U.S. Department of Energy
Hanford Site

20-SGD-0026

DEC 18 2019

Ms. Alexandra K. Smith, Program Manager
Nuclear Waste Program
Washington State Department of Ecology
3100 Port of Benton Boulevard
Richland, Washington 99354

Dear Ms. Smith:

GROUNDWATER ASSESSMENT FIRST DETERMINATION REPORT FOR WASTE MANAGEMENT AREA A-AX, DOE/RL-2019-21, REVISION 0

This letter transmits the Groundwater Assessment First Determination Report for Waste Management Area A-AX, DOE/RL-2019-21, Revision 0 to the Washington State Department of Ecology.

The conclusions of this first determination report did not definitively identify any dangerous waste constituents in groundwater that are attributable to WMA A-AX. Chloroform was measured at low-level concentrations but is not considered a dangerous waste constituent attributable to WMA A-AX because concentrations are estimated values with associated "J" qualifiers. However, it is recommended that volatile organic compounds (to include chloroform) continue to be monitored because the potential exists for groundwater concentrations to increase due to tank inventory volatile organic compound listings at the site. It is recommended that the site revert back to detection monitoring of the indicator parameters pH, specific conductivity, total organic carbon, and total organic halogens. Monitoring for site-specific constituents including U.S. Environmental Protection Agency (EPA) Method 8260 (SW-846) for chloroform and EPA Method 6020 (SW-846) for metals (filtered and unfiltered) is recommended in addition to detection monitoring parameters. Anions and field parameters including pH, temperature, turbidity, and specific conductivity will be analyzed to monitor sample integrity. Semi-annual monitoring for the revised constituent list is recommended.

Based on this first determination recommendation the U.S. Department of Energy, Richland Operations Office is returning WMA A-AX to detection monitoring and semi-annual monitoring. This report fulfills the requirements of the first determination as described in 40 CFR 265.93(d)(5).

If you have any questions, please contact me, or your staff may contact, Mike Cline, of my staff, on (509) 376-6070.

Sincerely,

William F. Hamel, Assistant Manager
for the River and Plateau
Richland Operations Office

SGD:KLH

Attachment

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DOE/RL-2019-21
Revision 0

GROUNDWATER ASSESSMENT FIRST DETERMINATION REPORT FOR WASTE MANAGEMENT AREA A-AX

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

U.S. DEPARTMENT OF ENERGY Richland Operations Office

P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

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

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Terms

ANOVA	analysis of variance
DWS	drinking water standard
EPA	U.S. Environmental Protection Agency
K_d	distribution coefficient
MDL	method detection limit
PUREX	Plutonium-Uranium Extraction
WMA	waste management area

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1 Introduction

This first determination, as allowed under 40 CFR 265.93[d][5], "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Preparation, Evaluation, and Response," provides the owner/operator of a facility an opportunity to determine if dangerous waste from the Waste Management Area (WMA) A-AX (Figure 1) have entered the groundwater. Groundwater beneath WMA A-AX has been monitored under the *Resource Conservation and Recovery Act of 1976* in accordance with WAC 173-303-400(3), "Dangerous Waste Regulations," "Interim Status Facility Standards," as defined by 40 CFR 265.92(d), "Sampling and Analysis," since 1989. The groundwater quality assessment program is used to determine whether dangerous waste or dangerous waste constituents from WMA A-AX have entered the groundwater. If dangerous waste constituents from WMA A-AX are detected, the migration rate and extent, as well as the concentration of the dangerous waste constituents in groundwater, must be determined (40 CFR 265.93(d)(4)). Through examining the groundwater assessment sampling data, the WMA was determined to possibly be a contributor of the dangerous waste chloroform to the groundwater.

DOE/RL-2015-49, *Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area A-AX*, stipulates that a first determination report be prepared after the first two quarterly sampling events or when either it is determined that any dangerous waste constituent attributable to WMA A-AX has impacted groundwater, or the dangerous waste constituents are found to either not be detected in groundwater, or if detected, are not attributable to WMA A-AX. It was determined that assessment needed to be extended beyond the first two quarterly events to be able to evaluate for groundwater contamination attributable to WMA A-AX because comparison of upgradient versus downgradient constituent comparisons would not be accurate with limited data. In addition, one year of quarterly sampling for 40 CFR 265, Appendix III, "EPA Interim Primary Drinking Water Standards," constituents was needed to evaluate for groundwater contamination in the newly added network well 299-E25-237 (DOE/RL-2015-49).

This first determination deviates from the evaluation procedure described in DOE/RL-2015-49 because additional sampling data were deemed necessary for a proper assessment of impact to groundwater from WMA A-AX. The monitoring plan specifies that after two sampling events, data be binned into three categories:

1. Dangerous waste constituent is attributable to previous WMA A-AX release(s), with routine quarterly monitoring required.
2. Dangerous waste constituent is not detected in groundwater, detected at or below background concentrations, or detected below upgradient concentrations, with no further monitoring required.
3. Analytical results are inconclusive, and additional monitoring is required to make a determination.

After two sampling events, all data were binned into category three and thus the need for additional sampling was ascertained. The groundwater assessment plan will be revised to update the dangerous waste constituents in accordance with the findings of the data evaluation/categorization in this first determination report.

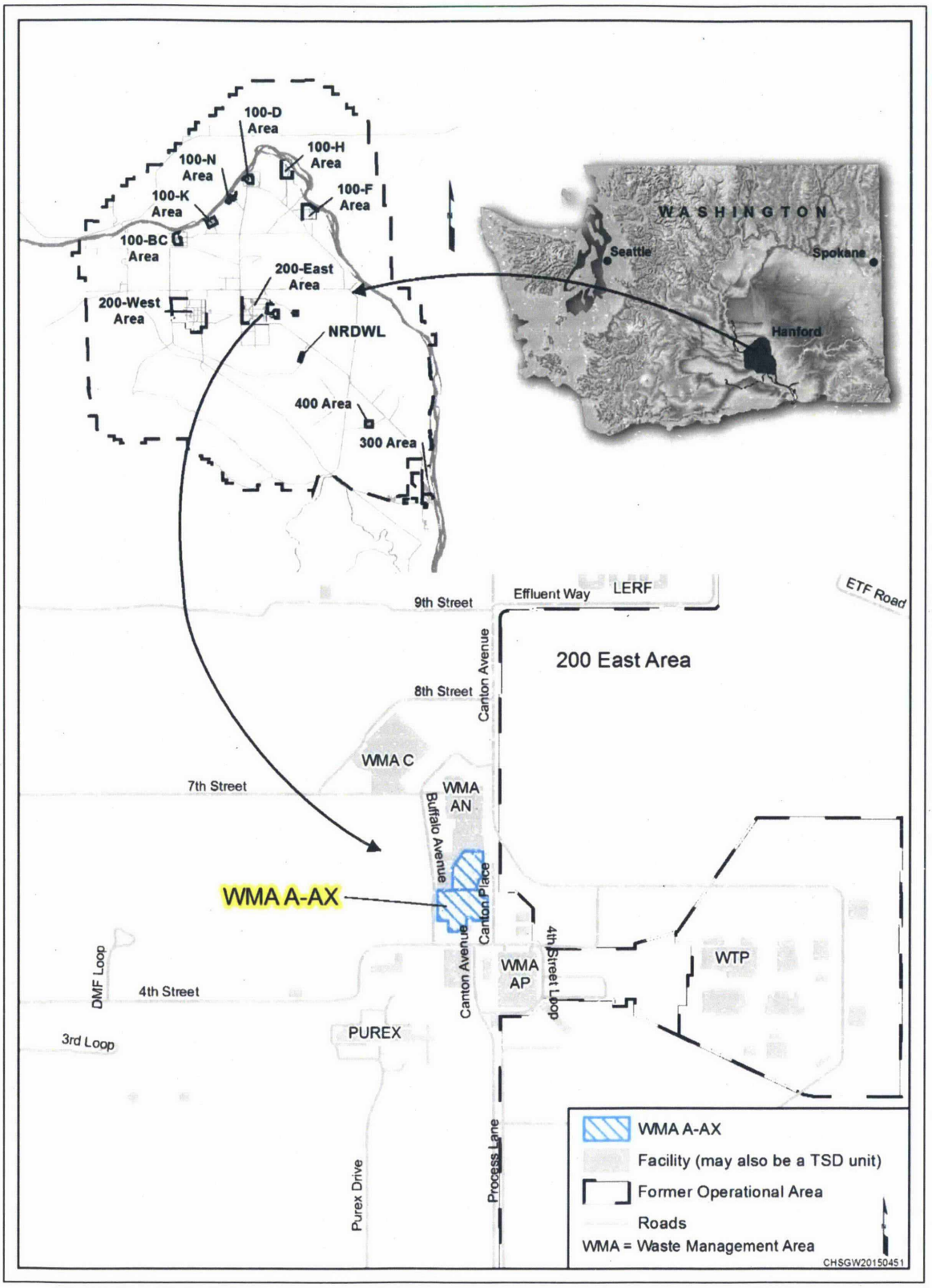


Figure 1. Location of WMA A-AX

2 Groundwater Quality Assessment Monitoring Program

WMA A-AX was placed in groundwater quality assessment monitoring (40 CFR 265.93(d)) in 2005 because the indicator parameter specific conductance showed an exceedance relative to the statistical comparison value between upgradient and downgradient wells (PNNL-15315, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area A-AX at the Hanford Site*; 40 CFR 265.93(b)). Quadruplicate measurements of specific conductance collected in June 2005 from downgradient well 299-E25-93 averaged 536 µS/cm, which exceeded the critical mean value of 522 µS/cm (PNNL-15315). The elevated specific conductance is likely caused by elevated levels of groundwater constituents nitrate and sulfate. Detections of the dangerous waste constituent nickel occurred in samples from two downgradient wells (299-E25-40 and 299-E25-236) in the WMA A-AX network at higher concentrations than the corresponding upgradient wells. The elevated nickel was determined to be the result of stainless steel casing corrosion in well 299-E25-236 and the well was replaced. Currently, corrosion is affecting wells 299-E25-40 and 299-E25-41.

The current groundwater quality assessment plan (DOE/RL-2015-49) was prepared to revise the previous plan (PNNL-15315) that was written in 2006. The previous monitoring plan was revised due to its age and to ensure that the plan contains the most current Hanford Site groundwater monitoring information for WMA A-AX (e.g., changes to the well network, sampling frequency, groundwater quality assessment constituents, and data evaluation methodology). The current monitoring plan presents an updated groundwater quality assessment plan to determine whether dangerous waste constituents associated with WMA A-AX have affected the underlying groundwater and is a continuation of the previous plan (PNNL-15315).

Under the current assessment monitoring plan, quarterly sampling began in March 2016. Chapter 3 of this report presents results of nine sampling events occurring between March 2016 and June 2018.

3 Assessment Analytical Results and Evaluation

Additional sampling beyond the first two quarterly events were required for WMA A-AX assessment based on the evaluation procedure in Section 4.2 of DOE/RL-2015-49 because having only two samples is inadequate for upgradient versus downgradient constituent concentration comparisons. All results of constituent analyses from the March 2016 through June 2018 WMA A-AX assessment sampling events were loaded into the Hanford Environmental Information System. Seven of the constituents analyzed required further evaluation based on the data screening procedure for the first determination (ECF-200PO1-19-0007, *Data Screening Procedure for the WMA A-AX RCRA First Determination Report*). Chromium, chloroform, copper, nickel, octachlorodibenzo-p-dioxin, sulfide, and vanadium were considered for further evaluation. A discussion of the evaluation process used to assess the analytical results is provided in the following paragraphs. Results of the seven constituents that were evaluated as possible contaminants attributable to WMA A-AX are provided in Table A-1, Appendix A.

WMA A-AX assessment groundwater monitoring data were acquired by querying the Hanford Environmental Information System database for all of the wells in the WMA A-AX network (Figure 2). The data were then screened on a well-by-well basis for consecutive occurrences of valid detections. All data associated with laboratory qualifiers "A," "E," "N," "O," "P," "Q," "T," "U," and "W" were considered invalid and were excluded from the dataset (Table 1). Data associated with "F," "H," "P," "Q," "R," or "Y" review qualifiers were considered not valid because they indicate high uncertainty or data quality issues with associated analytical results. If a given analyte for a given well had at least two consecutive valid detections, that constituent was carried forward for further evaluation.

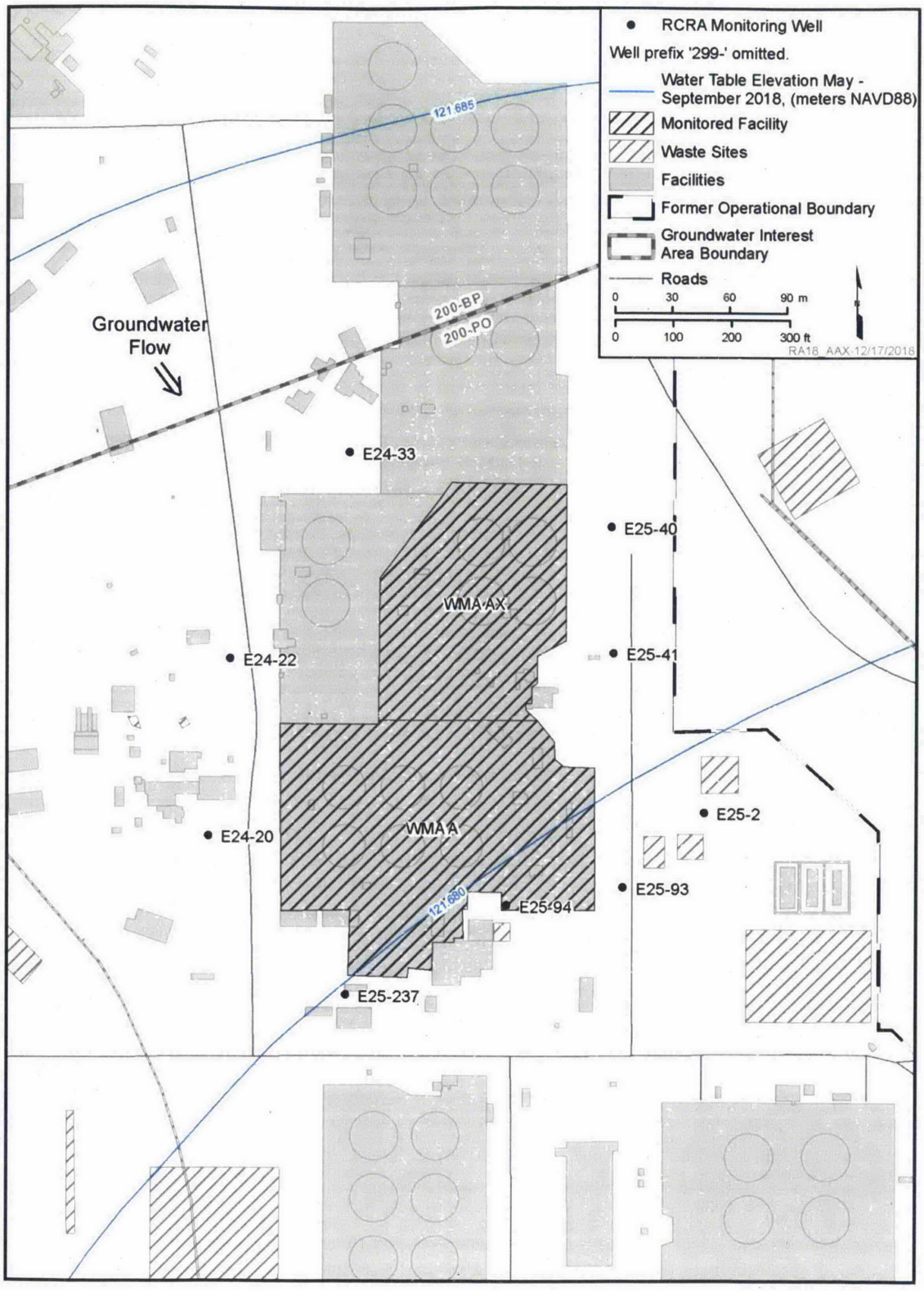


Figure 2. WMA A-AX Monitoring Well Network

Table 1. Hanford Environmental Information System Data Qualifiers

Qualifier		Translation
Laboratory Qualifier	A	INORGANICS and WETCHEM. Valid for TIC only. The TIC is a suspected alcohol-condensation product.
	B	INORGANICS and WETCHEM. The analyte was detected at a value less than the contract RDL, but greater than or equal to the IDL/MIDL (as appropriate). ORGANICS. The analyte was detected in both the sample and the associated QC blank, and the blank concentration was greater than the PQL but <=5% of the sample concentration.
	C	INORGANICS/WETCHEM. The analyte was detected in both the sample and the associated QC blank, and the blank concentration was greater than the PQL but <=10% of the sample concentration. ORGANICS (PESTICIDE only). The identification of a pesticide confirmed by GC/MS.
	D	ALL. Analyte was reported at a secondary dilution factor, typically DF >1 (i.e., the primary preparation required dilution to either bring the analyte within the calibration range or to minimize interference). Required for ORGANICS/WETCHEM if the sample was diluted.
	E	INORGANICS. Reported value is estimated because of interference. See comment on cover page, hardcopy case narrative, or specific inorganic hardcopy datasheet. ORGANICS. Concentration exceeds the calibration range of the GC/MS.
	J	ORGANICS. Estimated value: constituent detected at a level less than the RDL or PQL and greater than or equal to the MDL and estimated concentration for TICs.
	N	ALL (except GC/MS based analysis). Spike and/or spike duplicate sample recovery is outside control limits. ORGANICS (GC/MS only). Presumptive evidence of compound based on mass spectral library search.
	O	ALL. The associated laboratory control sample recovery is outside control limits.
	P	ORGANICS (PCB only). Aroclor target analyte with >25% difference between column analyses.
	Q	ORGANICS (dioxins & PCB-congeners only). Estimated maximum concentration. Used if one of the qualitative identification criteria is not met (e.g., Cl isotopic ratios outside theoretical range).
	S	INORGANICS. Reported value determined by MSA.
	T	Organics (GC/MS only). Spike and/or spike duplicate sample recovery is outside control limits.

Table 1. Hanford Environmental Information System Data Qualifiers

Qualifier		Translation
Laboratory Qualifier (cont.)	U	ALL. Analyzed for but not detected above limiting criteria. Limiting criteria may be any of the following: value reported <0; value reported less than counting error, value reported less than total analytical error; value reported less than or equal to contract MDL/IDL/MDA/PQL.
	W	INORGANICS. Post-digestion spike recovery for GFAA out of control limit. Sample absorbency <50% of spike absorbency.
	X	ALL. The result-specific translation of this qualifier code is provided in the hardcopy data report and/or case narrative. Additional result-specific translation information may also be found in the RESULT_COMMENT field for this record.
	Y	Same as X if more than one flag is required.
	Z	ALL. The result-specific translation of this qualifier code is provided in the hardcopy data report and/or case narrative.
Review Qualifier	A	Chain-of-custody issues associated with sample.
	F	Result is undergoing further review.
	G	Record has been reviewed and determined to be correct, or the record has been corrected with laboratory confirmation or other supporting information.
	H	Laboratory holding time was exceeded before the sample was analyzed.
	P	Potential problem. Collection/analysis circumstances makes value questionable.
	Q	Associated quality control sample is out of limits.
	R	Do not use. Further review indicates the result is not valid.
	Y	Result suspect. Review - insufficient evidence to show result valid or invalid.
	Z	Miscellaneous circumstances exist. Additional information may be found in the RESULT_COMMENT field for this record and/or in the SAMP_COMMENT field of the parent sample record.

Laboratory Qualifier Source: CP-15383, *Common Requirements of the Format for Electronic Analytical Data (FEAD).*

Review Qualifier Source: HNF-38155, *HEIS Sample, Result, and Sampling Site Data Dictionary.*

DF	=	dilution factor	MSA	=	method of standard additions
GC/MS	=	gas chromatograph/mass spectrometer	PCB	=	polychlorinated biphenyl
GFAA	=	graphite-furnace atomic absorption	PQL	=	practical quantitation limit
IDL	=	instrument detection limit	QC	=	quality control
MDA	=	minimum detectable activity	RDL	=	required detection limit
MDL	=	method detection limit	TIC	=	tentatively identified compound
MIDL	=	method instrument detection limit	WMA	=	waste management area

Organic constituent data with consecutive values with associated "J" laboratory qualifiers were retained because they indicate the presence of low-level organic compound contamination that may be of interest to the site owner/operator. Consistent, consecutive "J" qualifiers suggest that the organic constituent is detectable in groundwater at very low concentrations. Results were then screened for values above Hanford sitewide background 95th percentile concentrations (DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*). ECF-200PO1-91-0007 explains the data screening process for WMA A-AX in detail.

Dangerous waste detections in downgradient wells that were carried forward for further evaluation were those constituents with valid detections elevated above Hanford Site background levels (metals) or detected organics. At least two consecutive valid detections were required for both metals and organic dangerous wastes for carrying forward with further evaluation. This process resulted in chloroform, chromium, copper, nickel and vanadium being evaluated for statistical significance relative to concentrations detected in upgradient wells (ECF-200PO1-19-0008, *Statistical Evaluation of Assessment Sampling Results for WMA-A-AX*). Sulfide and octachlorodibenzo-p-dioxin were not statistically evaluated because both were detected only in downgradient locations and therefore did not have upgradient populations with valid detections for comparison. Statistical significance is typically used as a decision criterion for determining whether two groups of data (i.e., filtered nickel in upgradient well 299-E24-20 versus filtered nickel in downgradient well 299-E25-2) are different from each other or whether the differences observed could have been derived by chance. The logic of statistical significance is as follows: suppose that the two populations were actually identical in how they generated the data observed. Under this assumption, the likelihood of the observations' occurrence is estimated. If the occurrence of the observed data is unlikely under the assumption of identical populations, the difference in the observations between populations is statistically significant, allowing the observer to conclude that the two populations actually are different up to a degree of confidence.

Hypothesis testing utilized t-tests instead of analysis of variance (ANOVA) because detected dangerous waste constituent concentrations varied between upgradient wells, suggesting different population means between upgradient sources. For example, if population means are the same between an upgradient and a downgradient well, then it is likely that both wells are sampling contamination from the same source. If population means differ between sources, then the wells likely sample contamination from different sources. T-tests and ANOVA are two parametric statistical techniques used in hypothesis testing. A t-test is used to compare the means of two populations (i.e., between upgradient and downgradient wells). ANOVA is used to compare the means of more than two populations (i.e., compiled constituent concentrations of all upgradient wells compared to compiled constituent concentrations of all downgradient wells).

The t-tests compared upgradient and downgradient constituent concentrations on a well-by-well basis. For example, each downgradient well detecting a given constituent had the detected constituent concentrations tested against the concentrations of that constituent in each upgradient well in which that constituent was detected. Prior to hypothesis testing, datasets were subjected to Shapiro-Wilke tests for normality.

If compared constituent concentration datasets were normally distributed, a two-sample t-test was performed. If one or both of the two constituent datasets being compared were not normally distributed and/or had differing numbers of values, then a nonparametric Wilcoxon test was performed.

Result sets shown by statistical hypothesis testing as having a low relational probability are statistically significant and therefore the null hypothesis can be rejected. The null hypothesis states that a population parameter (such as the mean, the standard deviation, etc.) is equal to a hypothesized value. For example,

the two-sample t-test test statistic (hypothesized mean value of 5.208) is similar to the population mean of 5.63 of nickel concentrations in well 299-E24-20 but is not as similar to the population mean of 3.754 for well 299-E25-40. This is reasonable because this test produced a low p-value of 5.007E-5 for which the null hypothesis is rejected. The null hypothesis is often an initial claim that is based on previous analyses or specialized knowledge. If the null hypothesis is accepted, the compared populations are related by having the same sample means. If the null hypothesis is rejected, the compared populations have differing sample means and are therefore unrelated. Thus, an alternative hypothesis is needed to explain the difference in population means. Statistical significance suggests that the population means of upgradient and downgradient constituent concentrations are different and therefore indicating different sources of a given constituent for both populations. In the previous example, the p-value of 5.007E-5 for which the null hypothesis is rejected in the two-sample t-test between filtered nickel concentrations in wells 299-E24-20 and 299-E25-40, indicates statistical significance. If the downgradient concentration was not statistically significant and had a sample mean less than upgradient well sample means, then the dangerous waste constituent was not considered attributable to WMA A-AX. If downgradient sample means are greater and are statistically significant when compared to upgradient results, then the possibility exists that the dangerous waste constituent is attributable to WMA A-AX.

Constituents of interest include metals that may be associated with corrosion of stainless steel (e.g., chromium, iron, manganese, and nickel); these were evaluated and past incidents of known well casing corrosion were considered. Corrosion of well casing and/or screen components confirmed by visual inspection and corresponding detection of elevated stainless steel alloy metals (e.g., iron, chromium, nickel, molybdenum, manganese [depending on the specific alloy]) in groundwater at ratios comparable to those in the corroding metal (e.g., 304 or 316 stainless steel). The presence of elevated concentration of a single alloy metal, particularly in the absence of elevated iron, is not clearly the result of casing corrosion. Visual confirmation of casing corrosion is an essential element of the casing corrosion argument.

3.1 Dangerous Waste Constituents

Five inorganic potentially dangerous waste/dangerous waste constituents were identified as above site background levels and four required a final statistical evaluation (Table 2). The constituents identified were chromium, copper, nickel, sulfide, and vanadium. The evaluation process chosen for comparison used filtered metals results to evaluate for statistical significance between upgradient and downgradient constituent concentration populations and sample means of upgradient versus downgradient concentrations (ECF-200PO1-19-0008). Filtered metals results values were chosen because unfiltered results can be elevated from particulate matter originating from within the well and therefore not being representative of actual aquifer conditions. Sample means were calculated by averaging the observed concentration values for each constituent at each well location where the constituents were detected. If the constituent concentration sample means of downgradient wells were greater than in upgradient wells, then it would be possible that WMA A-AX is responsible for impacting groundwater.

Chloroform and octachlorodibenzo-p-dioxin were the only organic waste constituents identified for further evaluation. Chloroform was subjected to statistical evaluation. Octachlorodibenzo-p-dioxin in well 299-E25-41 had two consecutive J-flagged values in 2018, but was not carried forward for statistical evaluation because of very low concentrations (on the order of magnitude of 10^{-6} µg/L). Similar low-level dioxin concentrations are frequently found in both field samples and quality control blanks. This phenomenon is common among multiple analytical laboratories and suggests that dioxin residues are present throughout the environment and often detected at very low levels by sensitive analytical methods.

Table 2. Statistical Evaluation Results of Dangerous Waste Constituents Detected at WMA A-AX

Constituent	Upgradient Well	Downgradient Well	Comparison Test[a]	p-Value[b]	Null Hypothesis
Chromium (filtered)	299-E24-20	299-E25-2[c]	Two-sample t-test	1.87E-07	Reject
		299-E25-40		3.75E-04	
		299-E25-41	Wilcoxon	1.62E-03	
		299-E25-93[c]		1.42E-02	
	299-E24-22	299-E25-2[c]	Wilcoxon	1.57E-03	Reject
		299-E25-40		5.16E-02	Accept
		299-E25-41		6.73E-03	Reject
		299-E25-93[c]		1.33E-01	Accept
Copper (filtered)	299-E24-20[c]	299-E25-40	Wilcoxon	8.60E-01	Accept
		299-E25-94		6.06E-01	
Nickel (filtered)	299-E24-20	299-E25-2	Two-sample t-test	2.13E-02	Reject
		299-E25-40		2.25E-07	
		299-E25-41		7.30E-01	Accept
Vanadium (filtered)	299-E24-20	299-E25-2	Wilcoxon	7.95E-05	Reject
		299-E25-237		4.58E-02	
		299-E25-40	Two-sample t-test	1.43E-01	Accept
		299-E25-41		9.53E-02	
		299-E25-93		2.64E-02	Reject
		299-E25-94		5.65E-03	
	299-E24-22	299-E25-2	Wilcoxon	8.00E-01	Accept
		299-E25-237		1.05E-03	Reject
		299-E25-40	Two-sample t-test	1.31E-05	
		299-E25-41		1.26E-05	
		299-E25-93		5.30E-04	
		299-E25-94		8.21E-03	
Chloroform	299-E24-20	299-E25-237	Wilcoxon	5.97E-04	Reject
	299-E24-22[c]	299-E25-237	Two-sample t-test	7.34E-03	Reject

a. Wilcoxon test is used when one or both samples are not normally distributed.

b. p-Values were compared to a level of significance of 0.05.

c. Data subjected to regression on order statistics.

WMA = waste management area

The following paragraphs provide a discussion of each constituent (with the exception of octachlorodibenzo-p-dioxin) and the determination based on the evaluation process for the constituent. Table 2 provides a summary of the statistical analysis. The p-value is the probability under the null

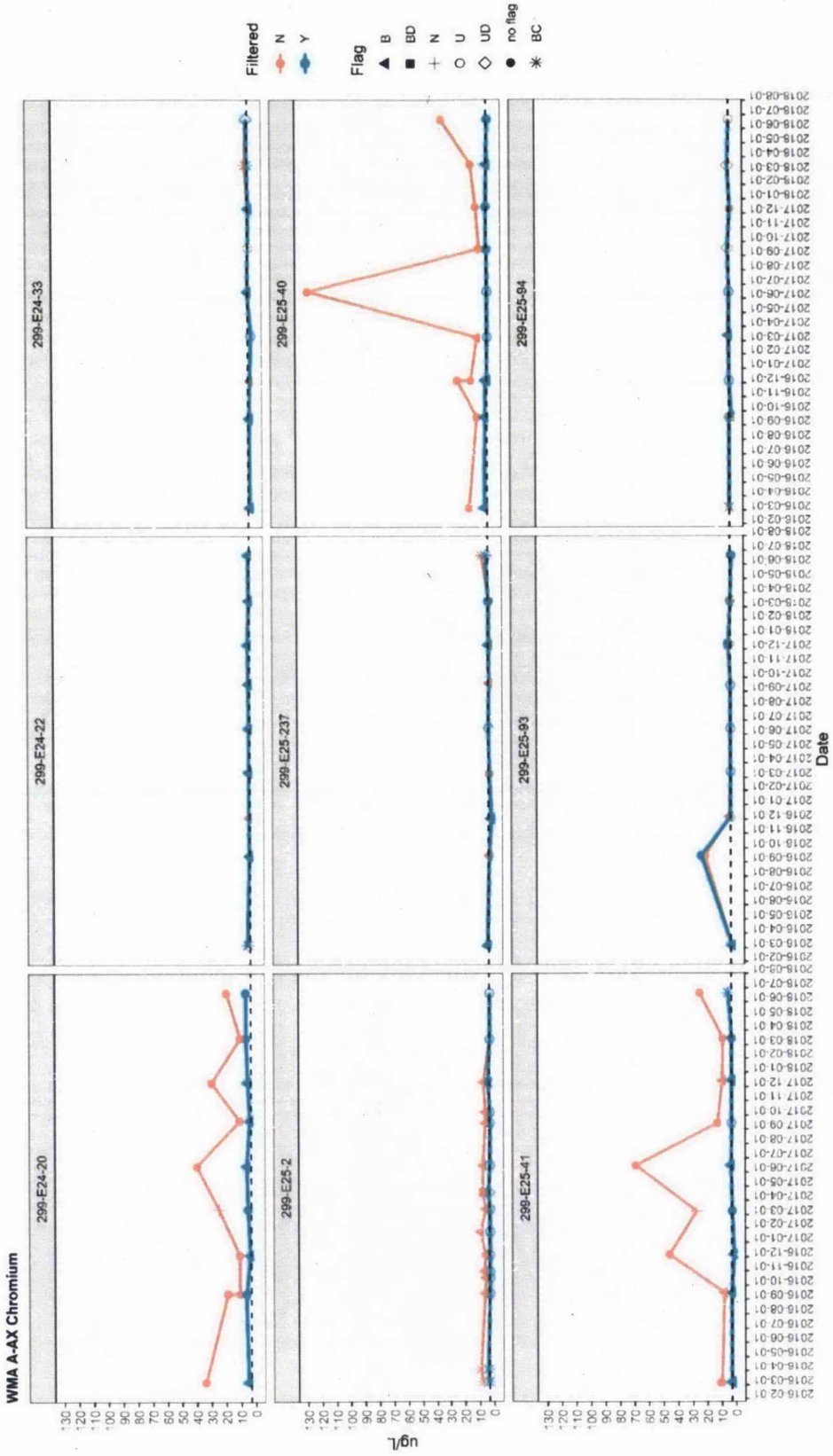
hypothesis, of obtaining a statistically modeled result equal to or more extreme than was actually observed. The smaller the p-value, the higher the significance because it tells the investigator that the hypothesis under consideration may not adequately explain the observation. The null hypothesis is rejected if the p-value is less than or equal to an arbitrarily pre-defined level of significance (most commonly 0.05, and that value applies here).

For example, Table 2 lists a p-value of 2.13E-02 for the t-test comparing 299-E24-20 and 299-E25-2, which is less than the significance level of 0.05. Therefore, the null hypothesis is rejected. The rejected null hypothesis indicates that the sample sets between wells 299-E24-20 and 299-E25-2 are statistically significant and therefore are likely sampling contamination from different sources.

Filtered chromium (Figure 3) was above the Hanford Site 95th percentile background levels in upgradient wells 299-E24-20 and 299-E24-22 and downgradient wells 299-E25-2, 299-E25-40, 299-E25-41, and 299-E25-93 (Figure 2). Wells 299-E24-20, 299-E25-2, 299-E25-40, and 299-E25-41 have nonfiltered results that are greater than upgradient results. Casing corrosion is known to have affected wells 299-E25-40 and 299-E25-41. Well 299-E25-237 was installed to replace well 299-E25-236, which was decommissioned due to casing corrosion. At WMA A-AX, the corrosion observed in well 299-E25-236 occurred above the water table at (or slightly above) a fine-grained geologic unit (the Cold Creek silt-dominated unit). This unit retains a higher percentage of moisture due to its fine-grained nature. It is unlikely that single-shell tanks and other liquid waste facilities in WMA A-AX (e.g., 216-A-39 Crib and Trench) leaked or discharged a large enough volume that contained the corrosive constituents necessary to corrode the three wells. The most likely source of the corrosion is chloride-bearing effluent from the 200 East Area powerhouse (284-E Powerhouse) that was discharged to an unlined ditch (200-E-286 Ditch) that traversed the southwest end of what later became the 241-A Tank Farm (WHC-EP-0342, Addendum 24, *284-E Powerplant Wastewater Stream-Specific Report*). This ditch was active from 1946 to 1953.

Chromium concentration sample populations were found to be statistically significant in downgradient wells 299-E25-2, 299-E25-40, 299-E25-41, and 299-E25-93 when compared to upgradient well 299-E24-20 (Table 2). Sample means in the downgradient wells were lower than those in the upgradient wells (Table 3). Therefore, chromium concentrations in the downgradient wells are likely the result of different (or additional) factors (e.g., casing corrosion) than those in the upgradient well. Chromium-to-nickel ratios in stainless steel are approximately 2:1. Wells 299-E24-20, 299-E25-2, and 299-E25-41 average unfiltered chromium-to-nickel ratios were within ±0.2 of 2, suggesting that casing and/or screen corrosion could be a major driver of the metals concentrations data patterns at these locations. Well 299-E25-93 had unfiltered and filtered chromium-to-nickel concentration ratios of 2.1 and 2.2, respectively. Casing corrosion as a cause of elevated nickel in wells 299-E25-2 and 299-E25-41 is supported by the chromium-to-nickel concentration ratios in those wells. Based on the sample means comparison, chromium-to-nickel concentration ratios and known corrosion issues at wells 299-E25-40, 299-E25-41, and 299-E25-236 chromium is ruled out as dangerous waste constituent attributable to WMA A-AX.

Copper (Figure 4) in filtered aliquots was above background levels in upgradient wells 299-E24-20 and 299-E24-33 and in downgradient wells 299-E25-2, 299-E25-40, 299-E25-41, 299-E25-93, 299-E25-94, and 299-E25-237. Upgradient copper concentration means were greater than downgradient concentration means (Table 3). Downgradient concentration populations were not significantly different when compared to upgradient concentrations, suggesting that the copper detected downgradient of WMA A-AX is likely from an upgradient source.



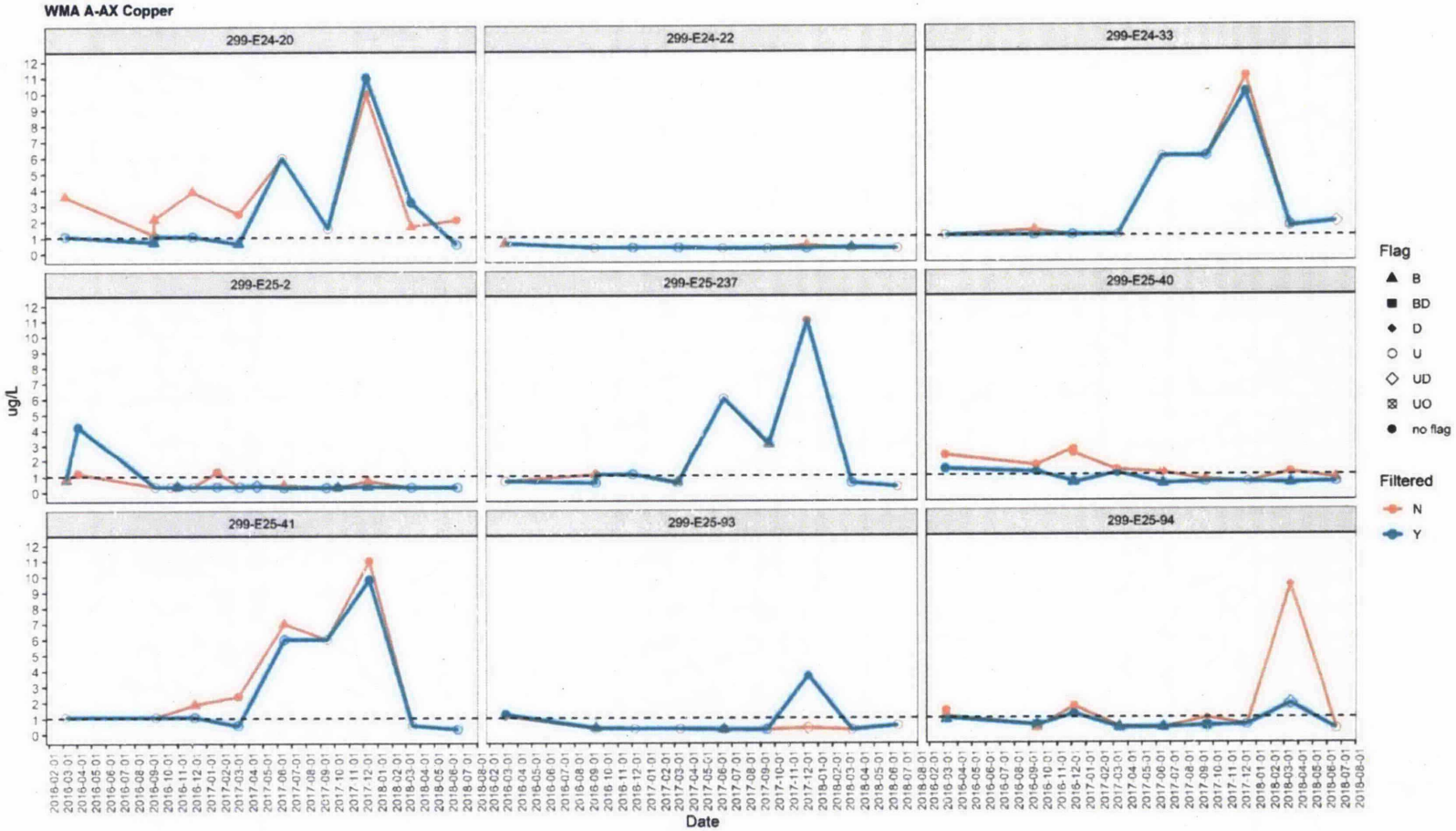
Note: Wells 299-E24-20, 299-E24-22, and 299-E24-33 are upgradient. The black dashed horizontal line indicates the Hanford sitewide background value for chromium of 3.17 µg/L.

Figure 3. WMA A-AX Chromium

Table 3. Summary Statistics of Statistically Evaluated Data

Well	Constituent	Mean	Median	Variance	Standard Deviation
299-E24-20	Chloroform	0.17	0.16	0	0.02
299-E24-22		0.26	0.22	0.01	0.12
299-E25-237		0.4	0.4	0	0.05
299-E24-20	Chromium	5.53	5.5	1.12	1.06
299-E24-22		4.11	4.03	0.21	0.46
299-E25-2		2.85	2.69	0.5	0.71
299-E25-40		3.56	3.4	0.62	0.79
299-E25-41		3.12	3	1.11	1.05
299-E25-93		4.94	2.35	48.83	6.99
299-E24-20	Copper	1.96	0.65	12.35	3.51
299-E25-40		0.77	0.56	0.14	0.38
299-E25-94		0.61	0.51	0.11	0.34
299-E24-20	Nickel	4.56	3.9	4.48	2.12
299-E25-2		2.34	2.3	0.75	0.87
299-E25-40		17.05	18.1	11.71	3.42
299-E25-41		4.99	4.2	6.72	2.59
299-E24-20	Vanadium	23.59	23	1.67	1.29
299-E24-22		19.36	18.8	0.92	0.96
299-E25-2		19.16	19.35	2.1	1.45
299-E25-237		22.21	22	2.03	1.42
299-E25-40		22.66	22.6	1.64	1.28
299-E25-41		22.54	22.5	1.46	1.21
299-E25-93		21.96	21.5	2.34	1.53
299-E25-94		21.32	21.2	2.89	1.7

Note: All values are in μg/L.



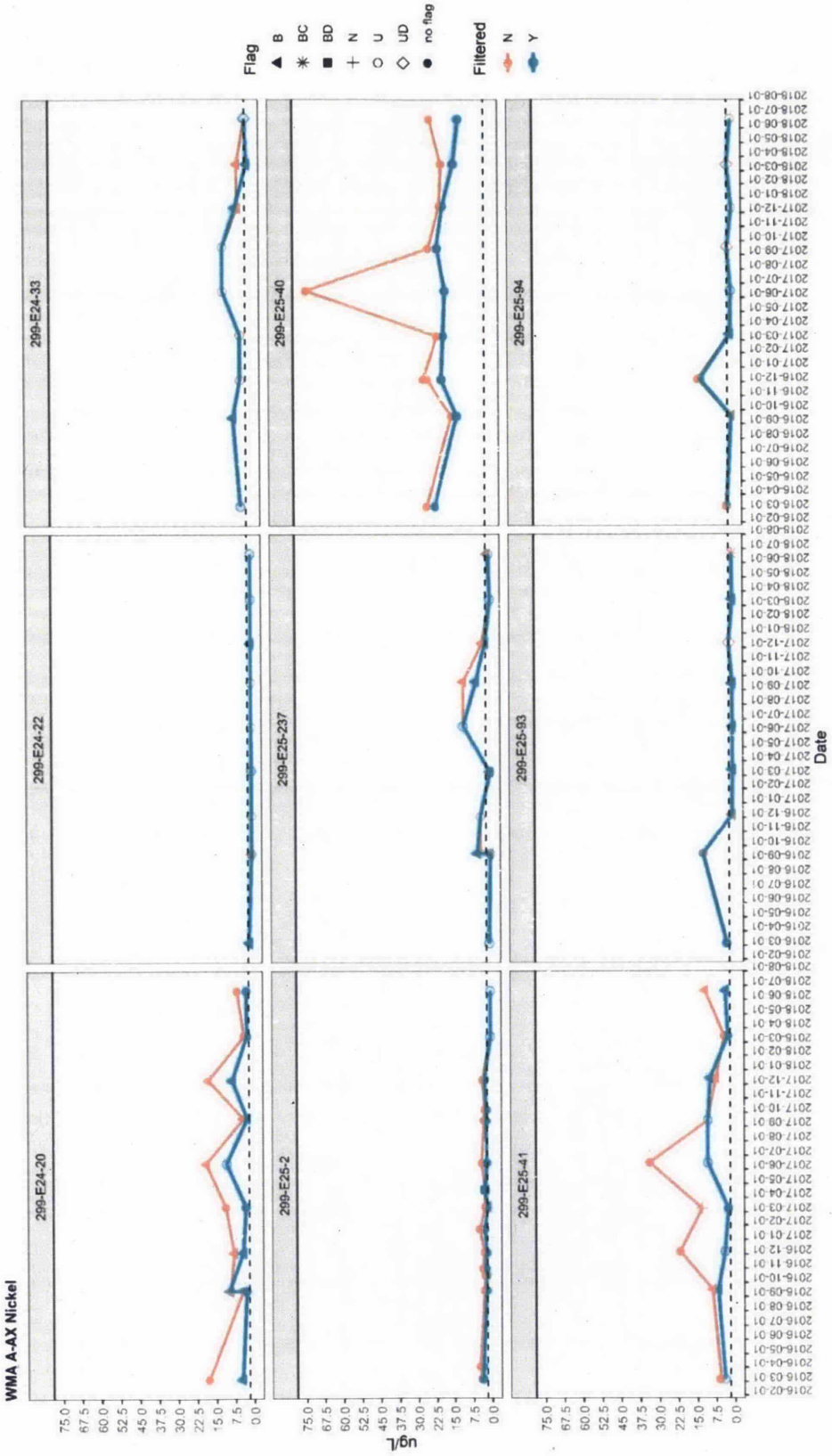
Notes: Wells 299-E24-20, 299-E24-22, and 299-E24-33 are upgradient. The black dashed horizontal line indicates the Hanford sitewide background value for copper of 1.04 µg/L.

Figure 4. WMA A-AX Copper

Nickel (Figure 5) in filtered aliquots was detected above background levels in upgradient wells 299-E24-20 and 299-E24-33 and in downgradient wells 299-E25-2, 299-E25-40, 299-E25-41, 299-E25-93, 299-E25-94, and 299-E25-237. Wells 299-E25-2 and 299-E25-40 were statistically significant when compared to both upgradient wells. Well 299-E25-40 also had a nickel (filtered) sample concentration mean greater than the upgradient sample mean. Well 299-E25-40 has known casing corrosion issues (DOE/RL-2015-49) and therefore filtered nickel concentrations measured at that location likely do not represent dangerous waste contamination associated with WMA A-AX. Nickel is one of the primary components of stainless steel wells based on Driscoll, 1986, *Groundwater and Wells*. Wells 299-E25-2 and 299-E25-40 had chromium-to-nickel concentration ratios in unfiltered aliquots that averaged 2.0 and 0.9 respectively. Casing corrosion as a cause of elevated nickel in well 299-E25-2 is supported by the chromium-to-nickel concentration ratio in that well. Nickel in unfiltered aliquots was higher than in filtered aliquots for wells 299-E24-20, 299-E25-2, 299-E25-40, and 299-E25-41. The principal initial analytical indicators of casing corrosion are the presence of elevated iron, chromium, and nickel in unfiltered aliquots. Unfiltered iron aliquots are higher than filtered iron aliquots in 299-E24-20, 299-E25-2, 299-E25-237, 299-E25-40, and 299-E25-41 (Figure 6). A downhole camera survey was conducted in November 2012 to evaluate the condition of the inner casing of well 299-E25-40.

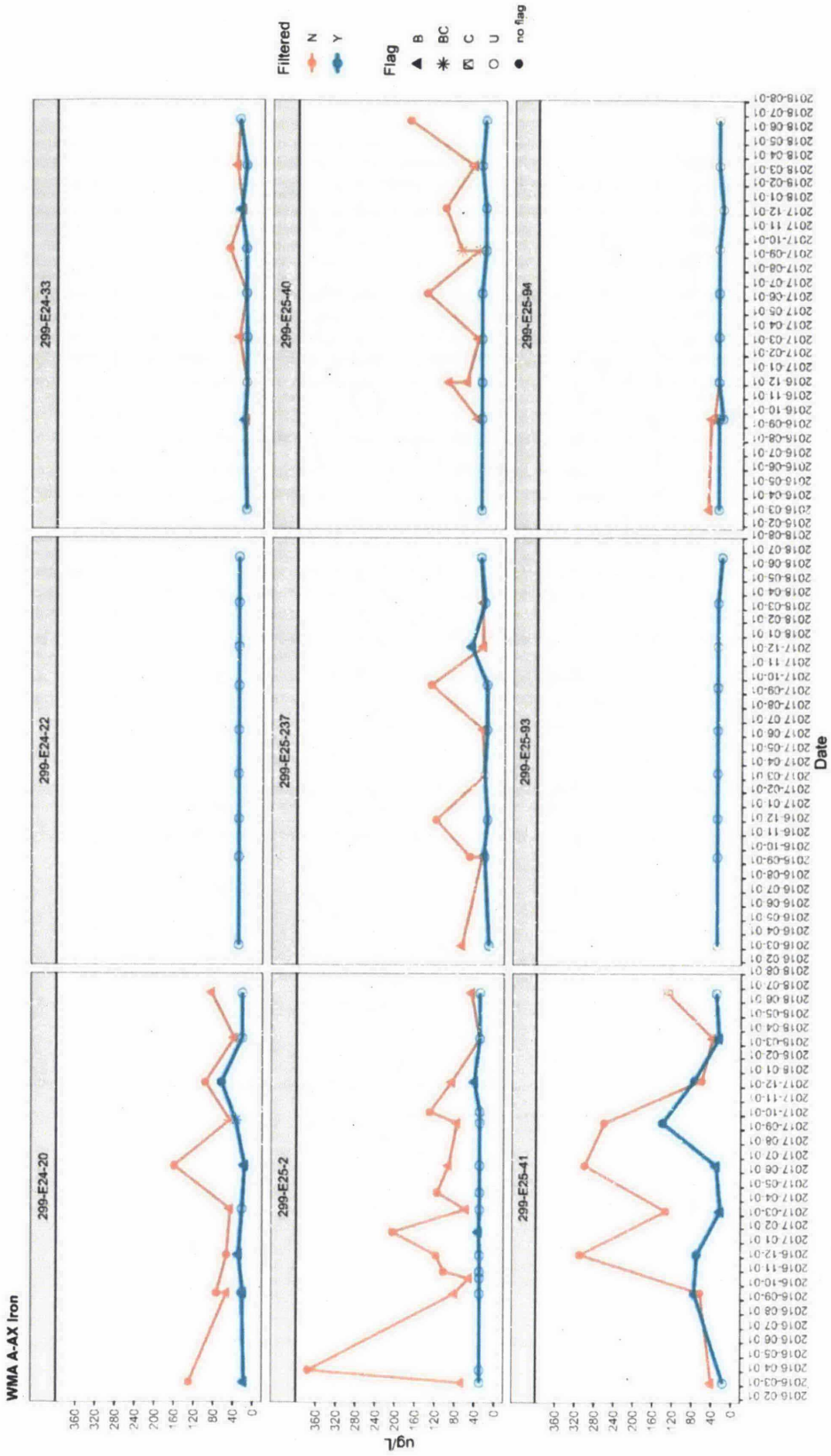
Definitive signs of casing corrosion were not identified, but portions of the well screen above the water table had attributes of breakdown. Nickel concentrations in this well continue to be elevated but have been showing a stable trend since mid-2007. Nickel has low mobility under conditions observed in Hanford Site groundwater, making it unlikely that nickel detected at well 299-E25-40 is from single-shell tanks or any liquid waste facility within WMA A-AX. Nickel (nickel II, the most soluble state for nickel) has a retardation factor (distribution coefficient [K_d]) in the range of 300 to over 4,000 mL/g (PNNL-13895, *Hanford Contaminant Distribution Coefficient Database and Users Guide*). In contrast, the highly mobile nitrate and technetium-99 have K_d values near zero. The higher K_d values for nickel are associated with pH values >7. With the high alkalinity and ubiquitous carbonates typical of Hanford Site groundwater, groundwater pH remains above 7. In a groundwater environment with pH >7, it is unlikely that nickel would be transported through the vadose zone beneath WMA A-AX and encounter the water table. Because of known corrosion issues and indications from unfiltered versus filtered concentrations, nickel is not considered a dangerous waste/dangerous waste constituent associated with WMA A-AX.

Chloroform (Figure 7) was detected at low-level concentrations in upgradient wells 299-E24-20 and 299-E24-22 and in downgradient well 299-E25-237. All instances of chloroform detections were associated with the "J" laboratory qualifier that indicates that the analytical result is an estimated value above the method detection limit (MDL) and below the required detection limit. Consistent, consecutive "J" qualifiers suggest that the organic constituent is detectable in groundwater at very low concentrations. Unspecified organic waste was received from the Plutonium-Uranium Extraction (PUREX) Plant and introduced to the WMA A-AX tanks over the years of operation (RPP-ENV-37956, *Hanford A and AX-Farm Leak Assessments Report: 241-A-103, 241-A-104, 241-A-105, 241-AX-102, 241-AX-104 and Unplanned Waste Releases*). It is possible that chloroform was a component of the organic wastes mixture because chloroform is a known component of the PUREX waste stream (WHC-EP-0342, Addendum 2, *PUREX Plant Chemical Sewer Stream-Specific Report*). Chloroform was found to be statistically significant in the comparison of upgradient well 299-E24-22 and downgradient well 299-E25-237 (Table 2). The sample mean of chloroform in well 299-E25-237 (0.4 µg/L) was also greater than that in both upgradient wells where it was detected (0.17 and 0.26 µg/L in wells 299-E24-20 and 299-E24-22, respectively). Thus, it is possible that WMA A-AX has contributed to the low-level chloroform detections at the downgradient location well 299-E25-237. However, chloroform is not considered a dangerous waste groundwater contaminant attributable to WMA A-AX because its detections are estimated values as indicated by the associated "J" qualifiers.



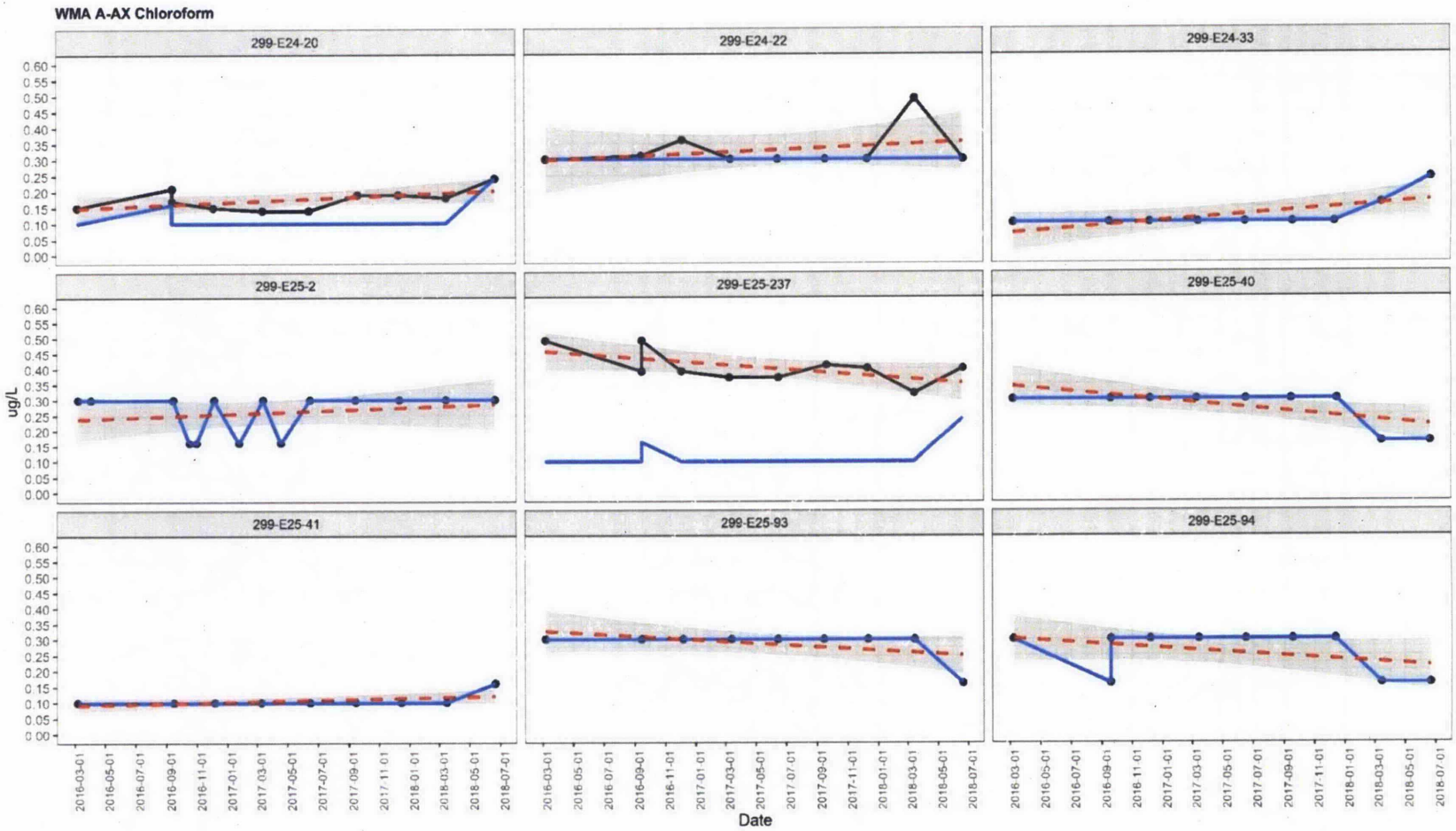
Notes: Wells 299-E24-20, 299-E24-22, and 299-E24-33 are upgradient. The black dashed horizontal line indicates the Hanford sitewide background value for nickel of 1.98 µg/L.

Figure 5. WMA A-AX Nickel



Notes: Wells 299-E24-20, 299-E24-22, and 299-E24-33 are upgradient. The Hanford sitewide background value for iron of 1,104 µg/L.

Figure 6. WMA A-AX Iron



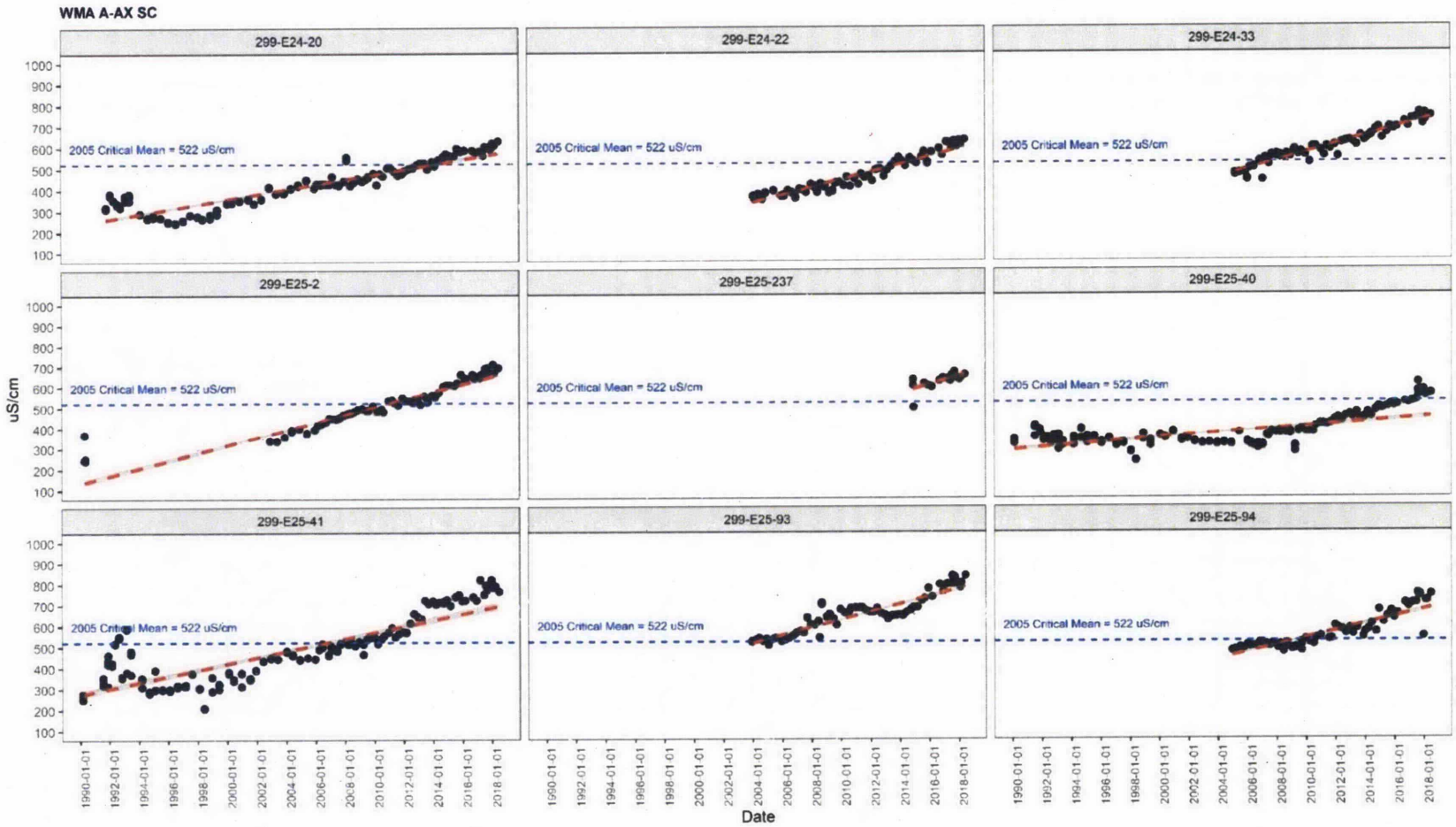
Notes: Wells 299-E24-20, 299-E24-22, and 299-E24-33 are upgradient. The gray shaded area represents the range of standard error. The blue line represents the method detection limit at the time of sampling. The red dashed line represents the simple linear data trend.

Figure 7. WMA A-AX Chloroform

Sulfide was detected at a single WMA A-AX network well location (299-E25-2) and therefore was not subjected to statistical comparison. Sulfide values were above the sitewide background threshold value of 2.35 µg/L in all samplings but MDLs are much higher than the background threshold value. Sulfide was analyzed by U.S. Environmental Protection Agency (EPA) Method 9034 (SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*), which has an MDL of 1,000 µg/L, from March 2016 to January 2017. Samples collected after January 2017 were analyzed by EPA Method 4500 D (SW-846), which has an MDL of 33 µg/L. Valid, consecutive sulfide detections occurred in well 299-E25-2 between April 2016 and December 2016. These values ranged between nondetect and 3,380 µg/L (Table A-1, Appendix A). The max value of 3,380 µg/L is a single high value with the rest of the valid detections being much closer to the Method 9034 MDL of 1,000 µg/L. The valid detections excluding the maximum value ranged from 1,370 to 1,570 µg/L, which are relatively close to the MDL. All subsequent values were nondetects. The regional presence of sulfate in groundwater is likely a potential source of the elevated sulfide in well 299-E25-2. Sulfur-reducing bacteria in low-oxygen environments such as deep wells can reduce sulfate to sulfide. Well 299-E25-2 has had declining water levels since 1990 and its open interval is defined by casing perforations rather than a stainless steel screen. The perforations could be occluded which would limit groundwater flow through the well and in return intrawell dissolved oxygen concentrations would be reduced. The groundwater sampling report from March 2, 2019, listed a low dissolved oxygen of 2.95 mg/L at the beginning of purging. Dissolved oxygen at the time of sampling was 7.71 mg/L, which is lower than the average measured dissolved oxygen of 8.3 mg/L for the entire WMA A-AX monitoring network for the period of assessment from March 2016 to June 2018. Because of sulfide values being relatively low, detected only at a single downgradient location, and the likelihood of sulfate reduction within well 299-E25-2, sulfide is not considered a dangerous waste constituent attributable to WMA A-AX.

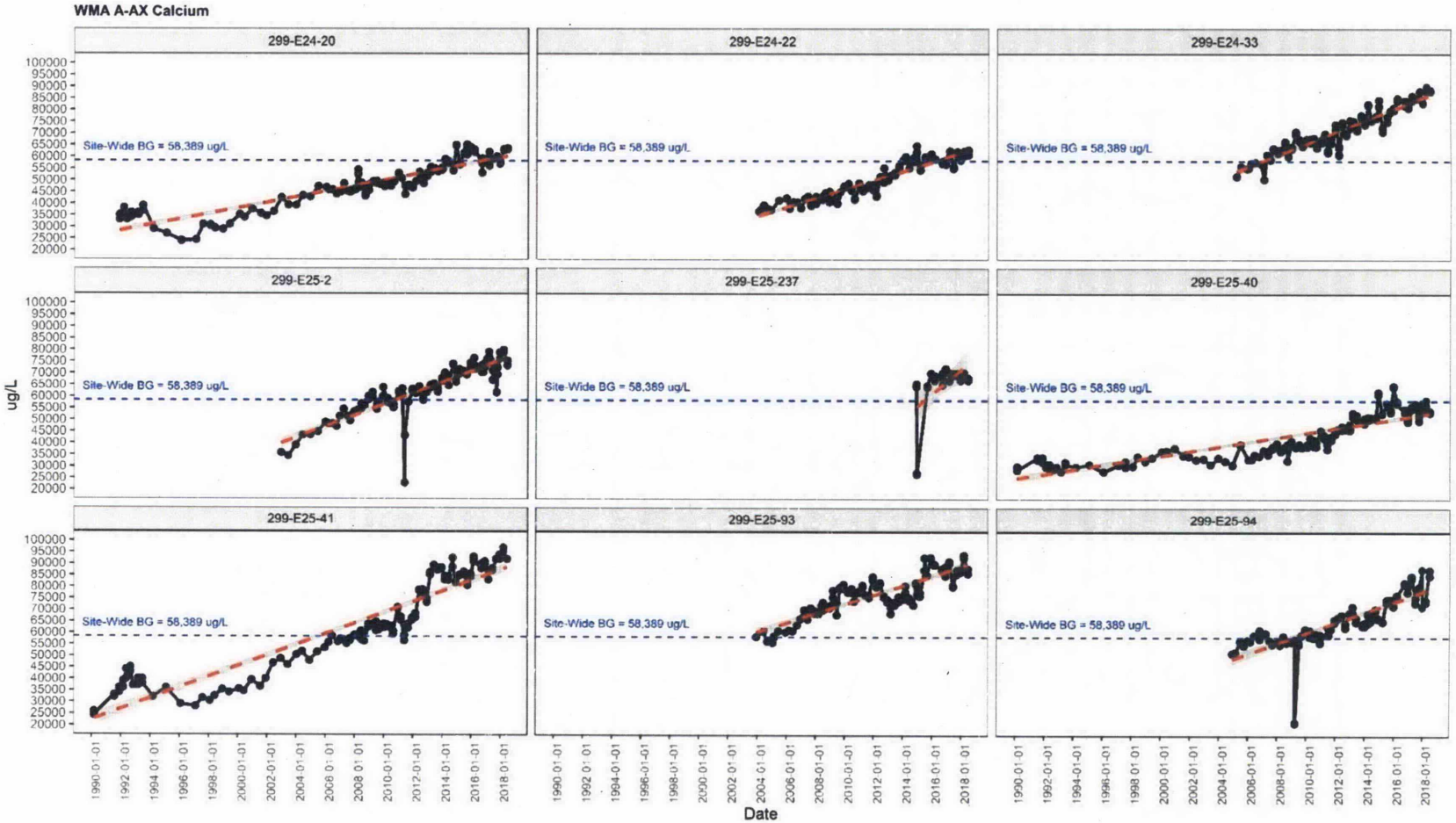
Vanadium in filtered aliquots was found above the background levels at two upgradient (299-E24-20 and 299-E24-22) and six downgradient (299-E25-2, 299-E25-40, 299-E25-41, 299-E25-93, 299-E25-94, and 299-E25-237) WMA A-AX wells. Downgradient wells 299-E25-237, 299-E25-93, and 299-E25-94 had filtered vanadium sample concentration populations statistically significant in comparison to the upgradient sample populations in both upgradient wells. Well 299-E25-2 is statistically significant compared to upgradient well 299-E24-20 and wells 299-E25-40 and 299-E25-41 are statistically significant compared to upgradient well 299-E24-22. Downgradient filtered vanadium sample mean concentrations are less than the upgradient mean concentration in well 299-E24-20, but downgradient concentrations are higher at all locations (with the exception of 299-E25-2) than at upgradient well 299-E24-22. These results could indicate that WMA A-AX could be contributing vanadium to the groundwater, but tank waste inventories obtained from the Hanford Tank Waste Inventory System do not show vanadium as part of the inventory of the 241-A and 241-AX tanks. Since the 241-A and AX tank inventories do not list vanadium, it is unlikely that WMA A-AX is attributable for groundwater vanadium contamination detected in downgradient monitoring locations.

Specific conductance concentrations (Figure 8) are increasing at WMA A-AX and would likely exceed critical means calculated in the future because of elevated nitrate and sulfate levels. Specific conductance increases at some sites (such as WMA A-AX and A-29 Ditch) coincide with the migration patterns of the larger sulfate and nitrate plumes. Calcium, nitrate, and sulfate trends (Figures 9 through 11) also continue to rise and could serve as drivers for the increasing specific conductance trends in all WMA A-AX monitoring network wells. For these reasons, specific conductance is not a definitive indicator of contamination release to groundwater at WMA A-AX at this time.



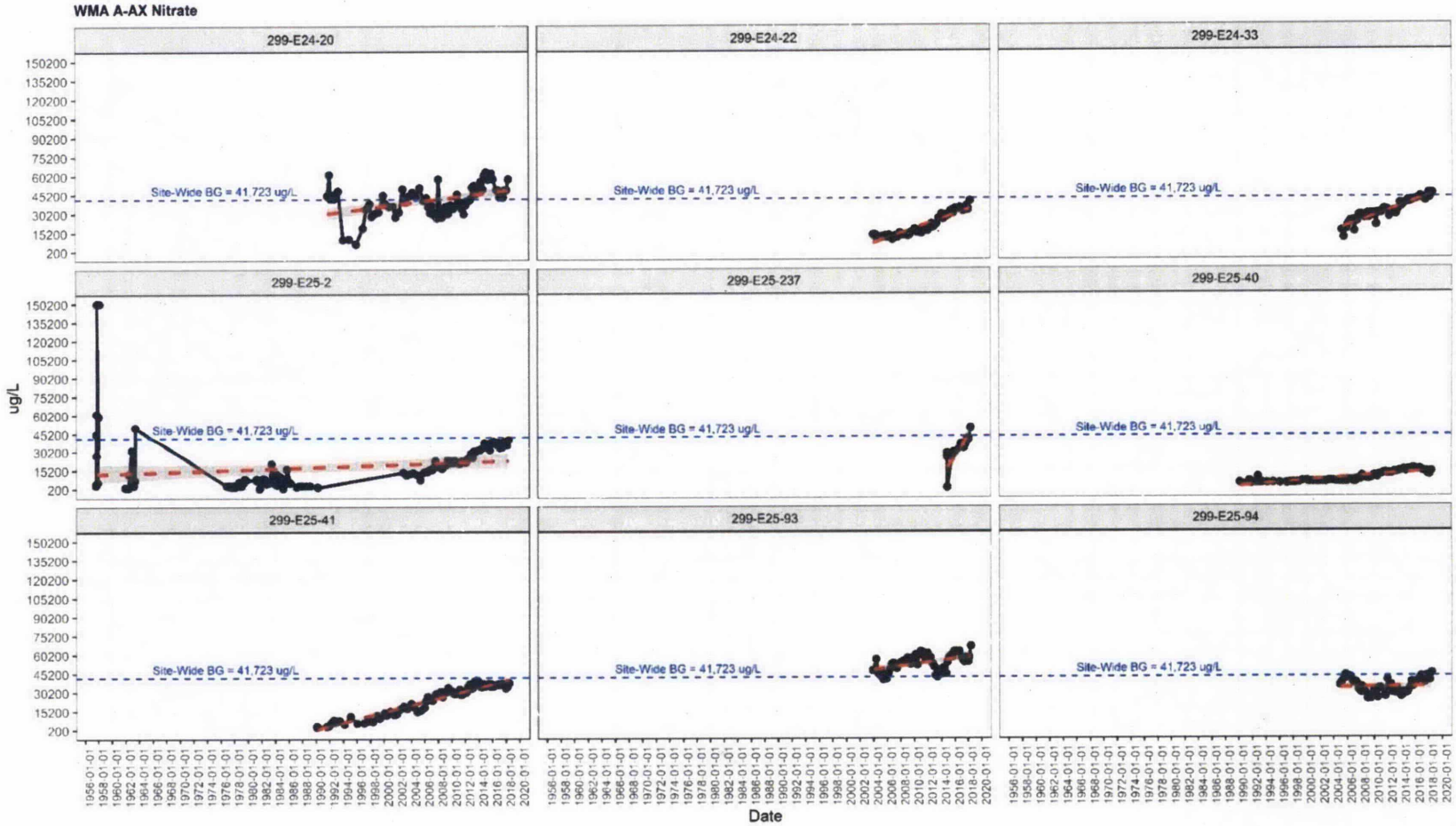
Notes: Wells 299-E24-20, 299-E24-22, and 299-E24-33 are upgradient. The gray shaded area represents the range of standard error. The red dashed line represents the simple linear data trend.

Figure 8. WMA A-AX Specific Conductance



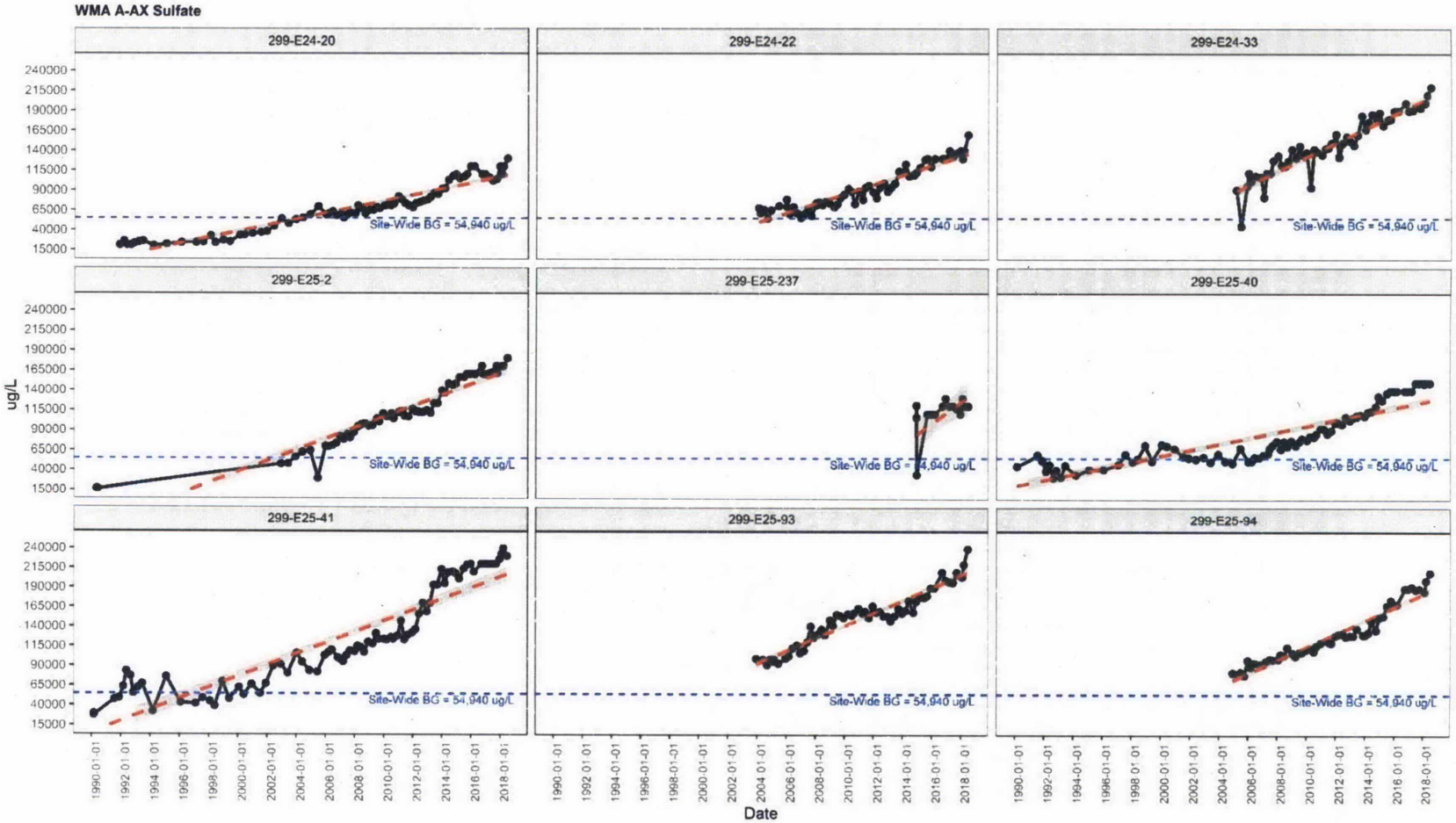
Notes: Wells 299-E24-20, 299-E24-22, and 299-E24-33 are upgradient. The gray shaded area represents the range of standard error. The red dashed line represents the simple linear data trend.

Figure 9. WMA A-AX Calcium



Notes: Wells 299-E24-20, 299-E24-22, and 299-E24-33 are upgradient. The gray shaded area represents the range of standard error. The red dashed line represents the simple linear data trend.

Figure 10. WMA A-AX Nitrate



Notes: Wells 299-E24-20, 299-E24-22, and 299-E24-33 are upgradient. The gray shaded area represents the range of standard error. The red dashed line represents the simple linear data trend.

Figure 11. WMA A-AX Sulfate

3.2 Supporting Constituents

Supporting constituents and field parameters provide information on general water chemistry and allow charge-balance computations to assess laboratory performance. The supporting constituents (nickel, chromium, manganese, and iron) provide information about corrosion of the stainless steel well screens and casings. Alkalinity and anions along with metal cations are used to compute charge balance for judging sample integrity. Assessment results of all supporting constituents for the WMA A-AX monitoring well network are listed in ECF-200PO1-19-0007, Appendix A, AAX_spprtng_cnsttnts.xlsx.

Chromium, iron, and nickel as discussed previously, have been elevated in multiple WMA A-AX monitoring wells where corrosion issues have been noted. Results of other metals including calcium, magnesium, manganese, potassium, and sodium were unremarkable.

3.3 Tentatively Identified Compounds

DOE/RL-2015-49 specifies that tentatively identified compound results also be evaluated. A single instance of a tentatively identified compound occurred for the June 2018 sampling event in well 299-E25-94 in which isopropyl alcohol was tentatively identified. Being that this substance is common in hand sanitizers and household cleaners, and because of its isolated occurrence of detection, isopropyl alcohol is not considered a groundwater contaminant attributable to WMA A-AX.

4 Conclusion

WMA A-AX has undergone assessment monitoring since 2005 under PNNL-15315 and most recently under DOE/RL-2015-49. Nine quarters of assessment monitoring, from March 2016 to June 2018, produced data for evaluation of potentially dangerous waste/dangerous waste constituents. During the assessment, specific conductance levels continued to increase in all wells at WMA A-AX (i.e., both upgradient and downgradient). Based on the evaluation process, seven (chloroform, chromium, copper, nickel, octachlorodibenzo-p-dioxin, sulfide, and vanadium) of the potentially dangerous waste/dangerous waste constituents required further evaluation. Further evaluation did not find that these dangerous waste constituents present in groundwater were attributable to WMA A-AX.

This first determination report does not definitively identify any dangerous waste constituents in groundwater that are attributable to WMA A-AX. Chloroform was measured at low-level concentrations but is not considered a dangerous waste constituent attributable to WMA A-AX because concentrations are estimated values with associated "J" qualifiers. However, it is recommended that volatile organic compounds (to include chloroform) continue to be monitored because the potential exists for groundwater concentrations to increase due to tank inventory volatile organic compound listings at the site. It is recommended that the site revert back to detection monitoring of the indicator parameters pH, specific conductivity, total organic carbon, and total organic halogens. Monitoring for site-specific constituents including EPA Method 8260 (SW-846) for chloroform and EPA Method 6020 (SW-846) for metals (filtered and unfiltered) is recommended in addition to detection monitoring parameters. Anions and field parameters including pH, temperature, turbidity, and specific conductivity will be analyzed to monitor sample integrity. Semi-annual monitoring for the revised constituent list is recommended.

This report fulfills the requirements of the first determination as described in 40 CFR 265.93(d)(5).

5 References

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265.93, "Preparation, Evaluation, and Response."

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Appendix A

Assessment Sampling Detection Results

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Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]
299-E24-20	Chloroform	8260_VOA_GCMS	03/08/2016	0.15	J
			09/15/2016	0.21	J
			09/15/2016	0.17	J
			12/06/2016	0.15	J
			03/14/2017	0.14	J
			06/15/2017	0.14	J
			09/20/2017	0.19	J
			12/11/2017	0.19	J
			03/16/2018	0.18	J
			06/21/2018	0.24	U
299-E24-22	Chloroform	8260_VOA_GCMS	03/08/2016	0.3	U
			09/15/2016	0.31	J
			12/06/2016	0.36	J
			03/13/2017	0.3	U
			06/15/2017	0.3	J
			09/18/2017	0.3	U
			12/11/2017	0.3	U
			03/16/2018	0.49	BJ
			06/22/2018	0.3	U
299-E25-237	Chloroform	8260_VOA_GCMS	03/07/2016	0.49	J
			09/16/2016	0.39	J
			09/16/2016	0.49	J
			12/04/2016	0.39	J
			03/10/2017	0.37	J
			06/16/2017	0.37	J
			09/20/2017	0.41	J
			12/11/2017	0.4	J
			03/15/2018	0.32	J
			06/21/2018	0.4	J
299-E24-20	Chromium	6020_METALS_ICPMS	03/08/2016	34	
			03/08/2016	5	B
			09/15/2016	19	
			09/15/2016	6.7	B
			09/15/2016	11	
			09/15/2016	6.3	
			12/06/2016	3.9	B

Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]
299-E24-20	Chromium	6020_METALS_ICPMS	12/06/2016	11	
			03/14/2017	25.1	N
			03/14/2017	5.3	
			06/15/2017	40	
			06/15/2017	6.2	B
			09/20/2017	11	
			09/20/2017	4.1	B
			12/11/2017	5.5	B
			12/11/2017	30	
			03/16/2018	6.6	
			03/16/2018	10.6	
			06/21/2018	6.7	
			06/21/2018	19.9	
299-E24-22	Chromium	6020_METALS_ICPMS	03/08/2016	4.21	CB
			03/08/2016	5.12	CB
			09/15/2016	3.99	B
			09/15/2016	3.65	B
			12/06/2016	4.03	B
			12/06/2016	4.05	B
			03/13/2017	4.11	B
			03/13/2017	3.99	B
			06/15/2017	3.85	B
			06/15/2017	4.05	B
			09/18/2017	4.3	B
			09/18/2017	4.03	B
			12/11/2017	4.62	B
			12/11/2017	4.51	B
			03/16/2018	3.61	B
			03/16/2018	3.6	B
			06/22/2018	3.87	B
			06/22/2018	4.02	B
299-E25-2	Chromium	6020_METALS_ICPMS	03/08/2016	7.78	CB
			03/08/2016	3.52	CB
			04/04/2016	9.49	CB
			04/04/2016	4.11	CB
			09/15/2016	6.37	B

Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]
299-E25-2	Chromium	6020_METALS_ICPMS	09/15/2016	3	U
			10/18/2016	3	U
			10/18/2016	5.79	B
			11/01/2016	6.78	B
			11/01/2016	3	U
			12/06/2016	6.16	B
			12/06/2016	3	U
			01/25/2017	9.61	B
			01/25/2017	3	U
			03/14/2017	5.92	B
			03/14/2017	3	U
			04/19/2017	8.1	BD
			04/19/2017	4	UD
			06/16/2017	7.81	B
			06/16/2017	3	U
			09/15/2017	6.24	B
			09/15/2017	3	U
			10/09/2017	3	U
			10/09/2017	6.17	B
			12/12/2017	7.5	B
			12/12/2017	4.3	B
			03/15/2018	3	U
			03/15/2018	3	U
			06/21/2018	3	U
			06/21/2018	3	U
299-E25-40	Chromium	6020_METALS_ICPMS	03/07/2016	15.7	
			03/07/2016	5	B
			09/19/2016	10	
			09/19/2016	4.51	B
			12/07/2016	23.7	
			12/07/2016	14.3	
			12/07/2016	4.35	B
			12/07/2016	3.35	B
			03/10/2017	9.67	B
			03/10/2017	3	U
			06/16/2017	128	

Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]
299-E25-40	Chromium	6020_METALS_ICPMS	06/16/2017	3	U
			09/15/2017	3.2	
			09/15/2017	3.6	
			09/15/2017	8.7	
			09/15/2017	8.2	
			12/15/2017	10.4	
			12/15/2017	3.6	
			03/16/2018	14	
			03/16/2018	3.2	B
			06/21/2018	34.2	
			06/21/2018	2.5	
299-E25-41	Chromium	6020_METALS_ICPMS	03/07/2016	11	
			03/07/2016	10	
			03/07/2016	2.5	B
			03/07/2016	3.1	B
			09/16/2016	3	B
			09/16/2016	8.2	B
			12/07/2016	1.5	B
			12/07/2016	46	
			03/10/2017	2.7	
			03/10/2017	27.3	N
			06/16/2017	69	
			06/16/2017	3.6	B
			09/15/2017	13	
			09/15/2017	3	U
			12/15/2017	9.5	B
			12/15/2017	3	B
			03/16/2018	9.1	
			03/16/2018	3	
			06/21/2018	5.5	BC
			06/21/2018	25	
299-E25-93	Chromium	6020_METALS_ICPMS	03/07/2016	2.11	B
			03/07/2016	2.35	B
			09/15/2016	21	
			09/15/2016	23.3	
			12/07/2016	3.85	B

Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]
299-E25-93	Chromium	6020_METALS_ICPMS	12/07/2016	3	U
			03/14/2017	3	U
			03/14/2017	3	U
			06/15/2017	3	U
			06/15/2017	3	U
			09/15/2017	3	U
			09/15/2017	3	U
			12/12/2017	4.5	BD
			12/12/2017	4	UD
			03/15/2018	3.04	B
			03/15/2018	3	U
			06/21/2018	2.7	
			06/21/2018	2.1	
299-E24-20	Copper	6020_METALS_ICPMS	03/08/2016	1.1	U
			03/08/2016	3.6	B
			09/15/2016	1.2	B
			09/15/2016	0.75	B
			09/15/2016	1.1	U
			09/15/2016	2.2	B
			12/06/2016	3.9	B
			12/06/2016	1.1	U
			03/14/2017	0.65	B
			03/14/2017	2.5	
			06/15/2017	6	U
			06/15/2017	6	U
			09/20/2017	1.6	U
			09/20/2017	1.6	U
			12/11/2017	11	
			12/11/2017	10	
			03/16/2018	3.2	
			03/16/2018	1.7	B
			06/21/2018	2.1	
			06/21/2018	0.56	U
			03/07/2016	1.42	
			03/07/2016	2.29	
			09/19/2016	1.22	

Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]
299-E24-20	Copper	6020_METALS_ICPMS	09/19/2016	1.65	
			12/07/2016	0.596	B
			12/07/2016	0.516	B
			12/07/2016	2.67	
			12/07/2016	2.39	
299-E25-40	Copper	6020_METALS_ICPMS	03/10/2017	1.15	
			03/10/2017	1.34	
			06/16/2017	0.454	B
			06/16/2017	1.17	
			09/15/2017	0.56	U
			09/15/2017	0.56	U
			09/15/2017	0.67	B
			09/15/2017	0.72	B
			12/15/2017	0.56	U
			12/15/2017	0.56	U
			03/16/2018	0.485	B
			03/16/2018	1.19	
			06/21/2018	0.8	B
			06/21/2018	0.56	U
			03/07/2016	1.1	U
			03/07/2016	1.1	U
			03/07/2016	1.1	U
			03/07/2016	1.1	U
299-E25-41	Copper	6020_METALS_ICPMS	09/16/2016	1.1	U
			09/16/2016	1.1	U
			12/07/2016	1.9	B
			12/07/2016	1.1	U
			03/10/2017	2.4	
			03/10/2017	0.56	U
			06/16/2017	6	U
			06/16/2017	7	B
			09/15/2017	6	U
			09/15/2017	6	U
			12/15/2017	11	
			12/15/2017	9.8	
			03/16/2018	0.56	U

Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]
299-E25-41	Copper	6020_METALS_ICPMS	03/16/2018	0.56	U
			06/21/2018	0.32	U
			06/21/2018	0.32	U
299-E25-94	Copper	6020_METALS_ICPMS	03/08/2016	1.49	
			03/08/2016	0.928	B
			03/08/2016	1.02	
			03/08/2016	1.14	
			09/19/2016	0.56	UO
			09/19/2016	0.56	U
			09/19/2016	0.381	B
			09/19/2016	0.535	B
			12/07/2016	1.27	
			12/07/2016	1.73	
			03/14/2017	0.451	B
			03/14/2017	0.372	B
			06/16/2017	0.365	B
			06/16/2017	0.393	B
			09/18/2017	0.49	BD
			09/18/2017	1	D
			12/12/2017	0.56	U
			12/12/2017	0.56	U
			03/15/2018	1.9	UD
			03/15/2018	9.4	D
			06/21/2018	0.3	U
			06/21/2018	0.3	U
299-E24-20	Nickel	6020_METALS_ICPMS	03/08/2016	18	
			03/08/2016	4.8	B
			09/15/2016	4.5	
			09/15/2016	3.1	
			09/15/2016	10	B
			09/15/2016	9.4	B
			12/06/2016	4.5	B
			12/06/2016	8.1	B
			03/14/2017	3.3	
			03/14/2017	11.3	
			06/15/2017	11	U

Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]
299-E24-20	Nickel	6020_METALS_ICPMS	06/15/2017	19	B
			09/20/2017	2.8	B
			09/20/2017	4.3	B
			12/11/2017	8.7	B
			12/11/2017	18	B
			03/16/2018	2.8	
			03/16/2018	4	
			06/21/2018	3	
			06/21/2018	6.7	
299-E25-2	Nickel	6020_METALS_ICPMS	03/08/2016	4.3	
			03/08/2016	3.6	
			04/04/2016	3.6	
			04/04/2016	4.93	
			09/15/2016	2.2	
			09/15/2016	3.14	
			10/18/2016	2.2	
			10/18/2016	2.84	
			11/01/2016	2.6	
			11/01/2016	3.79	
			12/06/2016	2.25	
			12/06/2016	3.19	
			01/25/2017	2.98	
			01/25/2017	5.08	
			03/14/2017	1.89	B
			03/14/2017	2.89	
			04/19/2017	3	BD
			04/19/2017	2.8	BD
			06/16/2017	4.25	
			06/16/2017	2.19	
			09/15/2017	3.35	
			09/15/2017	2.38	
			10/09/2017	2.3	
			10/09/2017	2.98	
			12/12/2017	3.86	
			12/12/2017	2.94	
			03/15/2018	0.6	U

Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]
299-E25-2	Nickel	6020_METALS_ICPMS	03/15/2018	0.6	U
			06/21/2018	0.6	U
			06/21/2018	0.6	U
299-E25-40	Nickel	6020_METALS_ICPMS	03/07/2016	25.3	
			03/07/2016	21.8	
			09/19/2016	14.9	
			09/19/2016	12.8	
			12/07/2016	18.9	
			12/07/2016	18.8	
			12/07/2016	25	
			12/07/2016	26.6	
			03/10/2017	18.1	
			03/10/2017	20.8	
			06/16/2017	17.3	
			06/16/2017	73.5	
			09/15/2017	20.3	
			09/15/2017	20.7	
			09/15/2017	24.4	
			09/15/2017	24.4	
			12/15/2017	19.4	
			12/15/2017	18.2	
			03/16/2018	18.6	
			03/16/2018	13.9	
			06/21/2018	12	
			06/21/2018	23.6	
299-E25-41	Nickel	6020_METALS_ICPMS	03/07/2016	6.3	
			03/07/2016	5.8	
			03/07/2016	4.2	U
			03/07/2016	4.2	U
			09/16/2016	6.9	B
			09/16/2016	9.1	B
			12/07/2016	22	
			12/07/2016	4.2	U
			03/10/2017	2.8	
			03/10/2017	13.3	N

Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]
299-E25-41	Nickel	6020_METALS_ICPMS	06/16/2017	11	U
			06/16/2017	34	
			09/15/2017	11	U
			09/15/2017	11	U
			12/15/2017	10	B
			12/15/2017	7.8	B
			03/16/2018	4.4	
			03/16/2018	2.9	
			06/21/2018	3.9	B
			06/21/2018	12	B
299-E25-41	Octachlorodibenzo-p-dioxin	8290_DIOXINS_GCMS	03/07/2016	1.1E-06	QBJ
			03/07/2016	0.000004	BJ
			09/16/2016	1.1E-06	QJ
			12/07/2016	1.2E-06	BJ
			03/10/2017	1.06E-06	JB
			06/16/2017	8.6E-07	JB
			06/16/2017	3.12E-05	B
			09/15/2017	1.87E-05	JB
			12/15/2017	1.3E-07	U
			03/16/2018	6.21E-06	J
			06/21/2018	1.71E-06	J
299-E25-2	Sulfide	9034_SULFIDE	03/08/2016	1,000	U
			04/04/2016	1,000	U
			09/15/2016	1,370	B
			10/18/2016	1,440	B
			11/01/2016	3,380	
			12/06/2016	1,570	B
			01/25/2017	1,000	U
299-E25-2	Sulfide	4500D_SULFIDE	03/14/2017	33	U
			04/19/2017	33	U
			06/16/2017	33	U
			09/15/2017	33	U
			12/12/2017	33	U
			03/15/2018	33	U
			06/21/2018	33	U

Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]
299-E24-20	Vanadium	6010_METALS_ICP	03/08/2016	23	
			03/08/2016	23	
			09/15/2016	23	
			09/15/2016	22	
299-E24-20	Vanadium	6010_METALS_ICP	09/15/2016	20.4	
			09/15/2016	23.4	
			12/06/2016	23	
			12/06/2016	23	
			03/14/2017	25.9	
			03/14/2017	24.5	
			06/15/2017	24	
			06/15/2017	24	
			09/20/2017	25	
			09/20/2017	25	
			12/11/2017	23	
			12/11/2017	23	
			03/16/2018	24.1	
			03/16/2018	24.5	
			06/21/2018	22.6	
			6/21/2018	22.7	
299-E24-22	Vanadium	6010_METALS_ICP	03/08/2016	20.1	
			03/08/2016	20.1	
			09/15/2016	20.3	
			09/15/2016	19.7	
			12/06/2016	20	
			12/06/2016	21.1	
			03/13/2017	18.8	
			03/13/2017	19.1	
			06/15/2017	18.5	
			06/15/2017	18	
			09/18/2017	19.3	
			09/18/2017	18.7	
			12/11/2017	18.7	
			12/11/2017	19.3	
			03/16/2018	19.6	

Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]
299-E24-22	Vanadium	6010_METALS_ICP	03/16/2018	18.9	
			06/22/2018	18.4	
			06/22/2018	19.2	
299-E25-2	Vanadium	6010_METALS_ICP	03/08/2016	21.1	
			03/08/2016	21.7	
			04/04/2016	19.7	
			04/04/2016	18.8	
			09/15/2016	19.8	
			09/15/2016	19.2	
			10/18/2016	20.7	
			10/18/2016	20.4	
			11/01/2016	19.8	
			11/01/2016	19.4	
			12/06/2016	19.4	
			12/06/2016	20.4	
			01/25/2017	19.4	
			01/25/2017	20.6	
			03/14/2017	20.2	
			03/14/2017	19.7	
			04/19/2017	25	U
			04/19/2017	25	U
			06/16/2017	17.7	
			06/16/2017	16.3	
			09/15/2017	15.1	
			09/15/2017	18.2	
			10/09/2017	18.7	
			10/09/2017	17.7	
			12/12/2017	19.3	
			12/12/2017	18.6	
			03/15/2018	20.1	
			03/15/2018	19.7	
			06/21/2018	19.2	
			06/21/2018	18.4	

Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]
299-E25-237	Vanadium	6010_METALS_ICP	03/07/2016	24.8	B
			03/07/2016	21.9	B
			09/16/2016	22	
			09/16/2016	20.3	
			09/16/2016	20.5	
			09/16/2016	22	
			12/04/2016	21	
			12/04/2016	21	
			03/10/2017	21.1	C
			03/10/2017	24.1	
			06/16/2017	21	
			06/16/2017	21	
			09/20/2017	22	C
			09/20/2017	21	C
			12/11/2017	22	
			12/11/2017	21	
			03/15/2018	22.6	
			03/15/2018	22.8	
			06/21/2018	21	
			06/21/2018	22	
299-E25-40	Vanadium	6010_METALS_ICP	03/07/2016	23.2	
			03/07/2016	23.7	
			09/19/2016	22.3	
			09/19/2016	22.5	
			12/07/2016	23	
			12/07/2016	22.7	
			12/07/2016	21.6	
			12/07/2016	21	
			03/10/2017	23.5	
			03/10/2017	22.6	
			06/16/2017	23.9	
			06/16/2017	25.1	
			09/15/2017	20.9	
			09/15/2017	21.9	
			09/15/2017	21.1	

Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]
299-E25-40	Vanadium	6010_METALS_ICP	09/15/2017	21.5	
			12/15/2017	23.2	
			12/15/2017	21.9	
			03/16/2018	21.1	
			03/16/2018	21.4	
			06/21/2018	24.9	
			06/21/2018	25.4	
299-E25-41	Vanadium	6010_METALS_ICP	03/07/2016	23	
			03/07/2016	22	
			03/07/2016	22	
			03/07/2016	23	
			09/16/2016	22	
			09/16/2016	22	
			12/07/2016	21	
			12/07/2016	23	
			03/10/2017	24.5	
			03/10/2017	21.5	
			06/16/2017	21	
			06/16/2017	22	
			09/15/2017	24	
			09/15/2017	23	
			12/15/2017	22	
			12/15/2017	22	
			03/16/2018	22.9	
			03/16/2018	23.1	
			06/21/2018	23	
			06/21/2018	23	
299-E25-93	Vanadium	6010_METALS_ICP	03/07/2016	24.1	
			03/07/2016	23	
			09/15/2016	22.6	
			09/15/2016	23	
			12/07/2016	22.9	
			12/07/2016	21.4	
			03/14/2017	21.4	
			03/14/2017	22.6	
			06/15/2017	21.2	

Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]
299-E25-93	Vanadium	6010_METALS_ICP	06/15/2017	20.9	
			09/15/2017	21.5	
			09/15/2017	21.9	
			12/12/2017	20.3	B
			12/12/2017	19	B
			03/15/2018	22.7	
			03/15/2018	22.4	
			06/21/2018	23.1	
			06/21/2018	23.7	
299-E25-94	Vanadium	6010_METALS_ICP	03/08/2016	21.5	
			03/08/2016	21.2	
			03/08/2016	21.6	
			03/08/2016	21.8	
			09/19/2016	20.5	
			09/19/2016	21.2	
			09/19/2016	21.2	
			09/19/2016	21.5	
			12/07/2016	21.9	
			12/07/2016	22.2	
			03/14/2017	21.7	
			03/14/2017	22.2	
			06/16/2017	20	
			06/16/2017	20.7	
			09/18/2017	23.4	B
			09/18/2017	25	B
			12/12/2017	23.1	
			12/12/2017	19.3	
			03/15/2018	20.5	BC
			03/15/2018	22.7	BC
			06/21/2018	20.1	
			06/21/2018	20.7	

Table A-1. Dangerous Waste Compounds Detected in March 2016 to June 2018 Assessment Sampling at WMA A-AX

Well	Constituent	Analytical Method[a]	Sampled Date	Concentration (µg/L)	Associated Laboratory Flag[b]

a. Method numbers are from SW-846, 2015, *Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, Third Edition; Final Update V*, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Compendium methods available at: https://www.epa.gov/hw-sw846/sw-846-compendium.

b. Laboratory flags:

D = The analyte was reported at secondary dilution factor

B = The analyte was detected in both the associated quality control blank and the sample

C = The analyte was detected in both the sample and associated QC blank and the sample concentration was ≤5X the blank concentration

N = Spike and or spike duplicate recovery sample is outside control limits

QC = quality control

WMA = waste management area