DOE/RL-2012-35
Revision 0

First Determination RCRA Groundwater Quality Assessment Plan for Low-Level Burial Grounds Low-Level Waste Management Area-1

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
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Approved for Public Release;
Further Dissemination Unlimited

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Terms

Bgs	below ground surface
CFR	Code of Federal Regulations
CRDL	contractor required detection limit
DOE/RL	U.S. Department of Energy, Richland Operations Office
DQO	data quality objective
Ecology	Washington Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
HEIS	Hanford Environmental Information System
Hf	Hanford formation
LLBG	Low-Level Burial Grounds
LLWMA	Low-Level Waste Management Area
N/A	not applicable
NAVD88	North American Vertical Datum of 1988
PPu	Plio-Pleistocene Unit
RCRA	*Resource, Conservation, and Recovery Act of 1976*
SWMU	Solid Waste Management Unit
TOC	total organic carbon
TPH	total petroleum hydrocarbon
TDS	total dissolved solids
TSD	treatment, storage, and disposal
WAC	Washington Administrative Code
WMA	waste management area
WSCF	Waste Sampling and Characterization Facility

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1 Introduction

Groundwater beneath the 218-E-10 Burial Ground/Low-Level Waste Management Area-1 (LLWMA-1), shown on Figure 1, is monitored under the *Resource, Conservation, and Recovery Act of 1976* (RCRA) in accordance with WAC 173-303-400(3), "Dangerous Waste Regulations," "Interim Status Facility Standards," as defined by 40 CFR 265.92(d), "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis," since 1987. Under the interim status groundwater indicator parameter evaluation program pH, specific conductance, total organic carbon (TOC), and total organic halogen comparison values (defined by the critical mean) are determined from upgradient wells in accordance with 40 CFR 265.93(b), "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Preparation, Evaluation, and Response." The critical mean value is used for comparison with semi-annual sample results from downgradient wells to determine if a significant increase has occurred. Quadruplet samples for the indicator parameters at LLWMA-1 have been collected semi-annually in accordance with DOE/RL-2009-75, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-1*.

In a sample collected on January 25, 2012 from Well 299-E33-265, the critical mean value (1,330 µg/L) for TOC was exceeded (Figure 2). Well 299-E33-265 was installed in the summer of 2010 as a downgradient well for the RCRA monitoring of Trench 9. This trench received mixed waste after August 19, 1987 (Figure 3). The quadruplet TOC analyses for this well ranged between 2,620 µg/L and 2,740 µg/L, with an average value of 2,663 µg/L (Figure 2). The well was re-sampled on April 5, 2012, to determine if a laboratory error may have occurred in accordance with 40 CFR 265.93(c)(2). The split average quadruplet verification sample results were 1,375 and 1,468 µg/L. The first result was from Test America, St. Louis, Missouri, and the other result was from the Waste Sampling and Characterization Facility (WSCF), Hanford, Washington. Because the verification values exceed the critical mean, the results indicate LLWMA-1 may be affecting groundwater quality.

This plan provides the direction for wells to be sampled, analyses of constituents, and additional considerations for determining whether LLWMA-1 has impacted groundwater. Additional considerations include: past and present groundwater flow directions, upgradient liquid waste disposal history, and existing groundwater analytical results. Existing data will provide the framework for the sequence of actions to be completed to determine whether the LLWMA-1 has affected groundwater.

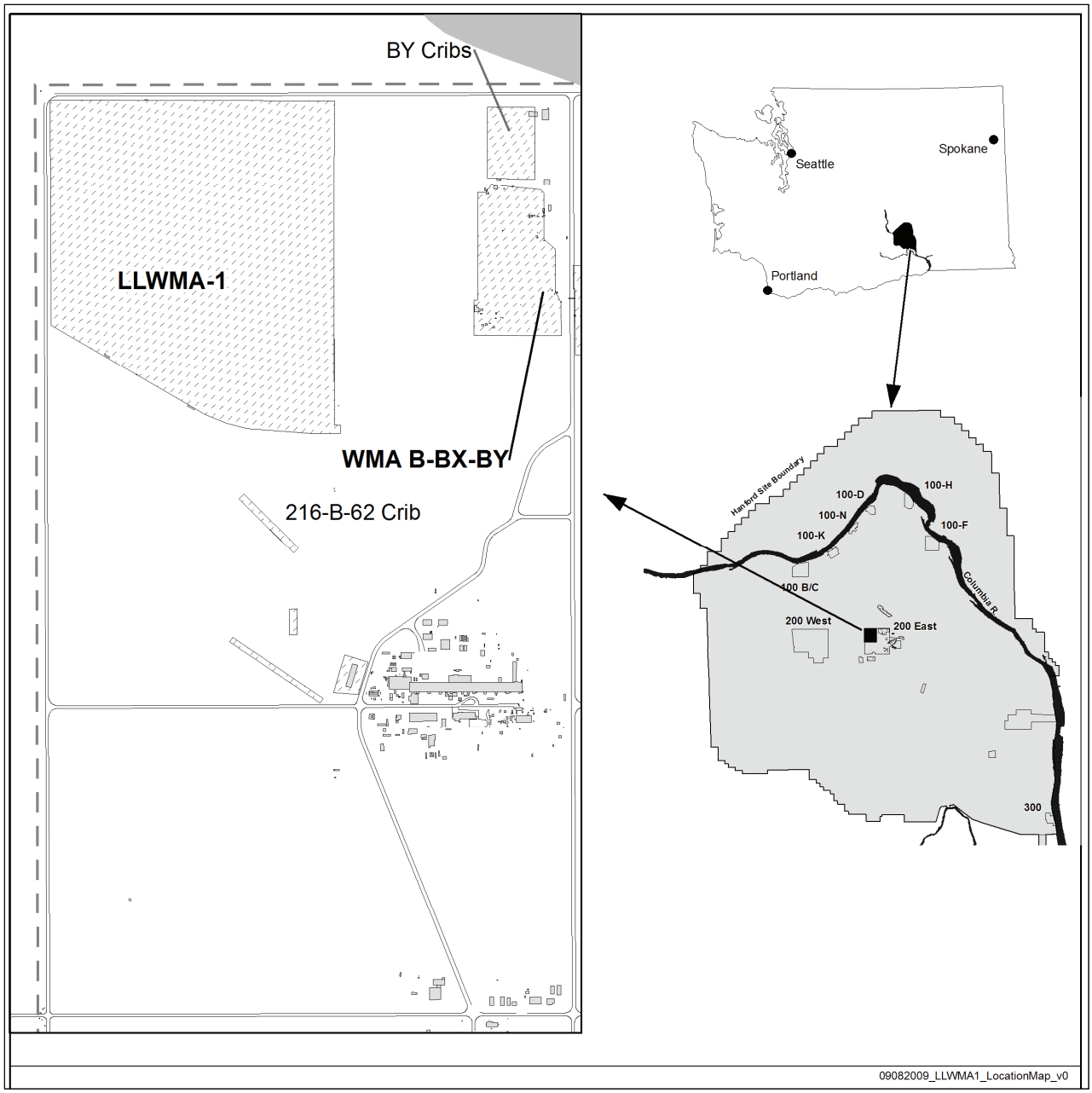


Figure 1. Location of Low-Level Waste Management Area-1

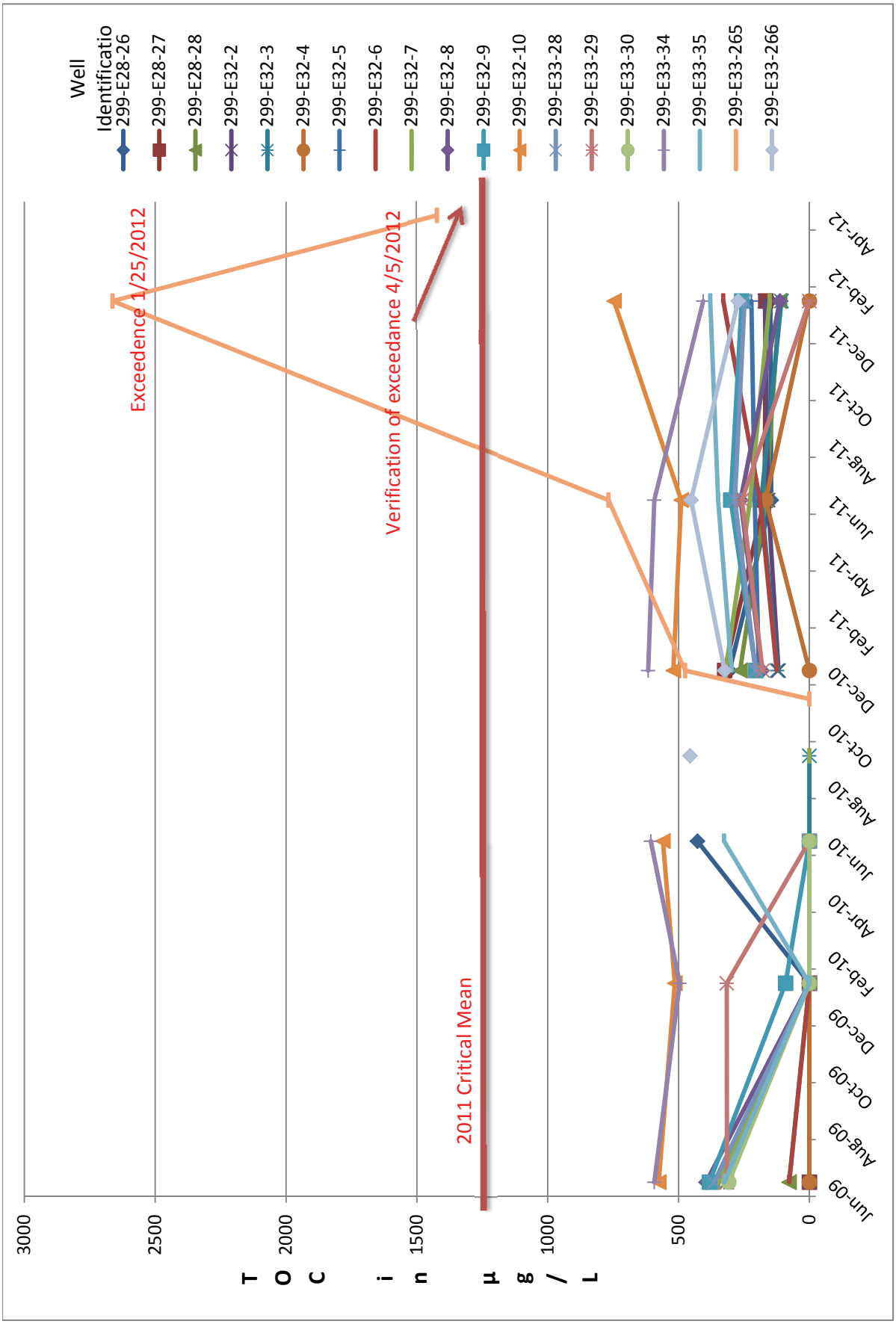


Figure 2. LLWMA-1 Total Organic Carbon Results from June 2009 to April 2012

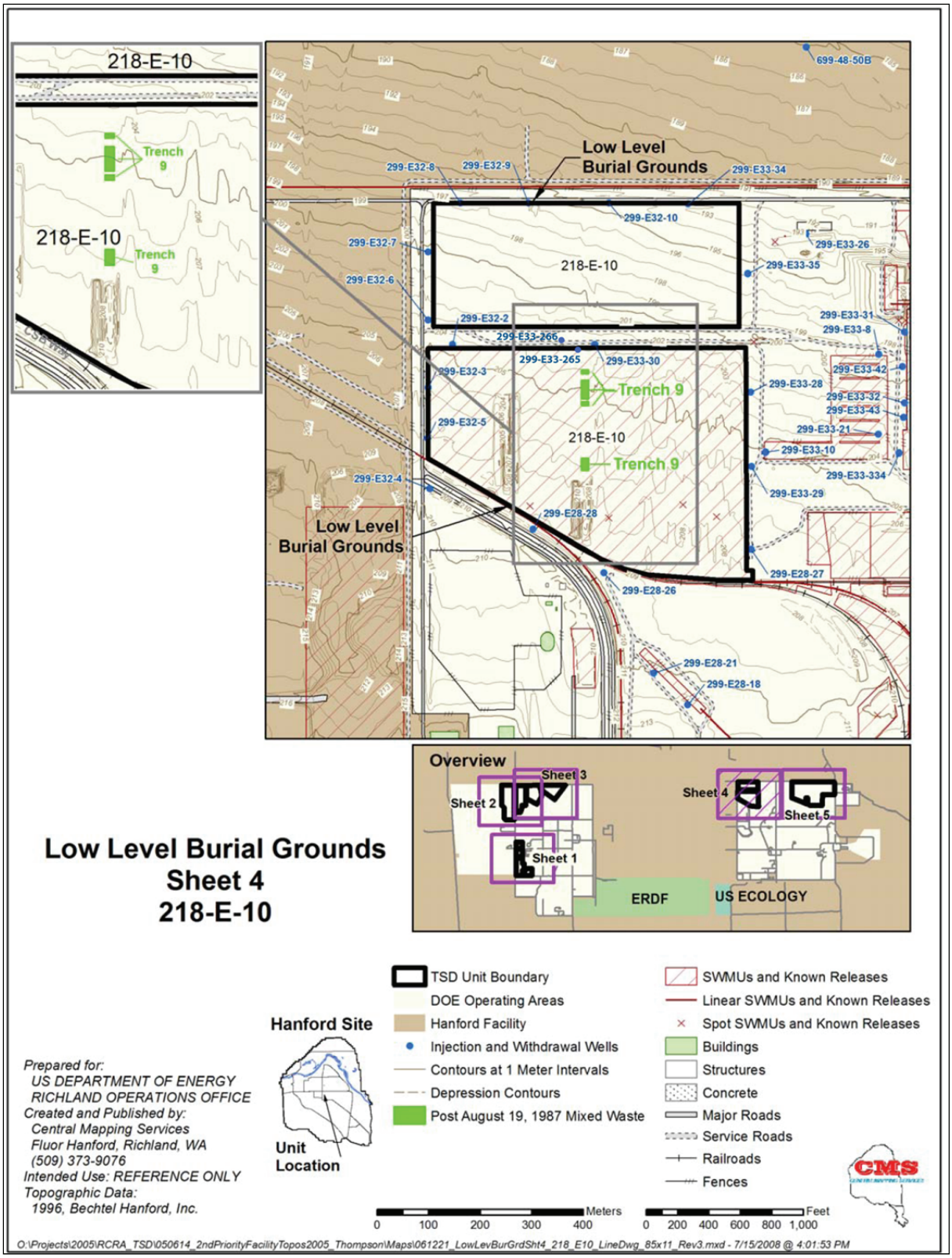


Figure 3. Location of the 218-E-10 Burial Ground Trenches and Associated LLWMA-1 Groundwater Monitoring Wells

2 Geology and Hydrogeology

The geology and hydrology of the 200 East Area, including the area of LLWMA-1, are described in detail in PNL-6820, *Hydrogeology of the 200 Areas Low Level Burial Grounds—An Interim Report: Volume 1: Text*, and WHC-SD-EN-TI-290, *Geologic Setting of the Low-Level Burial Grounds*. Other reports providing significant information include the following:

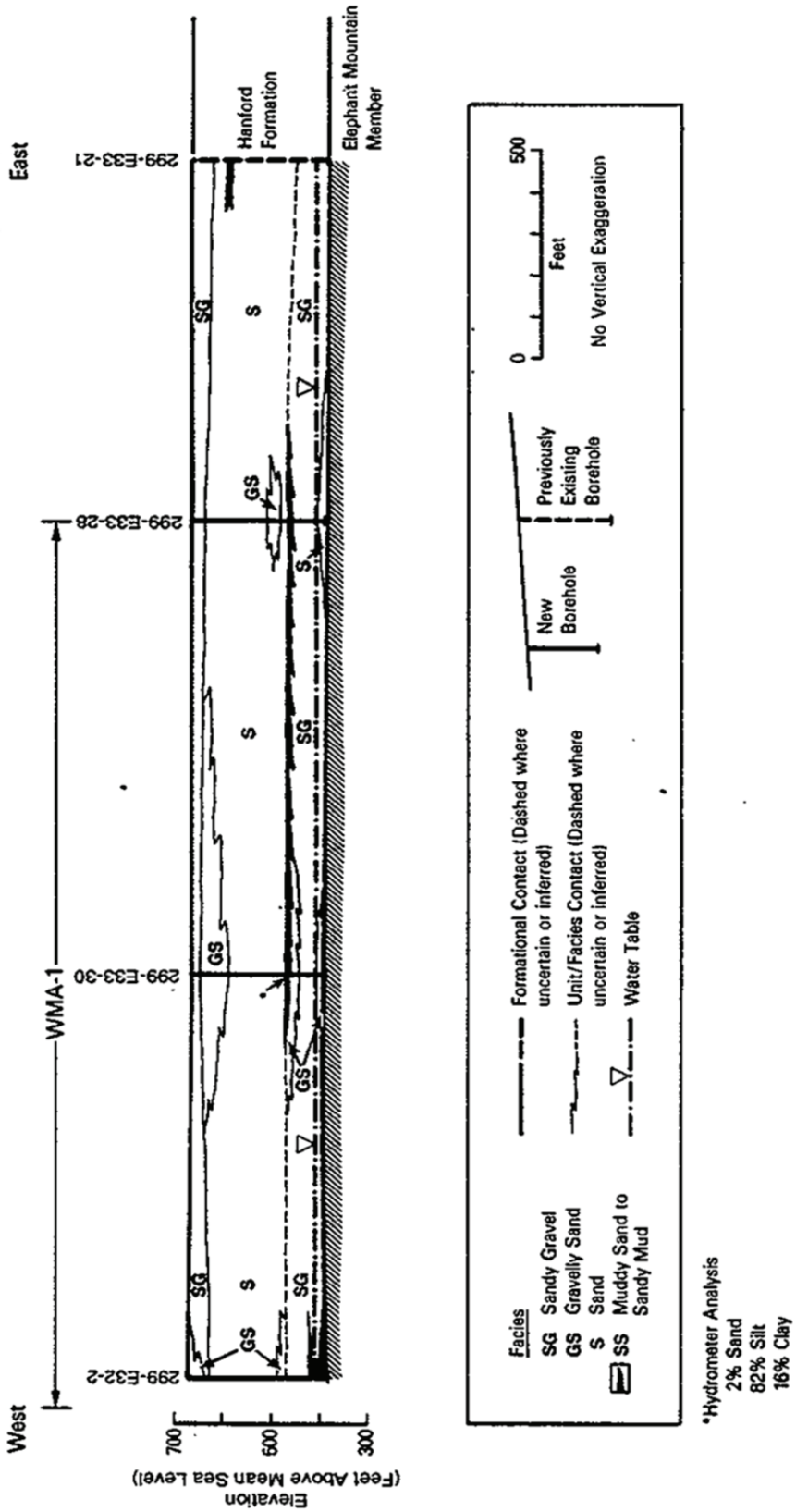
- HNF-5507, Subsurface Conditions Description of the B-BX-BY Waste Management Area
- PNNL-12261, Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington
- WHC-MR-0204, 200-East and 200-West Areas Low-Level Burial Grounds Borehole Summary Report
- WHC-MR-0205, Borehole Completion Data Package for the Low-Level Burial Grounds – 1990
- WHC-SD-EN-DP-044, 1991 Borehole Completion Data Package for the Low-Level Burial Grounds
- WHC-SD-EN-DP-049, 1992 Borehole Completion Data Package for the Low-Level Burial Grounds
- WHC-SD-EN-DP-086, 1993 Borehole Completion Data Package for the Low-Level Burial Grounds
- WHC-SD-EN-TI-019, *Hydrogeologic Model for the 200 East Groundwater Aggregate Area*

The following discussion summarizes information from these reports. This section also identifies the uppermost aquifer and the aquifers hydraulically interconnected beneath LLWMA-1.

In the past, LLWMA-1 underlying sediments from the ground surface to the top of the basalt were interpreted as Hanford and Ringold Formation sediments (PNL-6820). More recently, a determination that no Ringold Formation sediments are present beneath LLWMA-1 was made (WHC-SD-EN-TI-290). The suprabasalt sediments overlying the Elephant Mountain Basalt and extending into the lower vadose zone are described as mostly a gravel-dominated facies, with local intercalated intervals of sand-dominated facies (WHC-SD-EN-TI-290) (Figure 4).

Most recently, interpretation of the suprabasalt sediments beneath Waste Management Area B-BX-BY (located to the east) described the presences of Cold Creek sediments. The lowest unit is a gravel unit with undistinguishable texture from the Hanford basal gravels (H-3). The Cold Creek unit has previously been defined as the Hanford formation/Plio-Pleistocene unit (Hf/PPu). No new interpretation beneath LLWMA-1 has occurred for the aquifer sediments.

The suprabasalt sediment beneath LLWMA-1 ranges from 73 m (240 ft) to more than 100 m (328 ft) thick. The water table as of June 2009 ranged from 71.3 to 87.8 m (233.9 to 288.1 ft) below ground surface (bgs). Historically, the water table level was approximately 3.05 m (10 ft) higher in the late 1960s and 1980s due to peak production at Hanford and associated artificial recharge. Transmissivity measurements from LLWMA-1 boreholes varied from 148.6 m^2/day (1,600 ft^2/day) in Well 299-E33-35 to more than 4,645.2 m^2/day (50,000 ft^2/day) in Wells 299-E33-28 through 299-E33-30. Currently, the transmissivity is considered to ranged between 2,500 to 7,500 m^2/day based on the movement of contaminants through the northeast corner of the site (e.g., well 299-E33-34) and revised values for WMA B/BX/BY discussed in PNNL-14753, *Groundwater Data Package for Hanford Assessments.* Because of the permeable nature of aquifer sediments, the groundwater gradient has historically been very small beneath LLWMA-1 (Figure 5). The dominant flow direction has been to the northwest; however, occasional high Columbia River Spring stages have caused groundwater flow reversals to the south-southeast (DOE/RL-2011-118, *Hanford Site Groundwater Monitoring and Performance Report for 2011*).



*Hydrometer Analysis
2% Sand
82% Silt
16% Clay

Figure 4. Geologic Cross-Section beneath the Northern Boundary of the Southern Portion of Low-Level Waste Management Area-1

The reversals occurred in July 2008 and July/August, 2011. The duration of the first reversal was approximately nine months. The most recent reversal may continue into 2013 or longer.

Underlying the suprabasalt sediments is the Elephant Mountain Member of the Saddle Mountains Basalt formation. During the drilling of LLWMA-1 wells, some of the drilling extended into the upper portion of the Elephant Mountain Basalt. Examination of basalt drill cuttings found only sparse vesicles in basalt chips from one well and none from two other wells (PNL-6820). Based on this information, it was concluded that past fluvial events removed part, to the entire, flow top from the Elephant Mountain Basalt in this area. This substantiates earlier conclusion that the Elephant Mountain Member acts hydrologically as an aquiclude, confining the underlying Rattlesnake Ridge aquifer.

3 Data Quality Objectives Process

To define the required information for the first determination assessment, the data quality objectives (DQOs) process is used to ensure that the data gathered are of appropriate quantity and quality to meet specific objectives. This DQO addresses the following items, which are required to be specified in this plan in accordance with 40 CFR 265.93(d)(3):

1. The number, location, and depth of wells
2. Sampling and analytical methods for those dangerous wastes or dangerous waste constituents in the facility (e.g., 40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Appendix IX, "Ground-Water Monitoring List")
3. Evaluation procedures, including any use of previously-gathered groundwater quality information
4. A schedule of implementation

Before discussing each of these topics, it is important to understand the groundwater flow history at LLWMA-1 and the relationship between flow and nearby facilities known to have impacted groundwater, the contaminants associated with those facilities, and past groundwater TOC concentrations at the LLWMA-1. After providing this informational framework, a sequential process can be developed to determine whether LLWMA-1 has impacted groundwater. Following the informational framework, each of the requirements associated with 40 CFR 265.93(d)(3) will be discussed in the above presented order.

Groundwater flow at LLWMA-1 has generally been to the northwest since 1987. Evidence of this flow direction is included in several documents (e.g., WHC-SD-EN-AP-021, *Interim-Status Ground-Water Quality Assessment Program Plan for Waste Management Area 1 of the 200 Areas Low-Level Burial Grounds*, and Hanford Site Groundwater Monitoring Reports). The gradient determination in this area became more precise when precision elevation surveys and correction measures for well bore deviation were begun in 2005. In addition, because the water table is nearly flat, a regional fourteen-well monitoring network was used to measure water elevations from south of B Plant to northwest of 200 East area. The location of the wells and the corrected water level measurements were analyzed by least-squares regression to determine the azimuth and dip of a fitted plane. The statistical derived hydraulic gradient magnitude and direction from September 2005 through January 2011 were provided in Figure 9-6 of DOE/RL-2011-01, *Hanford Site Groundwater Monitoring Report for 2010*, and shown in Figure 5.

In understanding how flow direction relates to elevated TOC, past groundwater flow in this area along with hydraulic conductivity and porosity parameters were used to determine the groundwater movement. During the period from September 2005 through June 2008, the gradient measurements ranged between 6.4E-06 and 1.0E-05. Assuming a hydraulic conductivity of 7,500 m/day and a porosity of 0.3, an average northwest flow rate of approximately 0.22 m/day (0.75 ft/day) is derived (DOE/RL-2011-01, Table B-1).

At this average flow rate, it would take nearly 6.2 years for contamination to migrate from the southeast boundary of the LLWMA-1 to the location of Well 299-E33-265 (where the TOC indicator parameter was exceeded). During the past four years, two flow reversals have occurred. The first flow reversal occurred in August 2008 and was attributed to the high Columbia River spring stages of 2008. The groundwater flow direction did not statistically revert back to the northwest until July 2009. During the 2008 flow reversal, statistical analysis of the gradient magnitude ranged from too low to measure to a maximum of 1.3E-05. During August to October 2008, when three consecutive, statistically significant southeast gradient determinations were made, the derived flow rate using the same hydraulic parameters as above averaged 0.28 m/day, equivalent to approximately 25 m (82 ft) of southeast movement. From November 2008, until the groundwater flow reverted back to the northwest in July 2009, the gradient was not statistically significant, indicating uncertainty in direction and assumed low flow rates. After one statistical gradient measurement for a northwest flow direction in July of 2009, more non-statistical flow directions were measured until June of 2010, indicating low flow rates during this time. In June of 2010, a statistically significant northwest flow direction was determined (Figure 5). However, more non-statistical flow measurements followed until August 2011, when the flow reversed again and a southeast flow direction was statistically determined. The groundwater flow reversal to the southeast in August of 2011 was again attributed to high Columbia River spring stages in 2011. Through April of 2012, the flow direction has been to the southeast based on statistical analyses. However, the groundwater gradient has been decreasing since November 2011 when the gradient was 3.38E-05. In April of 2012, the groundwater gradient was 1.17E-05. This change is equivalent to a decrease in flow rate from 0.85 m/day (2.77 ft/day) to 0.29 m/day (0.96 ft/day). These values appear consistent with the southeast migration rate of contaminants from the BY Cribs located to the east (Figure 1). The average distance a water molecule would have traveled from Well 299-E33-265 during the flow reversal is 160 m (525 ft). The average distance traveled from the end of January 2012, when the exceedance occurred, to the end of April 2012 is approximately 48 m (157 ft). Based on the TOC increase during a continuous SE flow direction, it appears that either some elevated TOC migrated towards Well 299-E33-265 from the north/northwest or entered the groundwater from near Well 299-E33-265. However, because there are no sources to the north/northwest and the flow direction was predominantly northwest since at least 1987, the source site may have been to the southeast of this well.

Waste discharge descriptions and inventories were reviewed from sites south to east of LLWMA-1 to evaluate whether an upgradient source may be responsible for the elevated TOC (WMP-28945, *Data Quality Objective Summary Report in Support of the 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study Process*, Appendices A and B). The sites included: 216-B-12 Crib, 216-B-62 Crib, B Plant Cribs and Injection Wells, 216-B-5 Injection Well, 216-B-9 Crib, unplanned releases associated with WMA B/BX/BY, 216-B-7A&B, 216-B-11A&B French Drains, 216-B-8 Crib, 216-BX Trenches, 216-B-57 Crib, and BY Cribs. Many of these waste sites were only operational during early liquid waste discharges that did not include organics: 216-B-5 Injection Well, 216-B-8 and B-9 Cribs, UPR-200-E-131 associated with a release from Tank 241-BX-102, and the 216-B-11A&B French Drains. However, these sites as well as the others contained various metal wastes listed in 40 CFR 264, Appendix IX. These waste sites were terminated long before the enactment of RCRA regulations at Hanford in 1987, and fall under the remedial process of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*. The remaining sites that possibly received organic waste were the following: 216-B-12 Crib, 216-B-62 Crib, B Plant Cribs and Injection Wells, 216-B-7A&B, 216-BX Trenches, 216-B-57 Crib, and BY Cribs. Some of the above sites only received minor volumes of waste (RPP-26744, *Hanford Soil Inventory Model, Rev. 1*) or have been characterized and were not found to have volatile organics in the vadose zone. Based on this information, potential upgradient sites that may have affected groundwater with TOC constituents include 216-B-12, 216-B-62, 216-B-7A&B, 216-BX Trenches, and BY Cribs. The most prominent organics associated with these sites

were tributyl phosphate, normal paraffin hydrocarbons, di-(2-ethylhexyl) phosphoric acid, and ethylenediamine tetra acetic acid. Most of these constituents degrade through the thermal and radiolytical pathways; however, di-butyl phosphate, kerosene, and some carbon chain molecules within the gas or diesel range have been determined to persist within storage tanks at least for a short time (HNF-4020, *Installation Of Liquid Level Gauges And Subsequent Connection To TMACS*). Thus, kerosene and total petroleum hydrocarbon (TPH)-gas and diesel analyses will be included in this assessment. In addition, septic tanks are near the WMA B/BX/BY, which could be a source of elevated TOC. Thus, coliform bacteria will be added to the analytical list.

LLWMA-1 Trend Surface Results

Date	Mag.	Dir.	p-Value	Stat Sig?
9/1/2005	7.7E-06	312	0.020	Yes
9/12/2005	8.2E-06	329	0.017	Yes
10/11/2005	8.0E-06	356	0.005	Yes
10/25/2005	6.4E-06	320	0.060	No
11/23/2005	6.9E-06	336	0.017	Yes
12/29/2005	1.0E-05	13	0.014	Yes
2/2/2006	9.7E-06	350	0.011	Yes
3/8/2006	7.8E-06	332	0.070	No
6/8/2006	1.0E-05	347	0.0099	Yes
1/25/2007	7.3E-06	336	0.015	Yes
6/16/2008	8.1E-06	324	0.005	Yes
Averages:	**8.2E-06**	**338**		
7/21/2008	1.3E-06	97	0.964	No
8/29/2008	1.3E-05	213	0.004	Yes
9/11/2008	9.3E-06	156	0.001	Yes
10/23/2008	1.1E-05	226	0.038	Yes
11/26/2008	1.1E-05	225	0.127	No
12/23/2008	5.7E-06	160	0.289	No
1/12/2009	8.9E-07	130	0.945	No
2/23/2009	5.3E-06	149	0.516	No
3/24/2009	6.3E-07	106	0.974	No
4/13/2009	4.7E-06	316	0.271	No
5/28/2009	8.2E-06	310	0.234	No
7/17/2009	2.0E-05	335	0.013	Yes
9/21/2009	3.7E-06	8	0.573	No
10/27/2009	6.0E-06	100	0.578	No
11/12/2009	3.5E-06	259	0.893	No
1/21/2010	1.1E-05	243	0.675	No
5/23/2010	6.3E-06	358	0.502	No
6/30/2010	1.8E-05	353	0.021	Yes
7/13/2010	1.0E-05	357	0.338	No
9/15/2010	7.6E-06	315	0.065	No
1/4/2011	1.1E-05	002	0.144	No

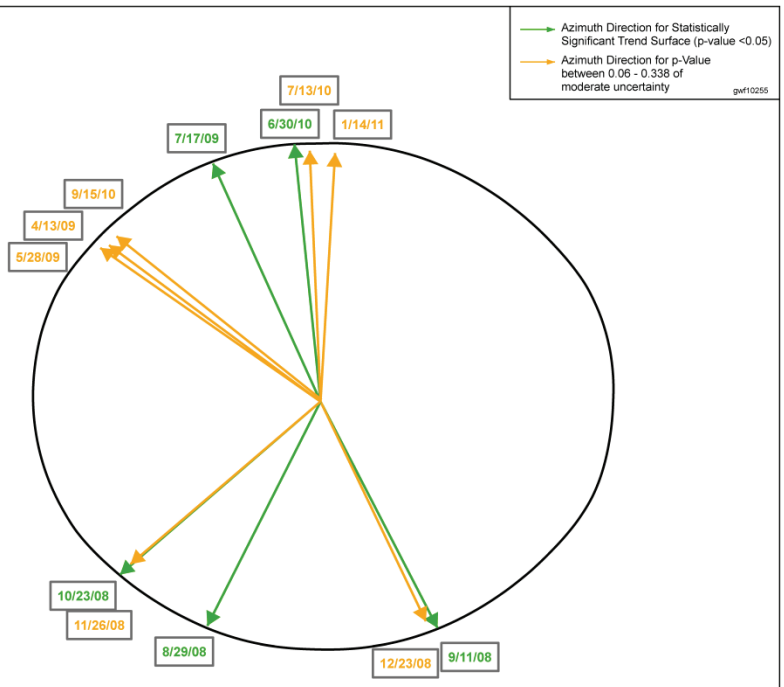


Figure 5. LLWMA-1 Groundwater Trend Surface Results

To evaluate whether an upgradient source may be responsible for the elevated TOC results, a review of the results at upgradient wells was completed. TOC results were reviewed for Wells 299-E28-26, 299-E28-27, 299-E28-28, 299-E32-4, 299-E33-28, 299-E33-29, and 299-E33-35. These are the upgradient LLWMA-1 wells listed in DOE/RL-2009-75 (Table 1). Because of the predominant flow direction, analytical analyses were reviewed back to 1989 (when analyses began for TOC). Before 2009, TOC results exhibited higher variability in wells to the south and east of Well 299-E33-265 than to the north and west. From 2001, the most prominent increases were in 2003, 2006, and 2008 in Wells 299-E28-27, 299-E32-4, and 299-E33-29 (Figure 6). Elevated results also were found in Well 299-E33-28 (Figure 7). Upon review of the data in the Hanford Environmental Information System (HEIS), the elevated results for these dates were either rejected or flagged as suspect. The 2008 values were rejected because of calibration errors at the WSCF laboratory. The other elevated results were flagged "suspect" by reviewers. The flags associated with the 2003 and 2006 results were because of the spatial irregularity of increases in wells at LLWMA-1. Excluding these results, the remaining TOC average results are below 1,000 µg/L, and typically are half that value back to 2001 (Figure 6). Other less prominent increases of TOC were also seen in 1998 and 2000-2001. The increases in 2000-2001 are related to laboratory contamination as the elevated results were flagged as having quality control blank

contamination. The 1998 results were highest in the south and east LLWMA-1 wells, though these concentrations were generally less than 1,000 µg/L. The data review suggests TOC results are highly variable and occasionally susceptible to laboratory issues. An alternate possibility is that elevated TOC may have migrated from upgradient sites in the past; however, there are no organic groundwater characterization samples for past elevated TOC results. The short duration of elevated concentrations suggests either a small plume size or laboratory error. The final possibility is that elevated TOC may have infiltrated into the aquifer near Well 299-E33-265.

Table 1. Groundwater Monitoring Wells for LLWMA-1 First Determination Assessment

Well Name	Screened Interval (m) NAVD88	Water level (m) NAVD88 (January 2012)	Water Remaining (m) (January 2012)	Monitoring Objective
299-E28-26	118.6 to 124.7	121.822	3.22	Downgradient chemistry; south
299-E28-27	119.4 to 125.5	121.825	2.43	Downgradient chemistry; southeast
299-E28-28	119.5 to 125.6	121.786	2.29	Downgradient chemistry; south
299-E32-2*	119.9 to 126.0	121.896	2.0	Crossgradient chemistry; west
299-E32-3	119.6 to 125.7	121.799	2.2	Crossgradient chemistry; west
299-E32-4	118.9 to 125.0	121.779	2.88	Crossgradient chemistry; southwest
299-E32-5	119.0 to 125.4	121.837	2.84	Crossgradient chemistry; southwest
299-E32-6	119.3 to 125.7	121.603	2.30	Crossgradient chemistry; west
299-E32-7	119.3 to 125.7	121.837	2.54	Upgradient chemistry; northwest
299-E32-8	118.9 to 125.1	121.834	2.93	Upgradient chemistry; northwest
299-E32-9	119.4 to 125.6	121.815	2.42	Upgradient chemistry; north
299-E32-10*	119.7 to 125.9	121.777	2.1	Crossgradient chemistry; northeast
299-E33-28	119.0 to 125.1	121.78	2.78	Crossgradient chemistry; east
299-E33-29	119.5 to 125.6	121.789	2.29	Downgradient chemistry; southeast
299-E33-30	119.0 to 125.1	121.833	2.83	Adjacent chemistry; east
299-E33-34	120.2 to 126.4	121.812	1.61	Crossgradient chemistry; northeast
299-E33-35	120.2 to 126.6	121.762	1.56	Crossgradient chemistry; northeast
299-E33-265	117.6 to 123.7	121.736	4.14	Target Well chemistry; east
299-E33-266	117.3 to 123.4	121.7	4.42	Adjacent chemistry; west

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

Note: All wells constructed to standards of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," resource protection wells.

* Estimated Water Level for January 2012 and Water Remaining

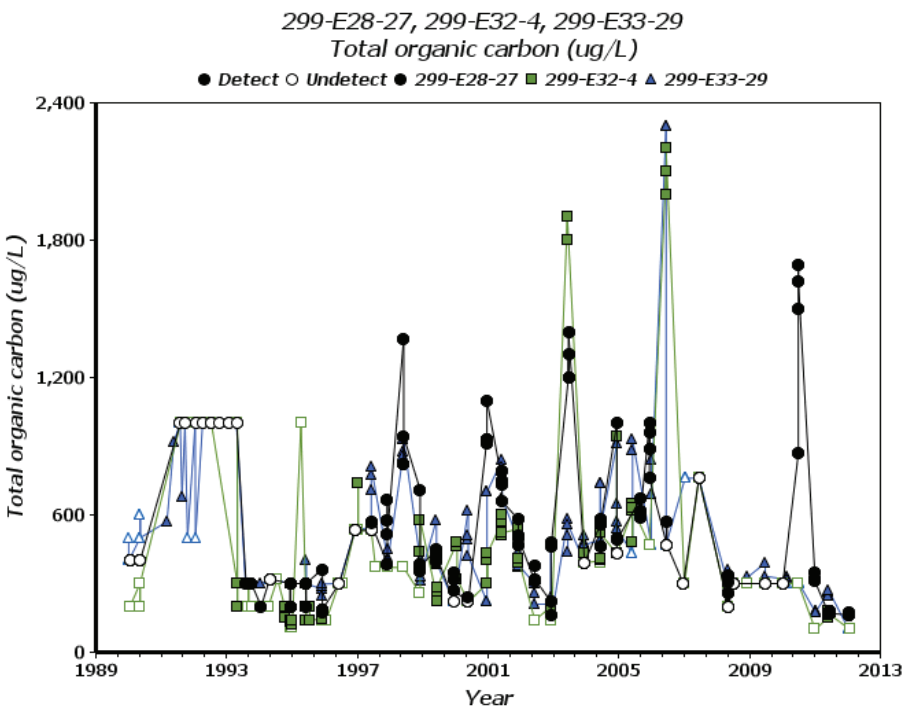


Figure 6. Total Organic Carbon Trend Plots for Wells 299-E28-27, 299-E32-4, and 299-E33-29

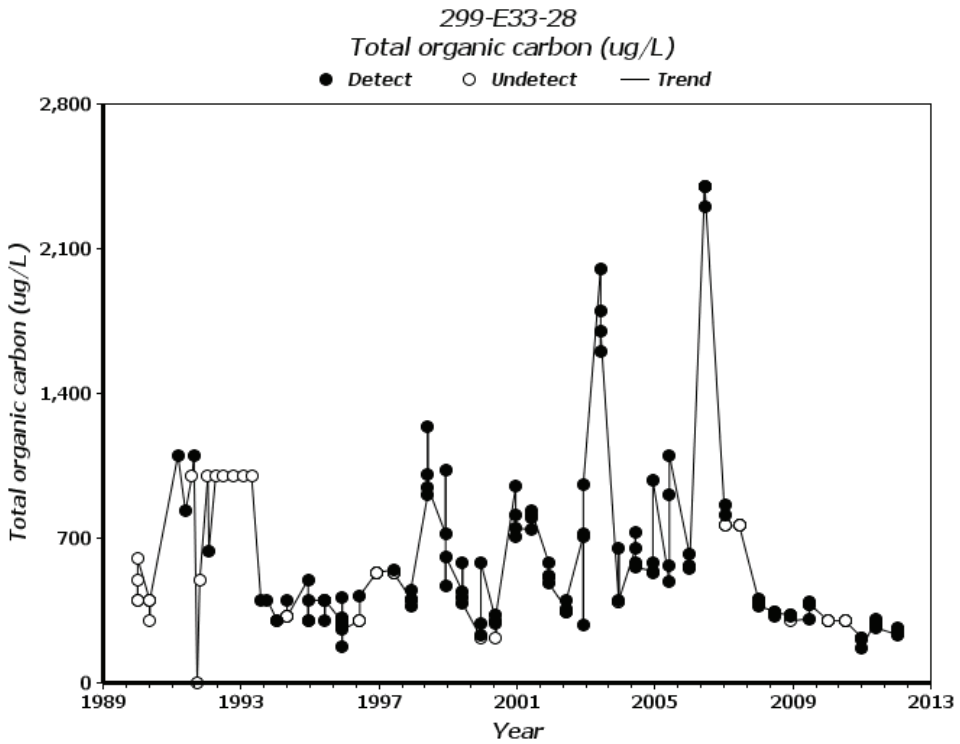


Figure 7. Total Organic Carbon Trend Plots for Well 299-E33-28

More recently, elevated TOC results, ranging from 3,220 to 4,950 µg/L, have been observed at Well 299-E33-265 (September 9, 2010). Verification of the elevated results, ranging from 396 to 538 µg/L, indicated that the initial data were associated with laboratory error. During the summer of 2010, several wells at LLWMA-1 had elevated TOC results: 299-E28-27, 299-E28-28, 299-E32-3, and 299-E32-7. Because of the ten-fold lower verification results for Wells 299-E32-3, 299-E32-7, and 299-E33-265, all elevated results for these wells were considered laboratory error.

The elevated results associated with this sampling event are not provided in Figure 2; however, the original results still remain flagged in HEIS as can be seen in Figure 5. This additional information would seem to indicate TOC results are highly variable and prone to laboratory issues.

During 2011, TOC concentrations increased at only the LLWMA-1 Well 299-E33-265 (Figure 2). The observed TOC trend before exceeding the critical mean may indicate either a migrating plume from another source or prolonged drainage from the vadose zone. If drainage, it would be limited because of the declining concentrations in the verification sample from April 2012. Concurrent with the TOC decline the groundwater flow slowed, indicating a limited drainage or plume size.

Based on review of the data, a sequence of actions has been established to determine if there are dangerous waste(s) or dangerous waste constituent(s) in the groundwater (40 CFR 265.93(a)(1)) and their concentration (40 CFR 265.93(a)(3)). If dangerous waste(s) or dangerous waste constituent(s) are present, then additional actions are provided along with evaluation procedures for determining if the dangerous waste(s) or dangerous waste constituent(s) are associated with LLWMA-1 or some upgradient source (40 CFR 265.93(d)(3)(iii)).

4 The Assessment Plan

4.1 Number, Location, and Depth of Wells to Be Sampled

The entire LLWMA-1 monitoring network will be sampled throughout the assessment. The monitoring well attributes are provided in Table 1, and the locations are shown on Figure 3. Additional wells may be used for the assessment based on the evaluation process described below. The well attributes for the additional wells are provided in Table 2. The well locations are provided in Figure 8.

Table 2. Expanded Groundwater Monitoring Wells for LLWMA-1 First Determination Assessment

Well Name	Screened Interval (m) NAVD88	Water level (m) NAVD88 (January 2012)	Water Remaining (m) (January 2012)	Monitoring Objective
299-E28-18[a]	116.8 to 132.0	121.832	5.03	Upgradient chemistry; south
299-E33-26[a]	120.0[c] to 132.5	121.822[b]	1.82	Upgradient chemistry; east
299-E33-31	119.4 to 125.8	121.825[b]	2.43	Upgradient chemistry; east
299-E33-38	120 to 126.4	121.838	1.84	Upgradient chemistry; east
299-E33-42	120.3 to 126.4	121.797	1.5	Upgradient chemistry; east
299-E33-43	119.2 to 125.6	121.78[b]	2.58	Upgradient chemistry; east
299-E33-334	117.0 to 124.7	121.853[b]	4.85	Upgradient chemistry; east

Table 2. Expanded Groundwater Monitoring Wells for LLWMA-1 First Determination Assessment

Well Name	Screened Interval (m) NAVD88	Water level (m) NAVD88 (January 2012)	Water Remaining (m) (January 2012)	Monitoring Objective

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

Note: All wells are constructed to standards of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," resource protection wells.

a. Perforated carbon steel casing. Partial annular seal.

b. November 2011 measurement date.

c. Estimated, not provided by as built.

4.2 Sampling and Analysis Methods

Because records of waste disposed at the burial ground were not consistently maintained until the mid-1980s, it is uncertain what contaminants from the 218E-10 Burial Ground could potentially impact groundwater quality. One known constituent associated with this burial ground was bis(2-ethylhexyl) phthalate. Another included lead (DOE/RL-2009-75). Therefore, the entire 40 CFR 264, Appendix IX list (as shown in Table 3) will be analyzed at select wells provided in the evaluation procedure below. The associated analyses with the 40 CFR 264, Appendix IX constituents and other relevant constituents are provided in Table 4. In addition, TPH for gas and diesel will be included for evaluating potential upgradient degradation products. The extra analyses will be collected in accordance with the evaluation procedure. TOC will be analyzed at all wells for determining whether there is a correlation between the 40 CFR 264, Appendix IX and TPH results, or if possible laboratory errors exist. Field parameters temperature, specific conductance, and pH will be measured. Finally, coliform bacteria and chemical oxygen demand will be analyzed to evaluate possible effects of sewage disposal from septic drain field systems as described in the evaluation procedure.

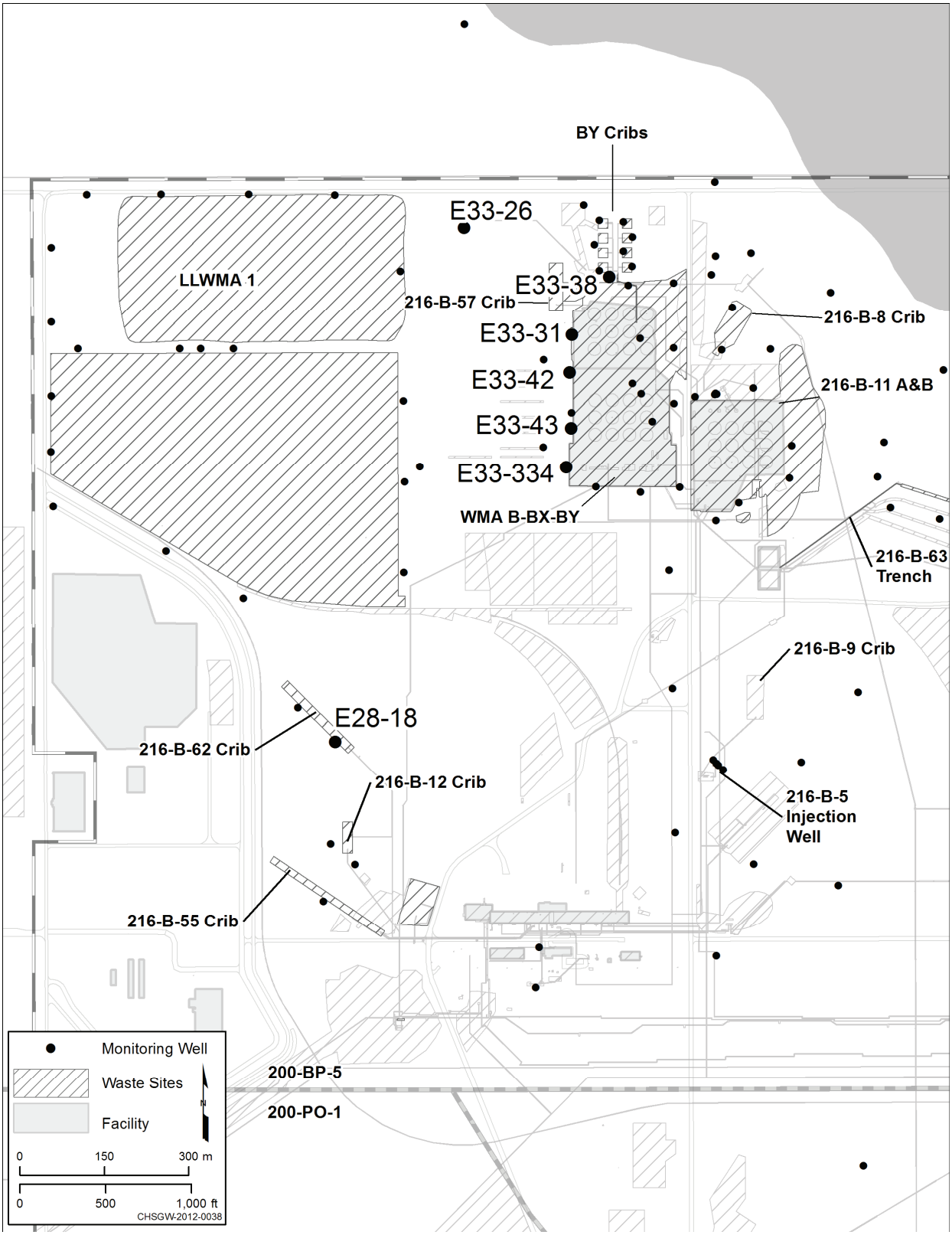


Figure 8. Additional Wells for Possible Extended Groundwater Monitoring

Table 3. 40 CFR 264, Appendix IX Groundwater Constituents for LLWMA-1 First Determination Assessment

Common Name	CAS Number[a]
1,1,1,2-Tetrachloroethane	630-20-6
1,1,1-Trichloroethane; Methylchloroform	71-55-6
1,1,2,2-Tetrachloroethane	79-34-5
1,1,2-Trichloroethane	79-00-5
1,1-Dichloroethane	75-34-3
1,1-Dichloroethylene; Vinylidene chloride	75-35-4
1,2,3-Trichloropropane	96-18-4
1,2,4,5-Tetrachlorobenzene	95-94-3
1,2,4-Trichlorobenzene	120-82-1
1,2-Dibromo-3-chloropropane; DBCP	96-12-8
1,2-Dibromoethane; Ethylene dibromide	106-93-4
1,2-Dichloroethane; Ethylene dichloride	107-06-2
1,2-Dichloropropane	78-87-5
1,4-Dioxane	123-91-1
1,4-Naphthoquinone	130-15-4
1-Naphthylamine	134-32-7
2,3,4,6-Tetrachlorophenol	58-90-2
2,3,7,8-TCDD; 2,3,7,8-Tetrachlorodibenzo-p- dioxin	1746-01-6
2,4,5-T; 2,4,5-Trichlorophenoxyacetic acid	93-76-5
2,4,5-Trichlorophenol	95-95-4
2,4,6-Trichlorophenol	88-06-2
2,4-D; 2,4-Dichlorophenoxyacetic acid	94-75-7
2,4-Dichlorophenol	120-83-2
2,4-Dimethylphenol	105-67-9
2,4-Dinitrophenol	51-28-5
2,4-Dinitrotoluene	121-14-2
2,6-Dichlorophenol	87-65-0
2,6-Dinitrotoluene	606-20-2
2-Acetylaminofluorene; 2-AAF	53-96-3
2-Chloronaphthalene	91-58-7

Table 3. 40 CFR 264, Appendix IX Groundwater Constituents for LLWMA-1 First Determination Assessment

Common Name	CAS Number[a]
2-Chlorophenol	95-57-8
2-Hexanone	591-78-6
2-Methylnaphthalene	91-57-6
2-Naphthylamine	91-59-8
2-Picoline	109-06-8
3,3[prime]-Dichlorobenzidine	91-94-1
3,3[prime]-Dimethylbenzidine	119-93-7
3-Methylcholanthrene.	56-49-5
4,4[prime]-DDD*	72-54-8
4,4[prime]-DDE**	72-55-9
4,4[prime]-DDT***	50-29-3
4,6-Dinitro-o-cresol	534-52-1
4-Aminobiphenyl	92-67-1
4-Bromophenyl phenyl ether.	101-55-3
4-Chlorophenyl phenyl ether	7005-72-3
4-Methyl-2-pentanone; Methyl isobutyl ketone.	108-10-1
4-Nitroquinoline 1-oxide	56-57-5
5-Nitro-o-toluidine	99-55-8
7,12-Dimethylbenz[a]anthracene	57-97-6
Acenaphthene.	83-32-9
Acenaphthylene	208-96-8
Acetone	67-64-1
Acetonitrile; Methyl cyanide	75-05-8
Acetophenone	98-86-2
Acrolein	107-02-8
Acrylonitrile	107-13-1
Aldrin	309-00-2
Allyl chloride	107-05-1
alpha, alpha-Dimethylphenethylamine	122-09-8
alpha-BHC	319-84-6

Table 3. 40 CFR 264, Appendix IX Groundwater Constituents for LLWMA-1 First Determination Assessment

Common Name	CAS Number[a]
Aniline	62-53-3
Anthracene	120-12-7
Antimony	7440-36-0
Aramite	140-57-8
Arsenic	7440-38-2
Benzene	71-43-2
Benzo[a]anthracene; Benzanthracene	56-55-3
Benzo[a]pyrene	50-32-8
Benzo[b]fluoranthene	205-99-2
Benzo[ghi]perylene	191-24-2
Benzo[k]fluoranthene	207-08-9
Benzyl alcohol	100-51-6
Beryllium	7440-41-7
beta-BHC	319-85-7
Bis(2-chloro-1-methylethyl) ether; 2,2[prime]-Di- chlorodiisopropyl ether	108-60-1
Bis(2-chloroethoxy)methane	111-91-1
Bis(2-chloroethyl)ether	111-44-4
Bis(2-ethylhexyl) phthalate	117-81-7
Bromodichloromethane	75-27-4
Bromoform; Tribromomethane	75-25-2
Butyl benzyl phthalate; Benzyl butyl phthalate	85-68-7
Cadmium	7440-43-9
Carbon disulfide	75-15-0
Carbon tetrachloride	56-23-5
Chlordane	57-74-9
Chlorobenzene	108-90-7
Chlorobenzilate	510-15-6
Chloroethane; Ethyl chloride	75-00-3
Chloroform	67-66-3
Chloroprene	126-99-8

Table 3. 40 CFR 264, Appendix IX Groundwater Constituents for LLWMA-1 First Determination Assessment

Common Name	CAS Number[a]
Chromium	7440-47-3
Chrysene	218-01-9
Cobalt	7440-48-4
Copper	7440-50-8
cis-1,3-Dichloropropene	10061-01-5
Cyanide	57-12-5
delta-BHC	319-86-8
Diallate	2303-16-4
Dibenz[a,h]anthracene	53-70-3
Dibenzofuran	132-64-9
Dibromochloromethane; Chlorodibromomethane	124-48-1
Dichlorodifluoromethane	75-71-8
Dieldrin	60-57-1
Diethyl phthalate	84-66-2
Dimethoate	60-51-5
Dimethyl phthalate	131-11-3
Di-n-butyl phthalate	84-74-2
Di-n-octyl phthalate	117-84-0
Dinoseb; DNBP; 2-sec-Butyl- 4,6-dinitrophenol	88-85-7
Diphenylamine	122-39-4
Disulfoton	298-04-4
Endosulfan I	959-98-8
Endosulfan II	33213-65-9
Endosulfan sulfate	1031-07-8
Endrin	72-20-8
Endrin aldehyde	7421-93-4
Ethylbenzene	100-41-4
Ethyl methacrylate	97-63-2
Ethyl methanesulfonate	62-50-0
Famphur	52-85-7

Table 3. 40 CFR 264, Appendix IX Groundwater Constituents for LLWMA-1 First Determination Assessment

Common Name	CAS Number[a]
Fluoranthene	206-44-0
Fluorene	86-73-7
gamma-BHC; Lindane	58-89-9
Heptachlor	76-44-8
Heptachlor epoxide	1024-57-3
Hexachlorobenzene	118-74-1
Hexachlorobutadiene	87-68-3
Hexachlorocyclopentadiene	77-47-4
Hexachloroethane	67-72-1
Hexachlorophene	70-30-4
Hexachloropropene	1888-71-7
Indeno(1,2,3-cd)pyrene	193-39-5
Isobutyl alcohol	78-83-1
Isodrin	465-73-6
Isophorone	78-59-1
Isosafrole	120-58-1
Kepone	143-50-0
Lead	7439-92-1
m-Cresol.	108-39-4
m-Dichlorobenzene	541-73-1
m-Dinitrobenzene	99-65-0
Mercury	7439-97-6
Methacrylonitrile	126-98-7
Methapyrilene	91-80-5
Methoxychlor	72-43-5
Methyl bromide; Bromomethane	74-83-9
Methyl chloride; Chloromethane	74-87-3
Methyl ethyl ketone; MEK	78-93-3
Methyl iodide; Iodomethane	74-88-4
Methyl methacrylate	80-62-6

Table 3. 40 CFR 264, Appendix IX Groundwater Constituents for LLWMA-1 First Determination Assessment

Common Name	CAS Number[a]
Methyl methanesulfonate	66-27-3
Methyl parathion; Parathion methyl	298-00-0
Methylene bromide; Dibromomethane	74-95-3
Methylene chloride; Dichloromethane	75-09-2
m-Nitroaniline	99-09-2
Naphthalene	91-20-3
Nickel	7440-02-0
Nitrobenzene	98-95-3
N-Nitrosodiethylamine	55-18-5
N-Nitrosodimethylamine	62-75-9
N-Nitrosodi-n-butylamine	924-16-3
N-Nitrosodiphenylamine	86-30-6
N-Nitrosodipropylamine; Di-n-propylnitrosamine	621-64-7
N-Nitrosomethylethylamine	10595-95-6
N-Nitrosomorpholine	59-89-2
N-Nitrosopiperidine	100-75-4
N-Nitrosopyrrolidine	930-55-2
O,O,O-Triethyl phosphorothioate.	126-68-1
O,O-Diethyl O-2-pyrazinyl phosphorothioate; Thionazin	297-97-2
o-Cresol	95-48-7
o-Dichlorobenzene	95-50-1
o-Nitroaniline	88-74-4
o-Nitrophenol	88-75-5
o-Toluidine	95-53-4
p-(Dimethylamino)azobenzene	60-11-7
Parathion	56-38-2
p-Chloroaniline	106-47-8
p-Chloro-m-cresol	59-50-7
p-Cresol	106-44-5
p-Dichlorobenzene	106-46-7

Table 3. 40 CFR 264, Appendix IX Groundwater Constituents for LLWMA-1 First Determination Assessment

Common Name	CAS Number[a]
Pentachlorobenzene	608-93-5
Pentachloroethane	76-01-7
Pentachloronitrobenzene	82-68-8
Pentachlorophenol	87-86-5
Phenacetin	62-44-2
Phenanthrene	85-01-8
Phenol	108-95-2
Phorate	298-02-2
p-Nitroaniline	100-01-6
p-Nitrophenol	100-02-7
Polychlorinated biphenyls; PCBs	1336-36-3[b]
Polychlorinated dibenzofurans; PCDFs	See Note[d]
Polychlorinated dibenzo-p-dioxins; PCDDs	See Note[c]
p-Phenylenediamine	106-50-3
Pronamide	23950-58-5
Propionitrile; Ethyl cyanide	107-12-0
Pyrene	129-00-0
Pyridine	110-86-1
Safrole	94-59-7
Selenium	7782-49-2
Silver	7440-22-4
Silvex; 2,4,5-TP	93-72-1
Styrene	100-42-5
Sulfide	18496-25-8
sym-Trinitrobenzene	99-35-4
Tetrachloroethylene; Perchloroethylene;Tetrachloroethene	127-18-4
Tetraethyl dithiopyrophosphate; Sulfotepp	3689-24-5
Thallium	82870-81-3
Tin	7440-31-5
Toluene	108-88-3

Table 3. 40 CFR 264, Appendix IX Groundwater Constituents for LLWMA-1 First Determination Assessment

Common Name	CAS Number[a]
Toxaphene	8001-35-2
trans-1,2-Dichloroethylene	156-60-5
trans-1,3-Dichloropropene	10061-02-6
trans-1,4-Dichloro-2-butene	110-57-6
Trichloroethylene; Trichloroethene	79-01-6
Trichlorofluoromethane	75-69-4
Vanadium	7440-62-2
Vinyl acetate	108-05-4
Vinyl chloride	75-01-4
Xylene (total)	1330-20-7
Zinc	7440-66-6

Source: 40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Appendix IX, "Ground-Water Monitoring List."

a. Chemical Abstracts Service registry number.

b. Polychlorinated biphenyls contains congener chemicals, including Aroclors.

c. This category contains congenor chemicals including dioxins.

d. This category contains congenor chemicals including benzofurans.

* DDD: P,P'-(Dichlorodiphenyl)dichloroethane

** DDE: 1,1'-(2,2-dichloroethene-1,1-diyl)bis(4-chlorobenzene)

*** DDT: 1,1,1-trichloro-2,2-di(4-chlorophenyl)ethane

Table 4. Preservation Techniques, Analytical Methods, and Contractually Required Detection Limit for Selected Organic Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Required Detection Limit (µg/L)[d]
Metals Analyzed by the Inductively Coupled Plasma Method – Unfiltered/Filtered			
Barium	P, HNO_3 to pH<2	SW-846*, Method 6010B/C; SW-846, Method 6020; or EPA-600/4-84-017, Method 200.8	20
Beryllium			5
Cadmium			5
Chromium			10
Cobalt			20
Copper			10

Table 4. Preservation Techniques, Analytical Methods, and Contractually Required Detection Limit for Selected Organic Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Required Detection Limit (µg/L)[d]
Nickel			40
Silver			10
Tin			100
Vanadium			25
Zinc			10
Trace Metals – Unfiltered/Filtered			
Antimony	P, HNO_3 to pH<2	SW-846, Method 6020 or EPA-600/4-84-017, Method 200.8	5
Arsenic			2
Lead			2
Selenium			4
Thallium			2
Trace Metals – Unfiltered/Filtered			
Mercury	G, HNO_3 to pH<2	SW-846, Method 7470A, EPA-600/4-84-017, Method 200.8	0.5
Volatile Organic Analytes			
1,1-Dichloroethane	Amber G, cool to 4°C, HCl to pH<2, No headspace	SW-846, Method 8260B	10
1,1-Dichloroethylene; Vinylidene chloride			10
1,1,1-Trichloroethane; Methylchloroform			5
1,1,1,2-Tetrachloroethane			5
1,1,2-Trichloroethane			2
1,1,2,2-Tetrachloroethane			5
1,2-Dibromoethane; Ethylene dibromide			5
1,2-Dibromo-3-chloropropane; DBCP			5
1,2-Dichloroethane; Ethylene dichloride			5
1,2-Dichloropropane			5

Table 4. Preservation Techniques, Analytical Methods, and Contractually Required Detection Limit for Selected Organic Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Required Detection Limit (µg/L)[d]
1,2,3-Trichloropropane			5
1, 4-Dioxane			500
2-Hexanone			20
4-Methyl-2-pentanone; Methyl isobutyl ketone			10
Acetone			20
Acetonitrile; Methyl cyanide			100
Acrolein			100
Acrylonitrile			100
Allyl chloride;(3-Chloropropene)			10
Benzene			5
Bromodichloromethane			5
Bromoform; Tribromomethane			5
Carbon disulfide			5
Carbon tetrachloride			5
Chlorobenzene			5
Chloroethane; (ethyl chloride)			10
Chloroform			5
Chloroprene			5
cis-1,3-Dichloropropene			5
Dibromochloromethane; Chlorodibromomethane			5
Dichlorodifluoromethane			5
Ethylbenzene			5
Ethyl methacrylate			10
Isobutyl alcohol			500
Methacrylonitrile			10
Methyl bromide; Bromomethane			10
Methyl chloride; Chloromethane			10

Table 4. Preservation Techniques, Analytical Methods, and Contractually Required Detection Limit for Selected Organic Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Required Detection Limit (µg/L)[d]
Methylene bromide; Dibromomethane			10
Methyl Chloride (Dichloromethane)			5
Methyl ethyl ketone; MEK (2-Butanone)			10
Methyl iodide; Iodomethane			10
Methyl methacrylate			10
Propionitrile; Ethyl cyanide			10
Pyridine			5
Styrene			5
Tetrachloroethylene; Perchloroethylene; Tetrachloroethene			5
Toluene			5
trans-1,2-Dichloroethylene (1,2-dichloroethene)			10
trans-1,3-Dichloropropene			5
trans-1,4-Dichloro-2-butene			50
Trichloroethylene			5
Trichlorofluoromethane			10
Vinyl acetate			50
Vinyl chloride			5
Xylene (total)			10
Semivolatile Organic Analytes			
1-Naphthylamine	Amber glass, cool to 4°C	SW-846, Method 8270D	25
1,2,4-Trichlorobenzene			10
1,4-Naphthoquinone			50
1,2,4,5-Tetrachlorobenzene			20
2-Acetylaminofluorene; 2-AAF			25

Table 4. Preservation Techniques, Analytical Methods, and Contractually Required Detection Limit for Selected Organic Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Required Detection Limit (µg/L)[d]
2-Chloronaphthalene			10
2-Chlorophenol			10
2-Methylnaphthalene			10
2-Naphthylamine			25
2-Picoline			20
2,3,4,6-Tetrachlorophenol			20
2,4,5-Trichlorophenol			10
2,4,6-Trichlorophenol			10
2,4-Dichlorophenol			10
2,4-Dimethylphenol			10
2,4-Dinitrophenol			25
2,4-Dinitrotoluene			10
2,6-Dichlorophenol			25
2,6-Dinitrotoluene			10
3-Methylcholanthrene			50
3,3[prime]-Dichlorobenzidine			10
3,3[prime]-Dimethylbenzidine			50
4-Aminobiphenyl			50
4-Bromophenyl phenyl ether			10
4-Chloro-3-methylphenol			10
4-Chlorophenyl phenyl ether			10
4-Nitroquinoline 1-oxide			25
4,6-Dinitro-o-cresol			10
5-Nitro-o-toluidine			20
7,12-Dimethylbenz[a]anthracene			20
Acenaphthene			10
Acenaphthylene			10
Acetophenone			10

Table 4. Preservation Techniques, Analytical Methods, and Contractually Required Detection Limit for Selected Organic Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Required Detection Limit (µg/L)[d]
alpha, alpha-Dimethylphenethylamine			200
Aniline			10
Anthracene			10
Aramite			50
Benzo[a]anthracene; Benzanthracene			10
Benzo[a]pyrene			10
Benzo[b]fluoranthene			10
Benzo[ghi]perylene			10
Benzo[k]fluoranthene			10
Benzyl alcohol			10
Bis(2-chloroethoxy)methane			10
Bis(2-chloroethyl)ether			10
Bis(2-chloro-1-methylethyl) ether; 2,2[prime]-Di- chlorodiisopropyl ether			10
Bis(2-ethylhexyl) phthalate (DEHP)			10
Butyl benzyl phthalate; Benzyl butyl phthalate			10
Chlorobenzilate			20
Chrysene			10
Diallate			20
Dibenz[a,h]anthracene			10
Dibenzofuran			10
Diethyl phthalate			10
Dimethoate			20
Dimethyl phthalate			10
Di-n-butyl phthalate			10

Table 4. Preservation Techniques, Analytical Methods, and Contractually Required Detection Limit for Selected Organic Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Required Detection Limit (µg/L)[d]
Di-n-octyl phthalate			10
Dinoseb; DNBP; 2-sec-Butyl-4,6-dinitrophenol			0.6
Diphenylamine			20
Disulfoton			50
Ethyl methanesulfonate			10
Famphur			200
Fluoranthene			10
Fluorene			10
Hexachlorobenzene			10
Hexachlorobutadiene			10
Hexachlorocyclopentadiene			10
Hexachloroethane			10
Hexachlorophene			500
Hexachloropropene			25
Indeno(1,2,3-cd)pyrene			10
Isodrin			20
Isophorone			10
Isosafrole			20
Kepone			100
Methapyrilene			100
Methyl methanesulfonate			10
Methyl parathion; Parathion methyl			50
m-Cresol; (3-methylphenol)			10
m-Dichlorobenzene; (1,3-dichlorobenzene)			10
m-Dinitrobenzene			15
m-Nitroaniline; (3-Nitroaniline)			10

Table 4. Preservation Techniques, Analytical Methods, and Contractually Required Detection Limit for Selected Organic Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Required Detection Limit (µg/L)[d]
Naphthalene			10
Nitrobenzene			10
N-Nitrosodiethylamine			10
N-Nitrosodimethylamine			10
N-Nitrosodi-n-butylamine			10
N-Nitrosodiphenylamine			10
N-Nitrosodipropylamine; Di-n-propylnitrosamine			10
N-Nitrosomethylethylamine			10
N-Nitrosomorpholine			10
N-Nitrosopiperidine			20
N-Nitrosopyrrolidine			10
o-Cresol; (2-Methylphenol)			10
o-Dichlorobenzene; (1,2-dichlorobenzene)			10
o-Nitroaniline; (2-Nitroaniline)			10
o-Nitrophenol; (2-nitrophenol)			20
O,O-Diethyl O-2-pyrazinyl phosphorothioate; Thionazin			20
O,O,O-Triethyl phosphorothioate			50
o-Toluidine			20
Parathion			50
p-Chloroaniline; (4-Chloroaniline)			10
p-Cresol; (4-methylphenol)			10
p-Dichlorobenzene; (1,4-dichlorobenzene)			5
p-(Dimethylamino)azobenzene			20
Pentachlorobenzene			10
Pentachloroethane			20

Table 4. Preservation Techniques, Analytical Methods, and Contractually Required Detection Limit for Selected Organic Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Required Detection Limit (µg/L)[d]
Pentachloronitrobenzene			50
Pentachlorophenol			10
Phenacetin			20
Phenanthrene			10
Phenol			10
Phorate			50
p-Nitroaniline; (4-Nitroaniline)			10
p-Nitrophenol; (4-Nitrophenol)			20
p-Phenylenediamine			400
Pronamide			20
Pyrene			10
Safrole			20
sym-Trinitrobenzene			100
Tetraethyl dithiopyrophosphate; Sulfotepp			50
Polychlorinated Dibenzo-p-Dioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs)			
2,3,7,8-TCDD; 2,3,7,8-Tetrachlorodibenzo-p-dioxin	Amber glass, cool to 4°C	SW-846, Method 8270D; SW-846, Method 8280; or SW-846, Method 8290	0.01
Polychlorinated dibenzofurans; PCDFs			0.05
Polychlorinated dibenzo-p-dioxins; PCDDs			0.05
Pesticides			
4,4[prime]-DDD*	Amber glass, cool to 4°C	SW-846, Method 8081 or SW-846, Method 8141	0.1
4,4[prime]-DDE**			0.1
4,4[prime]-DDT***			0.1
Aldrin			0.05
alpha-BHC			0.05
beta-BHC			0.05

Table 4. Preservation Techniques, Analytical Methods, and Contractually Required Detection Limit for Selected Organic Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Required Detection Limit (µg/L)[d]
Chlordane			0.5
delta-BHC			0.05
Dieldrin			0.05
Endosulfan I			0.05
Endosulfan II			0.1
Endosulfan sulfate			0.1
Endrin aldehyde			0.1
Endrin			0.1
gamma-BHC; Lindane			0.05
Heptachlor			0.05
Heptachlor epoxide			0.05
Methoxychlor			0.5
Toxaphene			2
PCBs			
Aroclor-1016	Amber glass, cool to 4°C	SW-846, Method 8082A	0.1
Aroclor-1221			0.1
Aroclor-1232			0.1
Aroclor 1242			0.1
Aroclor-1248			0.1
Aroclor-1254			0.1
Aroclor-1260			0.1
Herbicides			
2,4-D; 2,4-Dichlorophenoxyacetic acid	Amber glass, cool to 4°C	SW-846, Method 8151A	20
2,4,5-T; 2,4,5-Trichlorophenoxyacetic acid			1
Silvex; 2,4,5-TP			1

Table 4. Preservation Techniques, Analytical Methods, and Contractually Required Detection Limit for Selected Organic Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Required Detection Limit (µg/L)[d]
Other			
Chemical Oxygen Demand	P,G, H_2SO_4 to pH<2	EPA Method 410.4[e]	10,000
Coliform bacteria	P, $Na_2S_2O_3$, cool to 4°C	Standard Method 9222 or Standard Method 9223[f]	2.2 colonies/ 100 mL
Cyanide	G/P, NaOH to pH≥12, cool to 4°C	SW-846, Method 9012; Standard Method 4500[f]; or EPA-600/4-79-020, Method 335.2[e]	5
Sulfide	G/P, ZnAc+NaOH to pH>9, cool to 4°C	SW-846, Method 9030 or 9034[f] Or EPA or 376.1	500
Total petroleum hydrocarbons	Amber G, HCl to pH <2, cool to 4°C	WDOE[g] WTPH-G_x, WDOE WTPH-D_x	500
Total organic carbon	Amber G, HCl or H_2SO_4 to pH<2, cool to 4°C	SW-846, Method 9060[8]	1,000

a. P, plastic; G, glass

b. All samples will be cooled to 4ºC upon collection

c. Constituents grouped together are analyzed by the same method unless otherwise indicated

d. Detection limit units except where indicated

e. Analytical method adapted from EPA-600/4-79-020, Methods for Chemical Analysis of Water and Wastes, March 1983, Method 335.2

f. .EPA SW-846 Standards Methods

g. Washington Total Petroleum Hydrocarbons – Gasoline or Diesel

* EPA SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

General analysis groups, analytical methods, and contractor required detection limits (CRDLs) for each of the constituents are provided in Table 4. Chemical Abstracts Service registry numbers are also provided (Table 3). The routine analyses including anions and metals will continue to be analyzed as described in the original groundwater monitoring plan (DOE/RL-2009-75 and Table 5).

Table 5. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Low-Level Waste Management Area 1 Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Method Quantitation Limit (µg/L)[d]
Contamination Indicator Parameters			
Total organic carbon	G/P, HCL to pH<2	SW-846[e], Method 9060	1,000
Total organic halides	G, H_2SO_4 to pH<2, no head space	SW-846[e], Method 9020	20
Metals Analyzed by Inductively Coupled Plasma Method — Unfiltered/Filtered			
Calcium	P, HNO_3 to pH<2	SW-846[e], Method 6010B/C; SW-846, Method 6020; or EPA-600/4-84-017, Method 200.8	1,000
Chromium			10
Sodium			500
Manganese			5
Potassium			4,000
Iron			50
Magnesium			750
Anions by Ion Chromatography			
Nitrate	P, none	EPA-600/4-84-017, Method 300.0[f]	250
Sulfate			500
Chloride			200
Fluoride			200
Nitrite			250
Other			
Temperature	Field measurement	Instrument/meter	
Conductivity, field	N/A	Instrument/meter	1 µohm
pH, field measurement	N/A	Instrument/meter	0.1
Alkalinity	G/P, none	EPA Standard Method[g] 2320 EPA-600/4-84-017, Method 310.1 EPA-600/4-84-017, Method 310.2	5,000
Phenols[h]	G, residual chlorine 0.0008% $Na_2S_2O_3$	SW-846, Method 8041A	5

Table 5. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Low-Level Waste Management Area 1 Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Method Quantitation Limit (µg/L)[d]

a. P = plastic; G = glass.

b. All samples will be cooled to 4ºC upon collection.

c. Constituents grouped together are analyzed by the same method, unless otherwise indicated.

d. Detection limit units, except where indicated.

e. SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

f. Analytical method adapted from EPA-600/4-84-017, *Determination of Inorganic Anions by Ion Chromatography*, Method 300.0.

g. AWWA/APHA/WEF, 1998, *Standard Methods for the Examination of Water and Wastewater*.

h. Sampled annually.

EPA = U.S. Environmental Protection Agency

N/A = not applicable

4.2.1 Sampling

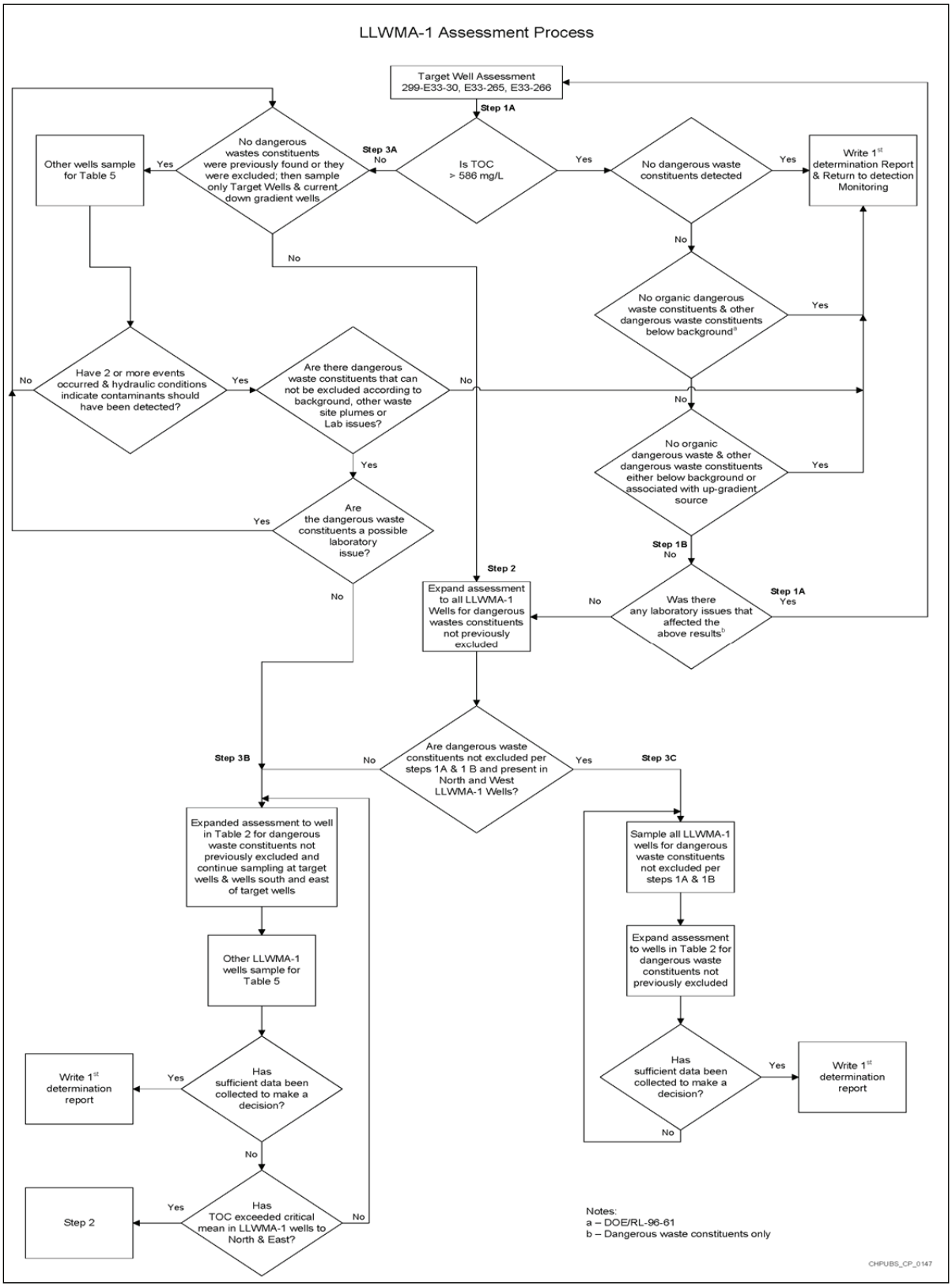
Sampling methods will be consistent with current sample collection, preservation, documentation, shipment, and chain-of-custody requirements. The sequence of sampling will follow the evaluation procedures discussed below.

The quality assurance project plan for this sampling is provided in Appendix A.

4.2.2 Evaluation Procedures

Data evaluation will initially include quality assurance reviews to assure that requested analyses were received and meet the analytical performance requirements. The evaluation of results will primarily consist of determining if the selected constituents are detected in concentrations greater than the respective CRDLs, background concentrations as described in DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*, or if any detected constituents are associated with a migrating plume from an upgradient source. Data evaluation will also include evaluating concentrations of total petroleum hydrocarbons, coliform bacteria, and chemical oxygen demand. The presence of these may indicate an effect from upgradient waste sites or nearby septic drain fields. If constituents identified in 40 CFR 264, Appendix IX are not detected above CRDLs, site background levels, or can be associated with migrating plumes from upgradient sources, then an indicator parameter evaluation program will be reinstated. A diagram of the assessment decision process is provided in Figure 9.

Making a first determination for LLWMA-1 may require a sequence of events because of the LLWMA-1 proximity to other waste sites known to have affected groundwater. Currently, data are unavailable for certain dangerous waste constituents. Therefore, the groundwater assessment process will be carried out in a sequence of steps provided below. The sequence of steps considers the changing flow directions, duration of flow directions, possible plume sizes, known waste types from other sources, and data gaps. If constituents identified in 40 CFR 264, Appendix IX are detected and it is determined that LLWMA-1 could be the source, this assessment plan will be revised.



Source: DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*.

Figure 9. LLWMA-1 Assessment Decision Process Diagram

4.2.2.1 Step 1A

The first step of the assessment will occur in July 2012 and consist of collection and analysis of 40 CFR 264, Appendix IX dangerous waste or dangerous waste constituents at the target Wells 299-E33-30, 299-E33-265, and 299-E33-266. In addition, samples for total organic carbon, coliform bacteria, and petroleum hydrocarbon will be collected and analyzed.

In the July sampling event (and any repeated Step 1A events), the other LLWMA-1 monitoring wells (e.g., excluding Wells 299-E33-30, 299-E33-265, and 299-E33-266) listed in Table 1 will be monitored for the constituents in Table 5.

The following decision statements consider whether the TOC indicator parameter still indicates the possible presence of a dangerous waste constituent, dangerous waste constituents at naturally occurring concentrations or from an upgradient site:

1. If elevated levels of total organic carbon are found (>586 µg/L) and no dangerous waste or dangerous waste constituents are present, then the site will return to detection monitoring status under DOE/RL-2009-75, in accordance with 40 CFR 265.93(d)(6). During the DQO process, a new critical mean for total organic carbon was calculated at 586.79 µg/L. If the above condition is true, proceed to action 4 in Step 1A. If this condition is not true, proceed to action 2 in Step 1A.

2. If elevated levels of total organic carbon are found (>586 µg/L) and no organic dangerous waste constituents are found, but other dangerous waste constituents are found and below background levels as provided in DOE/RL-96-61, then the site will return to detection monitoring status under DOE/RL-2009-75, in accordance with 40 CFR 265.93(d)(6). If this condition is true, proceed to action 4 in Step 1A. If this condition is not true, proceed to action 3 in Step 1A.

3. If elevated levels of total organic carbon are found (>586 µg/L) and no organic dangerous waste constituents are found, but other dangerous waste constituents are found and can be linked to an upgradient source, then the site will return to detection monitoring status under DOE/RL-2009-75, in accordance with 40 CFR 265.93(d)(6). If this condition is true, proceed to action 4 in Step 1A. If this condition is not true proceed to action 5 in Step 1A.

4. If a condition 1 through 3 is found, then prepare a first determination report as required in 40 CFR 265.93(d)(5).

5. If certain dangerous waste constituents can be excluded from the assessment based on conditions 2 or 3, then exclude those constituents from the assessment, and proceed to Step 1B.

4.2.2.2 Step 1B

This step deals with potential issues with laboratory analyses.

If dangerous waste(s) or dangerous waste constituent(s) detected are affected by laboratory or field blanks, then repeat Step 1A next quarter. If not proceed to Step 1C.

4.2.2.3 Step 1C

This decision statement considers if the plume has migrated beyond the target wells.

If TOC results are 586 µg/L or below and no dangerous waste or dangerous waste constituents are detected, then go to Step 3A. In addition, if TOC results are 586 µg/L or below and dangerous waste or dangerous waste constituents are able to be excluded based on background levels or linked to an upgradient source, then go to Step 3A. If this condition is not true, then proceed to Step 2.

4.2.2.4 Step 2

If dangerous waste or dangerous waste constituents are found at any of the target wells and cannot be excluded as described in Step 1 (A, B, and C), then quarterly assessment monitoring will begin in October 2012 to determine the extent of contamination in the groundwater beneath LLWMA-1 in accordance with 40 CFR 265.93(a)(2). Dangerous waste or dangerous waste constituents found at the target wells will be collected and analyzed for all LLWMA-1 monitoring wells listed in Table 1. Evaluate the data received starting at Step 3B.

4.2.2.5 Step 3A

This step continues to evaluate for a plume possibly between wells. Groundwater flow determinations will be used to determine the length of assessment.

1. If no dangerous waste or dangerous waste constituents are found or they were excluded based on Step 1A criteria 5, then the dangerous waste or dangerous waste constituent not excluded will be collected and analyzed at only the current downgradient wells along with the target wells. Proceed to action 2 in Step 3A.

2. The other LLWMA-1 monitoring wells will continue to be monitored for constituents in Table 5. Proceed to action 3 in Step 3A once data is available from this sampling event.

3. If two or more sampling events have been completed for this step and hydraulic conditions indicate contaminants should have been detected but were not then make the first determination and submit a report as required in 40 CFR 265.93(d)(5). Otherwise, go to action 1 in Step 3A if no dangerous waste contaminants or action 1 in Step 3B if dangerous wastes are present.

4.2.2.6 Step 3B

This step is to determine the extent of dangerous waste constituents. It also provides direction to expand the assessment to determine if dangerous waste constituents may have migrated from an upgradient source for which data is not available.

1. If dangerous waste or dangerous waste constituents are not found, can be excluded based on Step 1A criteria 5, or only found at LLWMA-1 monitoring wells located south and/or east of the target wells, then only those remaining dangerous waste or dangerous waste constituents will be collected and analyzed. These dangerous waste or dangerous waste constituents will be collected at wells located to the south and east of the target wells and at the target wells. If this condition is true, proceed to action 2 in Step 3B. If not proceed to Step 3C.

2. Other LLWMA-1 monitoring wells will continue to be monitored for constituents in Table 5. Proceed to action 3 in Step 3B.

3. Extend sampling to other possible source site wells listed in Table 2 for the dangerous waste or dangerous waste constituents not excluded or associated with another source site. This will provide data to determine if past upgradient sites affected groundwater rather than LLWMA-1. Proceed to action 4 in Step 3B.

4. After appropriate evaluation, make the first determination and submit a report as required in 40 CFR 265.93(d)(5). If sufficient data are not present, then repeat Step 3B. If TOC exceeds 1,330 µg/L in other wells, then repeat Step 2.

4.2.2.7 Step 3C

This step is to determine the extent of dangerous waste constituents. It is more encompassing than Step 3B because of the indication of possible dangerous waste constituents in wells north and west of the target wells. It also provides direction to expand the assessment to determine if dangerous waste constituents may have migrated from an upgradient source for which data are not available.

1. If dangerous waste or dangerous waste constituents are found at only LLWMA-1 monitoring wells located north or west of the target wells from the October event, then dangerous waste or dangerous waste constituents found at the target wells and in the wells located to the north or west will be collected and analyzed in all LLWMA-1 wells listed in Table 1. Proceed to action 2 in Step 3C.
2. Extend sampling to other possible source site wells listed in Table 2 for the dangerous waste or dangerous waste constituents not excluded or associated with another source site. This will provide data to determine if past upgradient sites affected groundwater rather than LLWMA-1. Proceed to action 3 in Step 3C.
3. After appropriate evaluation make the first determination and submit a report as required in 40 CFR 265.93(d)(5). If sufficient data is not present then repeat Step 3C.

5 Schedule

The first sampling event will occur in July 2012. If necessary, additional sampling events will occur quarterly until an indicator parameter evaluation program is reinstated or a revised assessment plan is provided. Laboratory analytical results should be received within 45 days of sample collection. Should the July 2012 analytical results show no organic dangerous waste constituents, then sampling for volatile organics and semi volatile organics will be eliminated from the January 2013 sampling event. However, because of CHPRC schedule limitations, an October 2012 sampling event would include these constituents. At the request of Ecology, tentatively identified organic compounds will be reviewed in an attempt to identify the cause of the elevated level of total organic carbon. Thus, if results meet the criteria in action 4 of Step 1A for the July 2012 sampling event and continue to meet the criteria for the October 2012 event, then the First Determination report would be completed by January 31, 2013.

If conditions in Step1A (4) are not found, then the First Determination will be completed in accordance with the sequence identified above. After the data are evaluated and conclusions are reached, a report will be transmitted to the Washington State Department of Ecology within 15 days, stating whether groundwater monitoring will return to indicator-evaluation or continue with a groundwater-quality assessment program.

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Appendix A

Quality Assurance Project Plan

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Terms

DOE	U.S. Department of Energy
DQO	data quality objective
EB	equipment blank
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FTB	full trip blank
FXR	field transfer blank
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Document*
HEIS	Hanford Environmental Information System
N/A	not applicable
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RL	U.S. Department of Energy, Richland Operations Office
RSD	relative standard deviation
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal

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A Quality Assurance Project Plan

The contractor's quality assurance (QA) program describes the contractor's QA structure, requirements, implementation methods, and responsibilities. The contractor's environmental QA program plan provides the requirements for collecting and assessing environmental data in accordance with the following:

- 10 CFR 830, Subpart A, "Nuclear Safety Management," "Quality Assurance Requirements"
- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD)
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*
- DOE O 414.1C, *Quality Assurance*

This quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection including the planning, implementation, and assessment of sampling, field measurements, and laboratory analyses. Sections 6.5 and 7.8 of the *Hanford Federal Facility Agreement and Consent Order*, also known as the Tri-Party Agreement (Ecology et al., 1989a), and the *Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al., 1989b), also known as the Tri-Party Agreement Action Plan, require that QA/quality control (QC) and sampling and analysis activities specify the QA requirements for treatment, storage, and disposal (TSD) units, as well as for past-practice processes. The HASQARD (DOE/RL-96-68) requirements also apply to this work.

The content of this QAPjP is patterned after the QA elements of EPA/240/B-01/003. The QAPjP demonstrates conformance to the Part B requirements of ANSI/ASQ E4, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use*. This QAPjP is divided into four sections (designated in EPA/240/B-01/003) that describe the quality requirements and controls applicable to this investigation. This QAPjP is intended to supplement the contractor's environmental QA program plan.

A1 Project Management

This section addresses the basic aspects of project management and will ensure that the project has defined goals, that the participants understand the goals and the approaches used, and that the planned outputs are appropriately documented.

A1.1 Project/Task Organization

The project organization in regard to planning, sampling, analysis, and data assessment is described in the following subsections and is shown in Figure A-1. For each functional primary contractor role, there is a corresponding oversight role within the U.S. Department of Energy (DOE).

A1.1.1 Regulatory Project Manager

The Washington State Department of Ecology (Ecology) project manager is responsible for oversight of the work being performed under this groundwater monitoring plan. Ecology will work with the DOE Richland Operations Office (RL) to resolve concerns regarding the work as described in this QAPjP. Ecology can request this plan during a regulatory compliance inspection for review.

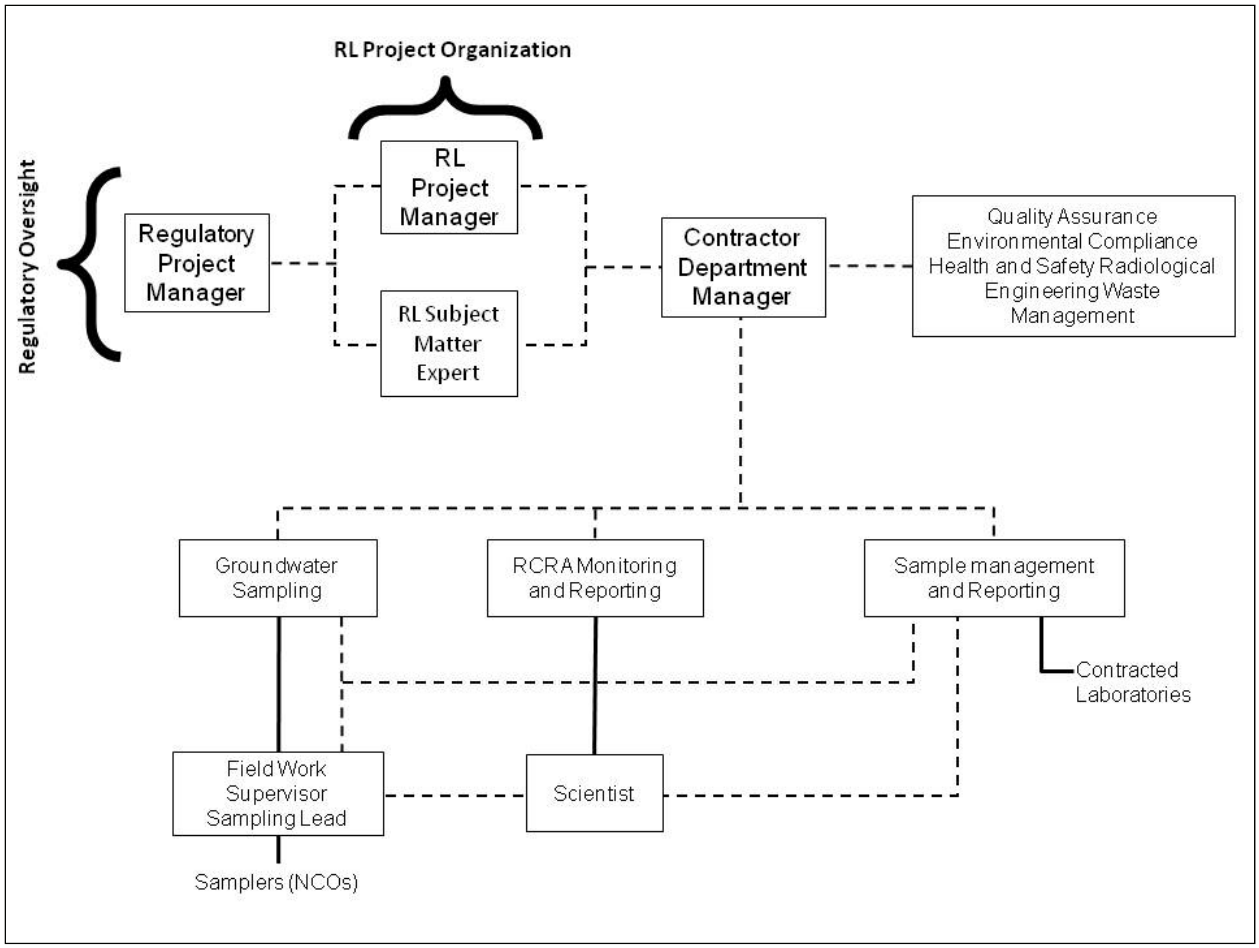

Figure A-1. Project Organization

A1.1.2 U.S. Department of Energy, Richland Operations Office Project Manager

Hanford Site cleanup is the responsibility of RL. The RL project manager is responsible for authorizing the contractor to perform activities under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, *Resource Conservation and Recovery Act of 1976* (RCRA), *Atomic Energy Act of 1954*, and Tri-Party Agreement (Ecology et al., 1989a) for the Hanford Site.

A1.1.3 U.S. Department of Energy, Richland Operations Office Subject Matter Expert

The RL subject matter expert is responsible for day-to-day oversight of the contractor's performance of work scope, for working with the contractor and the regulatory agencies to identify and work through issues, and for providing technical input to the RL project manager.

A1.1.4 Contractor Groundwater Remediation Department Manager

The contractor groundwater remediation department manager provides oversight for all activities and coordinates with DOE, the regulators, and primary contractor management in support of sampling and reporting activities. The remediation department manager also provides support to the RCRA Monitoring and Reporting manager to ensure that work is performed safely and cost effectively.

A1.1.5 Groundwater Sampling Operations

Groundwater sampling operations is responsible for planning and coordinating field sampling resources and provides the field work supervisor for routine groundwater sampling operations. The field work supervisor directs the samplers, who collect groundwater samples in accordance with the sampling and analysis plan, and corresponding standard procedures and work packages. The samplers also complete the field logbook and chain-of-custody forms, including any shipping paperwork, and ensure delivery of the samples to the analytical laboratory.

A1.1.6 RCRA Monitoring and Reporting

The RCRA Monitoring and Reporting manager is responsible for direct management of activities performed to meet RCRA TSD monitoring requirements. The RCRA Monitoring and Reporting manager coordinates with and reports to DOE and primary contractor management regarding RCRA TSD monitoring requirements. The RCRA Monitoring and Reporting manager assigns scientists to provide technical expertise.

A1.1.7 Sample Management and Reporting Organization

The Sample Management and Reporting organization coordinates laboratory analytical work to ensure that laboratories conform to HASQARD (DOE/RL-96-68) requirements (or their equivalent), as approved by DOE, the U.S. Environmental Protection Agency (EPA), and Ecology. Sample Management and Reporting receives analytical data from the laboratories, performs data entry into the Hanford Environmental Information System (HEIS) database, and arranges for data validation. Sample Management and Reporting is responsible for informing the RCRA Monitoring and Reporting manager of any issues reported by the analytical laboratories.

A1.1.8 Contract Laboratories

The contract laboratories analyze samples in accordance with established procedures and provide necessary sample reports and explanations of results to support data validation. The laboratories must meet site-specific QA requirements and must have an approved QA plan in place.

A1.1.9 Quality Assurance

The QA point of contact is matrixed to the subject matter expert and is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements; reviewing project documents, including data quality objective (DQO) summary reports, sampling and analysis plans, and the QAPjP; and participating in QA assessments on sample collection and analysis activities, as appropriate. The QA point of contact must be independent of the unit generating the data.

A1.1.10 Environmental Compliance Officer

The environmental compliance officer provides technical oversight, direction, and acceptance of project and subcontracted environmental work, and also develops appropriate mitigation measures with the goal of minimizing adverse environmental effects.

A1.1.11 Health and Safety

The Health and Safety organization is responsible for coordinating industrial safety and health support within the project as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by federal regulations or by internal primary contractor work requirements.

A1.1.12 Waste Management

Waste Management communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner.

A1.2 Problem Definition/Background

The problem definition, as required by WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," and 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring"), is outlined in the main text discussion of this monitoring plan. The background is also provided in the monitoring plan.

A1.3 Project/Task Description

The project description is provided in Chapters 3 and 4 of this monitoring plan and includes the selection of appropriate dangerous waste or dangerous waste constituents, collection and analyses of groundwater from the monitoring network, interpretation of analytical results, evaluation of the monitoring network, reporting, and schedule.

The target analytes, along with the monitoring wells and frequency of sampling, are provided in Chapter 3.

A1.4 Quality Objectives and Criteria

The quality objectives and criteria for groundwater monitoring are defined in the tables provided in this QAPjP in order to meet the evaluation requirements stated in the monitoring plan.

A1.5 Special Training/Certification

Workers receive a level of training that is commensurate with their responsibility of collecting and transporting groundwater samples according to the Dangerous Waste Training Plan maintained for the TSD unit to meet the requirements of WAC 173-303-330, "Dangerous Waste Regulations," "Personnel Training." The field work supervisor, in coordination with line management, will ensure that all field personnel meet training requirements.

A1.6 Documents and Records

The project scientist is responsible for ensuring that the current version of the groundwater monitoring plan is used and for providing any updates to field personnel. Version control is maintained by the administrative document control process. Significant changes to the plan that affect DQOs will be reviewed and approved by DOE and the regulatory agency before implementation. Table A-1 defines the types of changes that may be made to the sampling design and the documentation requirements.

Logbooks and data forms are required for field activities. The logbook must be identified with a unique project name and number. Individuals responsible for the logbooks shall be identified in the front of the logbook, and only authorized individuals may make entries into the logbooks. Logbooks will be controlled in accordance with internal work requirements and processes.

The HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file. Records may be stored in either electronic or hardcopy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the Tri-Party Agreement (Ecology et al., 1989a) will be managed in accordance with the requirements therein.

Assessment monitoring results are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." The reports will be part of the annual Hanford Site groundwater monitoring report (e.g., DOE/RL-2011-01, *Hanford Site Groundwater Monitoring for 2010*).

Table A-1. Actions and Documentation for Regulatory Notification

Type of Change	Action	Documentation
Temporary addition of wells or constituents, or increased sampling frequency	RCRA Monitoring and Reporting manager approval; notify regulatory agency, if appropriate	Project's schedule tracking system
Unintentional effect to groundwater monitoring plan including one-time missed well sampling due to operational constraints, delayed sample collection, broken pump, lost bottle set, missed sampling of indicator parameters, loss of samples in transit, etc.	Electronic notification	RCRA annual report
Planned change to groundwater monitoring activities, including addition or deletion of constituents or wells, change of sampling frequency, etc.	Revise monitoring plan	Revised RCRA groundwater monitoring plan
Anticipated unavoidable changes (e.g., dry wells)	Electronic notification; revise monitoring plan	RCRA annual report and revised groundwater monitoring plan

RCRA = *Resource Conservation and Recovery Act of 1976*

A2 Data Generation and Acquisition

This section addresses data generation and acquisition to ensure that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

A2.1 Sampling Process Design (Experimental Design)

The sampling design is based on regulatory requirements and judgmental sampling.

A2.1.1 Regulatory Requirements

The groundwater protection regulations of WAC 173-303-400 dictate the groundwater sampling and analysis requirements applicable to interim status TSD units.

A2.1.2 Judgmental Sampling

The selection of sampling and analysis requirements is based on knowledge of the feature or condition under investigation and is also based on professional judgment. The TSD monitoring is based on professional judgment. Conclusions depend on the validity and accuracy of professional judgment.

A2.2 Sampling Methods

Sampling is described in the contractor's environmental QA program plan, including the following:

- Field sampling methods
- Sample preservation, containers, and holding times
- Corrective actions for sampling activities
- Decontamination of sampling equipment

The groundwater sampling operations supervisor must ensure that situations that may impair the usability of samples and/or data are documented in field logbooks or on nonconformance report forms in

accordance with internal corrective action procedures, as appropriate. The groundwater sampling operations supervisor will note any deviations that occur from the standard procedures for sample collection, contaminants of potential concern, sample transport, or monitoring. The groundwater sampling operations supervisor is also responsible for coordinating all activities related to the use of field monitoring equipment (e.g., dosimeters and industrial hygiene equipment). Field personnel will document in the logbook all noncompliant measurements taken during field sampling. Ultimately, the groundwater sampling operations supervisor is responsible for developing, implementing, and communicating corrective action procedures; for documenting all deviations from procedure; and for ensuring that immediate corrective actions are applied to field activities. Problems with sample collection, custody, or data acquisition that adversely affect data quality or impair the ability to acquire data or failure to follow procedure will be documented in accordance with internal corrective action procedures, as appropriate.

A2.3 Sample Handling and Custody

A sampling and data tracking database is used to track samples from the point of collection through the laboratory analysis process. Laboratory analytical results are entered and maintained in the HEIS database. Each sample is identified and labeled with a unique HEIS sample number. The contractor's environmental QA program plan specifies sample handling information, including the following:

- Container requirements
- Container labeling and tracking process
- Sample custody requirements
- Shipping and transportation

Sample custody during laboratory analysis is addressed in the applicable laboratory's standard operating procedures. Laboratory custody procedures will ensure that sample integrity and identification are maintained throughout the analytical process. Storage of samples at the laboratory will be consistent with laboratory instructions prepared by the Sample Management and Reporting organization.

A2.4 Analytical Methods

Information on analytical methods is provided in Tables A-2 and A-3. These analytical methods are controlled in accordance with the laboratory's QA plan and the requirements of this QAPjP. The primary contractor participates in oversight of offsite analytical laboratories to qualify the laboratories for performing Hanford Site analytical work.

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Continuing Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Contamination Indicator Parameters			
Total organic carbon	G/P, HCL to pH<2	SW-846[e], Method 9060	1,000
Total organic halides	G, H_2SO_4 to pH<2, no head space	SW-846[e], Method 9020	20

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Continuing Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Metals Analyzed by Inductively Coupled Plasma Method – Unfiltered/Filtered			
Calcium	P, HNO_3 to pH <2	SW-846[d], Method 6010B/C; SW-846, Method 6020[e]; or EPA-600/R-94/111, Method 200.8[e]	1,000
Chromium			10
Sodium			500
Manganese			5
Potassium			4,000
Iron			50
Magnesium			750
Anions by Ion Chromatography			
Chloride	P, none	EPA-600/4-84-017, Method 300.0[f]	200
Nitrate			250
Nitrite			250
Fluoride			200
Sulfate			500
Other			
Alkalinity	G/P, none	Standard Method[g] 2320 EPA-600/4-84-017, Method 310.1 EPA-600/4-84-017, Method 310.2	5,000
Phenols	G, residual chlorine 0.0008% $Na_2S_2O_3$	SW-846, Method 8041A	5
Conductivity, field	N/A	Instrument/meter	1 µohm
Cyanide	P, NaOH to pH >12	SW-846, Method 9012 Standard Method[g] 4500 EPA-600/4-84-017, Method 335.2	5
pH, field measurement	N/A	Instrument/meter	0.1
Temperature	Field measurement	Instrument/meter	

a. All samples will be collected in plastic (P) or glass (G) containers and will be cooled to 4ºC upon collection.

b. Constituents grouped together are analyzed by the same method, unless otherwise indicated.

c. Detection limit units, unless otherwise indicated.

d. SW-846, *Test Methods for Evaluation of Solid Waste, Physical/Chemical Methods*.

e. SW-846, Method 6010 is the preferred method; however, Method 6020 or EPA-600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement I*, Method 200.8 may be used, as long as the method quantitation limit listed is met.

f. Analytical method adapted from EPA-600/4-84-017, *Determination of Inorganic Anions by Ion Chromatography*, Method 300.0.

g. AWWA/APHA/WEF, 2005, *Standard Methods for the Examination of Water and Wastewater*.

EPA = U.S. Environmental Protection Agency

N/A = not applicable

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Assessment Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Method Quantitation Limit (µg/L)[d]
Metals Analyzed by the Inductively Coupled Plasma Method – Unfiltered/Filtered			
Barium	P, HNO_3 to pH<2	SW-846*, Method 6010B/C; SW-846, Method 6020; or EPA-600/R-94/111, Method 200.8	20
Beryllium			5
Cadmium			5
Chromium			10
Cobalt			20
Copper			10
Nickel			40
Silver			10
Tin			100
Vanadium			25
Zinc			10
Trace Metals – Unfiltered/Filtered			
Antimony	P, HNO_3 to pH<2	SW-846, Method 6020 or EPA-600/R-94/111, Method 200.8	5
Arsenic			2
Lead			2
Selenium			4
Thallium			2
Trace Metals – Unfiltered/Filtered			
Mercury	G, HNO_3 to pH<2	SW-846, Method 7470A EPA-600/R-94/111, Method 200.8	0.5
Volatile Organic Analyses (VOA)			
1,1-Dichloroethane	Amber G, cool to 4°C, HCl to pH<2, No headspace	SW-846, Method 8260B	10
1,1-Dichloroethylene; Vinylidene chloride			10
1,1,1-Trichloroethane; Methylchloroform			5
1,1,1,2-Tetrachloroethane			5
1,1,2-Trichloroethane			2
1,1,2,2-Tetrachloroethane			5

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Assessment Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Method Quantitation Limit (µg/L)[d]
1,2-Dibromoethane; Ethylene dibromide			5
1,2-Dibromo-3-chloropropane; DBCP			5
1,2-Dichloroethane; Ethylene dichloride			5
1,2-Dichloropropane			5
1,2,3-Trichloropropane			5
1, 4-Dioxane			500
2-Hexanone			20
4-Methyl-2-pentanone; Methyl isobutyl ketone			10
Acetone			20
Acetonitrile; Methyl cyanide			100
Acrolein			100
Acrylonitrile			100
Allyl chloride;(3-Chloropropene)			10
Benzene			5
Bromodichloromethane			5
Bromoform; Tribromomethane			5
Carbon disulfide			5
Carbon tetrachloride			5
Chlorobenzene			5
Chloroethane; (ethyl chloride)			10
Chloroform			
Chloroprene			5
cis-1,3-Dichloropropene			5
Dibromochloromethane; Chlorodibromomethane			5
Dichlorodifluoromethane			5
Ethylbenzene			5
Ethyl methacrylate			10
Isobutyl alcohol			500
Methacrylonitrile			10

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Assessment Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Method Quantitation Limit (µg/L)[d]
Methyl bromide; Bromomethane			10
Methyl chloride; Chloromethane			10
Methylene bromide; Dibromomethane			10
Methyl ethyl ketone; MEK (2-Butanone)			10
Methylene chloride; Dichloromethane			5
Methyl iodide; Iodomethane			10
Methyl methacrylate			10
Propionitrile; Ethyl cyanide			10
Pyridine			5
Styrene			5
Tetrachloroethylene; Perchloroethylene;Tetrachloroethene			5
Toluene			5
trans-1,2-Dichloroethylene (1,2-dichloroethene)			10
trans-1,3-Dichloropropene			5
trans-1,4-Dichloro-2-butene			50
Trichloroethylene			5
Trichlorofluoromethane			10
Vinyl acetate			50
Vinyl chloride			5
Xylene (total)			10
Semi-Volatile Organic Analyses (Semi-VOA)			
1-Naphthylamine	Amber glass, cool to 4°C	SW-846, Method 8270D	25
1,2,4-Trichlorobenzene			10
1,4-Naphthoquinone			50
1,2,4,5-Tetrachlorobenzene			20
2-Acetylaminofluorene; 2-AAF			25
2-Chloronaphthalene			10
2-Chlorophenol			10
2-Methylnaphthalene			10

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Assessment Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Method Quantitation Limit (µg/L)[d]
2-Naphthylamine			25
2-Picoline			20
2,3,4,6-Tetrachlorophenol			20
2,4,5-Trichlorophenol			10
2,4,6-Trichlorophenol			10
2,4-Dichlorophenol			10
2,4-Dimethylphenol			10
2,4-Dinitrophenol			25
2,4-Dinitrotoluene			10
2,6-Dichlorophenol			25
2,6-Dinitrotoluene			10
3-Methylcholanthrene			50
3,3[prime]-Dichlorobenzidine			10
3,3[prime]-Dimethylbenzidine			50
4-Aminobiphenyl			50
4-Bromophenyl phenyl ether			10
4-Chloro-3-methylphenol			10
4-Chlorophenyl phenyl ether			10
4-Nitroquinoline 1-oxide			25
4,6-Dinitro-o-cresol			10
5-Nitro-o-toluidine			20
7,12-Dimethylbenz[a]anthracene			20
Acenaphthene			10
Acenaphthylene			10
Acetophenone			10
alpha, alpha-Dimethylphenethylamine			200
Aniline			10
Anthracene			10
Aramite			50
Benzo[a]anthracene; Benzanthracene			10

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Assessment Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Method Quantitation Limit (µg/L)[d]
Benzo[a]pyrene			10
Benzo[b]fluoranthene			10
Benzo[ghi]perylene			10
Benzo[k]fluoranthene			10
Benzyl alcohol			10
Bis(2-chloroethoxy)methane			10
Bis(2-chloroethyl)ether			10
Bis(2-chloro-1-methylethyl) ether; 2,2[prime]-Di- chlorodiisopropyl ether			10
Bis(2-ethylhexyl) phthalate (DEHP)			10
Butyl benzyl phthalate; Benzyl butyl phthalate			10
Chlorobenzilate			20
Chrysene			10
Diallate			20
Dibenz[a,h]anthracene			10
Dibenzofuran			10
Diethyl phthalate			10
Dimethoate			20
Dimethyl phthalate			10
Di-n-butyl phthalate			10
Di-n-octyl phthalate			10
Dinoseb; DNBP; 2-sec-Butyl- 4,6-dinitrophenol			0.6
Diphenylamine			20
Disulfoton			50
Ethyl methanesulfonate			10
Famphur			200
Fluoranthene			10
Fluorene			10
Hexachlorobenzene			10

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Assessment Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Method Quantitation Limit (µg/L)[d]
Hexachlorobutadiene			10
Hexachlorocyclopentadiene			10
Hexachloroethane			10
Hexachlorophene			500
Hexachloropropene			25
Indeno(1,2,3-cd)pyrene			10
Isodrin			20
Isophorone			10
Isosafrole			20
Kepone			100
Methapyrilene			100
Methyl methanesulfonate			10
Methyl parathion; Parathion methyl			50
m-Cresol; (3-methylphenol)			10
m-Dichlorobenzene; (1,3-dichlorobenzene)			10
m-Dinitrobenzene			15
m-Nitroaniline; (3-Nitroaniline)			10
Naphthalene			10
Nitrobenzene			10
N-Nitrosodiethylamine			10
N-Nitrosodimethylamine			10
N-Nitrosodi-n-butylamine			10
N-Nitrosodiphenylamine			10
N-Nitrosodipropylamine; Di-n-propylnitrosamine			10
N-Nitrosomethylethylamine			10
N-Nitrosomorpholine			10
N-Nitrosopiperidine			20
N-Nitrosopyrrolidine			10
o-Cresol; (2-Methylphenol)			10

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Assessment Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Method Quantitation Limit (µg/L)[d]
o-Dichlorobenzene; (1,2-dichlorobenzene)			10
o-Nitroaniline; (2-Nitroaniline)			10
o-Nitrophenol; (2-nitrophenol)			20
O,O-Diethyl O-2-pyrazinyl phosphorothioate; Thionazin			20
O,O,O-Triethyl phosphorothioate			50
o-Toluidine			20
Parathion			50
p-Chloroaniline; (4-Chloroaniline)			10
p-Cresol; (4-methylphenol)			10
p-Dichlorobenzene; (1,4-dichlorobenzene)			5
p-(Dimethylamino)azobenzene			20
Pentachlorobenzene			10
Pentachloroethane			20
Pentachloronitrobenzene			50
Pentachlorophenol			10
Phenacetin			20
Phenanthrene			10
Phenol			10
Phorate			50
p-Nitroaniline; (4-Nitroaniline)			10
p-Nitrophenol; (4-Nitrophenol)			20
p-Phenylenediamine			400
Pronamide			20
Pyrene			10
Safrole			20
sym-Trinitrobenzene			100
Tetraethyl dithiopyrophosphate; Sulfotepp			50

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Assessment Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Method Quantitation Limit (µg/L)[d]
Polychlorinated Dibenzo-p-Dioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs)			
2,3,7,8-TCDD; 2,3,7,8-Tetrachlorodibenzo-p- dioxin	Amber glass, cool to 4°C	SW-846, Method 8270D; SW-846, Method 8280; or SW-846, Method 8290	0.01
Polychlorinated dibenzofurans; PCDFs			0.05
Polychlorinated dibenzo-p-dioxins; PCDDs			0.05
Pesticides			
4,4[prime]-DDD**	Amber glass, cool to 4°C	SW-846, Method 8081 or SW-846, Method 8141	0.1
4,4[prime]-DDE***			0.1
4,4[prime]-DDT****			0.1
Aldrin			0.05
alpha-BHC a-1,2,3,4,5,6-hexachlorocyclohexane			0.05
beta-BHC B-1,2,3,4,5,6-hexachloro-cyclohexane			0.05
Chlordane			0.5
delta-BHC delta-Hexachlorocyclohexane			0.05
Dieldrin			0.05
Endosulfan I			0.1
Endosulfan II			0.1
Endosulfan sulfate			0.1
Endrin aldehyde			0.1
Endrin			0.1
gamma-BHC; Lindane			0.05
Heptachlor			0.05
Heptachlor epoxide			0.05
Methoxychlor			0.5
Toxaphene			2

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Assessment Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Method Quantitation Limit (µg/L)[d]
PCBs			
Aroclor-1016			0.5
Aroclor-1221			0.5
Aroclor-1232			0.5
Aroclor-1242			0.5
Aroclor-1248			0.5
Aroclor-1254			0.5
Aroclor-1260			0.5
Herbicides			
2,4-D; 2,4-Dichlorophenoxyacetic acid	Amber glass, cool to 4°C	SW-846, Method 8150 or SW-846, Method 8151	20
2,4,5-T; 2,4,5-Trichlorophenoxyacetic acid			1
Silvex; 2,4,5-TP			1
Other			
Chemical Oxygen Demand	P,G, H_2SO_4 to pH<2	EPA Method 410.4[e]	10,000
Coliform bacteria	P, $Na_2S_2O_3$, cool to 4°C	Standard Method 9222 or Standard Method 9223[f]	2.2 colonies/100 mL
Cyanide	G/P, NaOH to pH≥12, cool to 4°C	SW-846, Method 9012[g]; Standard Method 4500; or EPA-600/4-84-017, Method 335.2	5
Sulfide	G/P, ZnAc+NaOH to pH>9, cool to 4°C	SW-846, Method 9030	500
Total petroleum hydrocarbons	Amber G, HCl to pH <2, cool to 4°C	WTPH-G[h], WTPH-D	500
Total organic carbon	Amber G, HCl or H_2SO_4 to pH<2, cool to 4°C	SW-846, Method 9060	1,000

Source: SW-846, Test Methods for Evaluating Solid Waste Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.

a. P, plastic; G, glass

b. All samples will be cooled to 4ºC upon collection

c. Constituents grouped together are analyzed by the same method unless otherwise indicated

d. Detection limit units except where indicated

e. Analytical method adapted from EPA-600/4-84-017, *Determination of Inorganic Anions by Ion Chromatography*, Method 300.0

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Assessment Constituents

Constituent	Collection and Preservation[a,b]	Analysis Methods[c]	Method Quantitation Limit (µg/L)[d]

f. EPA S-W 846 Standard Methods

g. EPA SW-846 Standard Methods

h. Washington Total Petroleum Hydrocarbons – Gasoline or Diesel

** DDD: P,P'-(Dichlorodiphenyl)dichloroethane

*** DDE: 1,1'-(2,2-dichloroethene-1,1-diyl)bis(4-chlorobenzene)

**** DDT: 1,1,1-trichloro-2,2-di(4-chlorophenyl)ethane

Laboratories providing analytical services in support of this QAPjP will report errors to the Sample Management and Reporting project coordinator, who will then initiate a sample disposition record. The error-reporting process is intended to document analytical errors and the resolution of those errors with the project scientist. The corrective action program addresses the following:

- Evaluation of effects of laboratory QC failures on data quality
- Root-cause analysis of QC failures
- Evaluation of recurring conditions that are adverse to quality
- Trend analysis of quality-affecting problems
- Implementation of a quality improvement process
- Control of nonconforming materials that may affect quality

A2.5 Quality Control

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to field variability. Field QC for sampling will require the collection of field replicates (duplicates), trip or field blanks, and equipment blanks. Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table A-4.

Table A-4. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
Field QC		
Full trip blank	Contamination from containers or transportation	1 per 20 well trips
Field transfer blank	Contamination from sampling site	1 each day; volatile organic compounds sampled
Equipment blank	Contamination from non-dedicated equipment	As needed[a]
Replicate/duplicate samples	Reproducibility	1 per 20 well trips

Table A-4. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
Laboratory QC		
Method blanks	Laboratory contamination	1 per batch
Laboratory duplicates	Laboratory reproducibility	See footnote[b]
Matrix spikes	Matrix effect and laboratory accuracy	See footnote[b]
Matrix spike duplicates	Laboratory reproducibility/accuracy	See footnote[b]
Surrogates	Recovery/yield	See footnote[b]
Laboratory control samples	Method accuracy	1 per batch

a. For portable Grundfos® (registered trademark of Grundfos Pumps Corporation, Colorado Springs, Colorado) pumps, equipment blanks are collected 1 per 10 well trips. Whenever a new type of non-dedicated equipment is used, an equipment blank will be collected every time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination procedure for the nondedicated equipment.

b. As defined in the laboratory contract or quality assurance plan, and/or analysis procedures.

QC = quality control

A2.5.1 Field Quality Control Samples

Field QC samples will be collected to evaluate the potential for cross-contamination and field sampling performance. The QC samples and the required frequency for collection are described in this section.

Full trip blanks (FTBs) are prepared by the sampling team before traveling to the sampling site. The FTB is filled with high-purity reagent water. The bottles are sealed and transported, unopened, to the field in the same storage containers used for samples collected that day. Collected FTBs are analyzed for the same constituents as the samples. The FTBs are used to evaluate potential contamination of the samples due to the sample bottles, preservative, handling, storage, or transportation.

Field transfer blanks (FXRs) are preserved volatile organic analysis sample bottles that are filled at the sample collection site with high-purity reagent water that has been transported to the field. After collection, FXR bottles are sealed and placed in the same storage containers with the samples from the associated sampling event. The FXR samples are analyzed for volatile organic compounds only. The FXRs are used to evaluate potential contamination caused by conditions in the field.

Equipment blanks (EBs) are samples in which high-purity reagent water is passed through the pump or placed in contact with the sampling surfaces of the equipment to collect blank samples identical to the sample set that will be collected. The EB bottles are placed in the same storage containers with the samples from the associated sampling event. The EB samples are analyzed for the same constituents as the samples from the associated sampling event. The EBs are used to evaluate the effectiveness of the cleaning process to ensure that samples are not cross-contaminated from previous sampling events.

For the field blanks (i.e., FTBs, FXRs, and EBs), results above two times the method detection limit are identified as suspected contamination. However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the limit is five times the method detection limit.

Field duplicates, also known as replicates, are two samples that are collected as close as possible to the same time and same location, and they are intended to be identical. Field duplicates are stored and transported together and are analyzed for the same constituents. The field duplicates are used to determine precision for both sampling and laboratory measurements. The results of the field duplicates must have precision within 20 percent, as measured by the relative percent difference. Only field duplicates with at least one result greater than five times the method detection limit or minimum detectable activity are evaluated.

Double-blind samples contain a concentration of analyte known to the supplier but unknown to the analyzing laboratory. The laboratory is not informed that the samples are QC samples. The project submits double-blind samples to assess analytical precision and accuracy.

A2.5.2 Laboratory Quality Control Samples

The laboratory QC samples (e.g., method blanks, laboratory control sample/blank spikes, and matrix spikes) are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, and will be run at the frequency specified in that reference, unless superseded by agreement.

A2.5.3 Quality Control Requirements

Table A-5 lists the acceptance criteria for QC samples, and Table A-6 lists the acceptable recovery limits for the double-blind standards. These samples are prepared by spiking Hanford Site background well water with known concentrations of constituents of interest. Spiking concentrations range from the detection limit to the upper limit of concentration determined in groundwater on the Hanford Site. Investigations shall be conducted for double-blind standards that are outside of acceptance limits. The results from these standards are used to determine the acceptability of the associated parameter data.

Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Method[a]	QC Element	Acceptance Criteria	Corrective Action
General Chemical Parameters			
Alkalinity Chemical oxygen demand Conductivity pH	MB[b]	<MDL	Flagged with “C”
	LCS	80-120% recovery[c]	Data reviewed[d]
	DUP	≤20% RPD[c]	Data reviewed[d]
	MS[e]	75-125% recovery[c]	Flagged with “N”
	EB, FTB	<2 times MDL	Flagged with “Q”
	Field duplicate	≤20% RPD[f]	Flagged with “Q”
Ammonia and Anions			
Ammonia Anions by IC Cyanide	MB	<MDL	Flagged with “C”
	LCS	80-120% recovery[c]	Data reviewed[d]
	DUP	≤20% RPD[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with “N”
	EB, FTB	<2 times MDL	Flagged with “Q”
	Field duplicate	≤20% RPD[f]	Flagged with “Q”

Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Method[a]	QC Element	Acceptance Criteria	Corrective Action
Metals			
Arsenic Cadmium Chromium Lead Mercury Selenium Thallium ICP metals ICP/MS metals	MB	<CRDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with "N"
	MSD	≤20% RPD[c]	Data reviewed[d]
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"
Volatile Organic Compounds			
Volatiles by GC/MS Total petroleum hydrocarbons by GC	MB	<MDL	Flagged with "B"
	LCS	Statistically derived[g]	Data reviewed
	MS	Statistically derived[g]	Flagged with "N"
	MSD	Statistically derived[g]	Data reviewed[d]
	SUR	Statistically derived[g]	Data reviewed[d]
	EB, FTB, FXR	<2 times MDL[h]	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"
Semivolatile Organic Compounds			
Herbicides by GC PCBs by GC Pesticides by GC Phenols by GC Semivolatiles by GC/MS	MB	<2 times MDL	Flagged with "B"
	LCS	Statistically derived[g]	Data reviewed[d]
	MS	Statistically derived[g]	Flagged with "N"
	MSD	Statistically derived[g]	Data reviewed[d]
	SUR	Statistically derived[g]	Data reviewed[d]
	EB, FTB	<2 times MDL[h]	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"

a. Refer to Tables A-2 and A-3 for specific analytical methods.

b. Does not apply to pH.

c. Laboratory-determined, statistically derived control limits may also be used. Such limits are reported with the data.

d. After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck or flagging the data as suspect ("Y" flag) or rejected ("R" flag).

e. Applies to total organic carbon and total organic halides only.

f. Applies only in cases where one or both results are greater than five times the detection limit.

g. Determined by the laboratory based on historical data. Control limits are reported with the data.

h. For common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the acceptance criteria is less than five times the MDL.

Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Method[a]	QC Element	Acceptance Criteria	Corrective Action

CRDL = contract-required detection limit
DUP = laboratory matrix duplicate
EB = equipment blank
FTB = full trip blank
FXR = field transfer blank
GC = gas chromatography
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
LCS = laboratory control sample
MB = method blank
MDL = method detection limit
MS = matrix spike
MSD = matrix spike duplicate
PCB = polychlorinated biphenyls
QC = quality control
RPD = relative percent difference
SUR = surrogate

Data Flags:
B, C = possible laboratory contamination (analyte was detected in the associated method blank)
N = result may be biased (associated matrix spike result was outside the acceptance limits)
Q = problem with associated field QC sample (blank and/or duplicate results were out of limits)

Table A-6. Blind Standard Constituents and Schedule

Constituents	Frequency	Accuracy (Percent)	Precision (Percent RSD)*
Chloride	Quarterly	±25	≤25
Cyanide	Semiannually	±25	≤25
Fluoride	Quarterly	±25	≤25
Nitrate as nitrogen	Quarterly	±25	≤25
Nitrite as nitrogen	Quarterly	±25	≤25
Arsenic	Annually	±20	≤20
Barium	Annually	±20	≤20
Cadmium	Semiannually	±20	≤20
Carbon tetrachloride	Quarterly	±25	≤25
Chloroform	Quarterly	±25	≤25

Table A-6. Blind Standard Constituents and Schedule

Constituents	Frequency	Accuracy (Percent)	Precision (Percent RSD)*
Chromium (total)	Quarterly	±20	≤20
Cobalt	Semiannually	±20	≤20
Copper	Semiannually	±20	≤20
Hexavalent chromium	Quarterly	±20	≤20
Iron	Semiannually	±20	≤20
Magnesium	Annually	±20	≤20
Manganese	Annually	±20	≤20
Nickel	Annually	±20	≤20
Potassium	Annually	±20	≤20
Silver	Annually	±20	≤20
Sodium	Annually	±20	≤20
Trichloroethylene	Quarterly	±25	≤25
Vanadium	Annually	±20	≤20
Zinc	Annually	±20	≤20

* If the results are less than five times the required detection limit, then the criterion is that the difference of the results of the replicates is less than the required detection limit.

RSD = relative standard deviation

Holding time is the elapsed time period between sample collection and analysis. The contractor's environmental QA program plan provides a table with holding times. Exceeding the required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Recommended holding times depend on the analytical method, as specified in SW-846 or EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. Data associated with exceeded holding times are flagged with an "H" in the HEIS database. Data that exceed the holding time shall be maintained but potentially may not be used in statistical analyses.

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. The contract laboratories participate in national studies such as the EPA-sanctioned Water Pollution and Water Supply Performance Evaluation studies. The groundwater project periodically audits the analytical laboratories to identify and solve quality problems, or to prevent such problems from occurring. Audit results are used to improve performance, and the summaries of audit results and performance evaluation studies are presented in the annual groundwater monitoring report.

Failure of QC will be determined and evaluated during data validation and the data quality assessment process. Data will be qualified, as appropriate.

A2.6 Instrument/Equipment Testing, Inspection, and Maintenance

Measurement and testing equipment used in the field or in the laboratory that directly affects the quality of analytical data will be subject to preventive maintenance measures to minimize measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment. Maintenance requirements (e.g., documentation of routine maintenance) will be included in the individual laboratory and the onsite organization's QA plan or operating procedures, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with SW-846, or with auditable HASQARD (DOE/RL-96-68) and contractual requirements. Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use.

A2.7 Instrument/Equipment Calibration and Frequency

Specific field equipment calibration information is provided in the environmental QA program plan. Standards used for calibration will be certified and traceable to nationally recognized performance standards. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory's QA plan.

A2.8 Inspection/Acceptance of Supplies and Consumables

Supplies and consumables used to support sampling and analysis activities are procured in accordance with internal work requirements and processes that describe the contractor's acquisition system and the responsibilities and interfaces necessary to ensure that items procured/acquired for contractor meet the specific technical and quality requirements. The procurement system ensures that purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users before use.

Supplies and consumables that are procured by the analytical laboratories are procured, checked, and used in accordance with the laboratory's QA plan.

A2.9 Non-Direct Measurements

Non-direct measurements include data obtained from sources such as computer databases, programs, literature files, and historical databases. If evaluation includes data from historical sources, whenever possible such data will be validated to the same extent as the data generated as part of this effort. All data used in evaluations will be identified by source.

A2.10 Data Management

The Sample Management and Reporting organization, in coordination with the RCRA Monitoring and Reporting manager, is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with applicable programmatic requirements that govern data management procedures. Electronic data access, when appropriate, will be via a database (e.g., HEIS or a project-specific database). Where electronic data are not available, hardcopies will be provided in accordance with Section 9.6 of the Tri Party Agreement Action Plan (Ecology et al., 1989b). The HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file.

All field activities will be recorded in the field logbook.

Laboratory errors are reported to the Sample Management and Reporting organization on a routine basis. For reported laboratory errors, a sample disposition record will be initiated in accordance with contractor procedures. This process is used to document analytical errors and to establish resolution of the errors

with the RCRA Monitoring and Reporting manager. Sample disposition records become a permanent part of the analytical data package for future reference and for records management.

A3 Assessment and Oversight

The elements discussed in this section address the activities for assessing the effectiveness of project implementation and the associated QA and QC activities. The purpose of the assessment is to ensure that the QAPjP is implemented as prescribed.

A3.1 Assessments and Response Actions

The contractor management, Regulatory Compliance, Quality, and/or Health and Safety organizations may conduct random surveillances and assessments to verify compliance with the requirements outlined in this QAPjP.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratory's QA plan. The primary contractor conducts oversight of offsite analytical laboratories to qualify the laboratories for performing Hanford Site analytical work.

A3.2 Reports to Management

Reports to management on data quality issues will be made if and when these issues are identified. Issues reported by the laboratories are communicated to the Sample Management and Reporting organization, which initiates a sample disposition record in accordance with contractor procedures. This process is used to document analytical or sample issues and to establish resolution with the RCRA Monitoring and Reporting manager.

A4 Data Validation and Usability

The elements in this section address the QA activities that occur after the data collection phase of the project is completed. Implementation of these elements determines whether the data conform to the specified criteria, thus satisfying project objectives. These elements are further discussed in the contractor's environmental QA program plan.

A4.1 Data Review, Verification, and Validation

The criteria for verification may include review for completeness (e.g., all samples were analyzed as requested), use of the correct analytical method/procedure, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Laboratory personnel may perform data verification.

A4.2 Verification and Validation Methods

The work activities shall follow documented procedures and processes for data validation and verification, as summarized below. Validation of groundwater data consists of assessing whether the data collected and measured truly reflect aquifer conditions. Verification means assessing data accuracy, completeness, consistency, availability, and internal control practices to determine overall reliability of the data collected. Other DQOs that shall be met include proper chain-of-custody, sample handling, use of proper analytical techniques as applied for each constituent, and the quality and acceptability of the laboratory analyses conducted.

Groundwater monitoring staff perform checks on laboratory electronic data files for formatting, allowed values, data flagging (i.e., qualifiers), and completeness. Hardcopy results are verified to check for (1) completeness, (2) notes on condition of samples upon receipt by the laboratory, (3) notes on problems encountered during analysis of the samples, and (4) correct reporting of results. If data are incomplete or deficient, staff work with the laboratory to correct the problem found during the analysis.

The data validation process provides the requirements and guidance for validating groundwater data that are routinely collected. Validation is a systematic process of reviewing verified data against a set of criteria (listed in Table A-4) to determine whether the data are acceptable for their intended use.

Results of laboratory and field QC evaluations, double-blind sample results, laboratory performance evaluation samples, and holding-time criteria are considered when determining data usability. Staff review the data to identify whether observed changes reflect changes in groundwater quality or potential data errors, and they may request data reviews of laboratory, field, or water-level data for usability purposes. The laboratory may be asked to check calculations or re-analyze the sample, or the well may be resampled. Results of the data reviews are used to flag the data appropriately in the HEIS database (e.g., "R" for reject, "Y" for suspect, or "G" for good) and/or to add comments.

A4.3 Reconciliation with User Requirements

The data quality assessment process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet project DQOs. The RCRA Monitoring and Reporting manager is responsible for determining if data quality assessment is necessary and for ensuring that, if required, one is performed. The results of the data quality assessment will be used in interpreting the data and determining if the objectives of this activity have been met.

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