monitoring
399-2-1	N/A	Above CUL Decreasing Trend	N/A	N/A	N/A	Above CUL Decreasing Trend	Further Review and Continued Monitoring
399-2-2	N/A	Above CUL No Trend	N/A	N/A	N/A	Above CUL Decreasing Trend	Further Review and Continued Monitoring
399-2-32	N/A	Above CUL No Trend	N/A	N/A	N/A	Below CUL Decreasing Trend	Further Review and Continued Monitoring
399-3-6	N/A	Above CUL No Trend	N/A	N/A	N/A	Above CUL No Trend	Further Review and Continued Monitoring
399-3-9	N/A	Above CUL No Trend	N/A	N/A	N/A	Above CUL No Trend	Further Review and Continued Monitoring
399-3-12	N/A	Above CUL No Trend	N/A	N/A	N/A	Above CUL No Trend	Further Review and Continued Monitoring
399-3-20	N/A	Above CUL No Trend	N/A	N/A	N/A	Above CUL No Trend	Further Review and Continued Monitoring
399-4-1	N/A	Above CUL No Trend	N/A	N/A	N/A	Below CUL No Trend	Further Review and Continued Monitoring
399-4-7	N/A	Above CUL No Trend	N/A	N/A	N/A	Above CUL Decreasing Trend	Further Review and Continued Monitoring

**Table 1. Summary of Statistical Results**

Well Name	cis-1,2-DCE	Gross Alpha*	Nitrate	TCE	Tritium	Uranium*	Summary of Statistical Results
399-4-10	N/A	Above CUL No Trend	N/A	N/A	N/A	Above CUL No Trend	Further Review and Continued Monitoring
399-4-11	N/A	Above CUL No Trend	N/A	N/A	N/A	Above CUL No Trend	Further Review and Continued Monitoring
399-4-12	N/A	Above CUL No Trend	N/A	N/A	N/A	Above CUL No Trend	Further Review and Continued Monitoring
399-4-14	N/A	N/A	N/A	Below CUL No Trend	N/A	N/A	Achieved CUL, Candidate for Removal
399-4-15	N/A	Above CUL No Trend	N/A	N/A	N/A	Below CUL Decreasing Trend	Further Review and Continued Monitoring
399-6-3	N/A	Above CUL Increasing Trend	N/A	N/A	N/A	Above CUL No Trend	Further Review and Continued Monitoring
399-8-1	N/A	Above CUL No Trend	N/A	N/A	N/A	Above CUL Decreasing Trend	Further Review and Continued Monitoring
399-8-5A	N/A	Above CUL No Trend	N/A	N/A	N/A	Above CUL Decreasing Trend	Further Review and Continued Monitoring
AT-3-7-M	N/A	Above CUL No Trend	N/A	N/A	N/A	Below CUL No Trend	Further Review and Continued Monitoring

**Table 1. Summary of Statistical Results**

Well Name	cis-1,2-DCE	Gross Alpha*	Nitrate	TCE	Tritium	Uranium*	Summary of Statistical Results
<b>618-10 Burial Ground and 316-4 Crib</b>							
699-S6-E4B	N/A	Below CUL No Trend	N/A	N/A	N/A	Below CUL Decreasing Trend	Achieved CUL, Candidate for Removal
699-S6-E4E	N/A	Above CUL No Trend	N/A	N/A	N/A	Below CUL Increasing Trend	Further Review and Continued Monitoring
699-S6-E4K	N/A	Above CUL Increasing Trend	N/A	N/A	N/A	Below CUL No Trend	Further Review and Continued Monitoring
<b>618-11 Burial Ground</b>							
699-12-2C	N/A	N/A	Above CUL Decreasing Trend	N/A	Below CUL Decreasing Trend	N/A	Further Review and Continued Monitoring
699-13-0A	N/A	N/A	N/A	N/A	Above CUL Decreasing Trend	N/A	Further Review and Continued Monitoring
699-13-1E	N/A	N/A	Above CUL No Trend	N/A	Above CUL Decreasing Trend	N/A	Further Review and Continued Monitoring
699-13-2D	N/A	N/A	Above CUL Decreasing Trend	N/A	Above CUL Decreasing Trend	N/A	Further Review and Continued Monitoring
699-13-3A	N/A	N/A	Above CUL No Trend	N/A	Above CUL No Trend	N/A	Further Review and Continued Monitoring

Notes: Green cells indicate the well/COC pair is in the attainment monitoring phase.

Yellow cells indicate the well/COC pair is in the remediation monitoring phase.

\*The discrepancy between assessments based on uranium and gross alpha is most likely due to the limited data available for gross alpha. The trends based on uranium are deemed more reliable.

COC = contaminant of concern

N/A = not applicable

CUL = cleanup level

TCE = trichloroethene

DCE = dichloroethene

## 5 References

- DOE/RL-2014-42, 2015, *300-FF-5 Operable Unit Remedy Implementation Sampling and Analysis Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: <https://pdw.hanford.gov/arpir/pdf.cfm?accession=0079669H>.
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## Appendix A

**ECF-300FF5-18-0024, *Calculation of Concentration Trends, Means, and Confidence Limits for cis-1,2-Dichloroethene, Gross Alpha, Nitrate, Trichloroethene, Tritium, and Uranium in the 300-FF-5 Operable Unit Through CY 2017***

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