**Department of Energy**
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11-AMCP-0101

MAR 0 3 2011

Ms. J. A. Hedges, Program Manager
Nuclear Waste Program
State of Washington
Department of Ecology
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Dear Ms. Hedges:

INTERIM STATUS GROUNDWATER QUALITY ASSESSMENT PLAN FOR THE SINGLE-SHELL TANK WASTE MANAGEMENT AREA T, DOE/RL-2009-66, REVISION 0, INTERIM STATUS GROUNDWATER QUALITY ASSESSMENT PLAN FOR THE SINGLE-SHELL TANK WASTE MANAGEMENT AREA TX-TY, DOE/RL-2009-67, REVISION 0, INTERIM STATUS GROUNDWATER QUALITY ASSESSMENT PLAN FOR THE SINGLE-SHELL TANK WASTE MANAGEMENT AREA S-SX, DOE/RL-2009-73, REVISION 0, INTERIM STATUS GROUNDWATER QUALITY ASSESSMENT PLAN FOR THE SINGLE-SHELL TANK WASTE MANAGEMENT AREA U, DOE/RL-2009-74, REVISION 0

This letter transmits the subject final Interim Status Groundwater Quality Assessment Plans. These groundwater quality assessment plans incorporate responses to comments received on the Draft A versions.

If you have any questions, please contact me, or your staff may contact Briant Charboneau, of my staff, on (509) 373-6137.

Sincerely,

Richard A. Holten, Acting Assistant Manager
for the Central Plateau

AMCP:RDH

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DOE/RL-2009-66
Revision 0

# Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area T

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

DOE/RL-2009-66
Revision 0

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Date Published
January 2011

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

U.S. DEPARTMENT OF ENERGY
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**Richland, Washington 99352**

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# Executive Summary

Waste Management Area (WMA) T, which contains the T Tank Farm, is regulated under RCW 70.105[1] and its implementing requirements in WAC 173-303-400.[2] The Washington State Department of Ecology (Ecology) has been authorized by the U.S. Environmental Protection Agency, in accordance with *Authorized State Hazardous Waste Programs*,[3] to conduct its hazardous waste regulatory program in lieu of the *Resource Conservation and Recovery Act of 1976* (RCRA),[4] including the requirements in 40 CFR 265, Subpart F.[5] The WMA T is also subject to the requirements of the *Hanford Federal Facility Agreement and Consent Order*,[6] with Ecology identified as the lead regulatory agency for the unit.

The WMA T was placed in assessment monitoring in 1993 due to elevated specific conductance. A groundwater quality assessment plan was prepared in 1993 (WHC-SD-EN-AP-132)[7] that described the monitoring activities to be used to determine whether WMA T had affected groundwater. That plan was updated in 2000 (PNNL-12057)[8] for continued RCRA groundwater quality assessment, as required by 40 CFR 265.93(d)(7).[9] The WMA T assessment plan was updated again in 2006

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[1] RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*, Olympia, Washington. Available at: http://apps.leg.wa.gov/RCW/default.aspx?cite=70.105.

[2] WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303-400.

[3] *Authorized State Hazardous Waste Programs*, 42 USC 6926, et seq. Available at: http://www.law.cornell.edu/uscode/42/6926.html.

[4] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://epw.senate.gov/rcra.pdf.

[5] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring," *Code of Federal Regulations*. Available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=fbf815e6fc70c4b56f27b33a7b919fb6&rgn=div6&view=text&node=40:25.0.1.1.6.6&idno=40.

[6] Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

[7] WHC-SD-EN-AP-132, 1993, *Interim-Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Areas T and TX-TY*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[8] PNNL-12057, 2001, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area T at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D1662358.

[9] 40 CFR 265.93, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Preparation, Evaluation, and Response," *Code of Federal Regulations*. Available at: http://edocket.access.gpo.gov/cfr_2010/julqtr/40cfr265.93.htm.

(PNNL-15301)[10] to include information obtained from seven new wells installed at the WMA after 1999 and information from routine quarterly groundwater monitoring during the previous 5 years. This document supersedes the 2006 assessment plan to include significant events that have occurred at WMA T since that time.

This plan describes the WMA T facility and operating history, waste characteristics, hydrogeology, previous monitoring at the WMA, groundwater and vadose zone contamination associated with the WMA, and the conceptual model for the WMA. This plan also addresses the following:

- Number, locations, and depths of wells in the WMA T groundwater monitoring network
- Sampling requirements and schedule for monitoring WMA T
- Analytes, groundwater parameters, and analytical methods for hazardous wastes or hazardous waste constituents in the groundwater related to historical facility operations
- Procedures for evaluating groundwater quality information
- Reporting requirements

This assessment plan is the principal controlling document for conducting groundwater monitoring at WMA T.

[10] PNNL-15301, 2006, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area T*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15301.pdf.

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# Terms

| | |
|---|---|
| amsl | above mean sea level |
| CAS | Chemical Abstracts Service |
| CERCLA | *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* |
| DOE | U.S. Department of Energy |
| DQO | data quality objective |
| DWS | drinking water standard |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| ID | identification |
| NA | not available |
| NAVD88 | North American Vertical Datum of 1988 |
| OU | operable unit |
| PFP | Plutonium Finishing Plant |
| QAPjP | quality assurance project plan |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| REDOX | reduction-oxidation |
| SST | single-shell tank |
| TCE | trichloroethylene |
| WMA | waste management area |

# 1 Introduction

Waste Management Area (WMA) T, which contains the T Tank Farm, is located in the northern portion of the 200 West Area of the Hanford Site (Figure 1-1). The WMA was used for interim storage of radioactive waste from chemical processing of reactor fuel for plutonium production. The WMA T is regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA), as modified in 40 CFR 265, Subpart F ("Interim Status Standards for Owners and Operators of Hazardous Treatment, Storage, and Disposal Facilities"), RCW 70.105 ("Hazardous Waste Management Act"), and its implementing requirements in Washington State dangerous waste regulations (WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards"). The WMA T was placed in assessment monitoring in 1993 due to elevated specific conductance (a RCRA indicator parameter) in one downgradient well. Assessment monitoring has continued at WMA T since that time. The objectives for the continued assessment of groundwater quality at WMA T, as required by 40 CFR 265.93(d)(7)(i) ("Preparation, Evaluation, and Response"), are to determine the following:

- Rate and extent of migration of the hazardous waste or hazardous waste constituents in the groundwater
- Concentration of hazardous waste or hazardous waste constituents in the groundwater

The scope of this plan is to acquire necessary groundwater data to achieve these objectives. The objectives are also related to the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) 200-ZP-1 Groundwater Operable Unit (OU) investigations and the vadose zone RCRA facility investigation/corrective measures study at WMA T. The integration of RCRA groundwater quality assessment with the 200-ZP-1 OU and the vadose zone RCRA facility investigation/corrective measures study requires consideration of certain nondangerous waste constituents and radionuclides, in addition to the dangerous waste constituents regulated under RCRA. Radionuclides are monitored under separate plans to support the objectives of CERCLA and the *Atomic Energy Act of 1954*.

This document is a revision of the previous groundwater assessment plan (PNNL-15301, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area T*) and includes significant events that have occurred at WMA T since the previous plan was issued. This monitoring plan is prepared to be consistent, to the extent possible, with the final status monitoring plan that will be incorporated into the *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste* (WA7890008967) in the future.

Chapter 2 of this plan summarizes background information, with reference to other documents for more detailed information. Chapter 2 also describes the WMA and the types of waste present, provides a brief history of groundwater monitoring, and discusses the geology and hydrology pertinent to WMA T. This information is summarized as a site conceptual model to aid in development of the groundwater monitoring program. Chapter 3 describes the RCRA groundwater monitoring program, including the wells in the monitoring network, constituents analyzed, sampling frequency, and sampling protocols. Chapter 4 describes data evaluation, interpretation, and reporting. A list of the references cited in this document is provided in Chapter 5. Appendix A provides the quality assurance project plan (QAPjP).

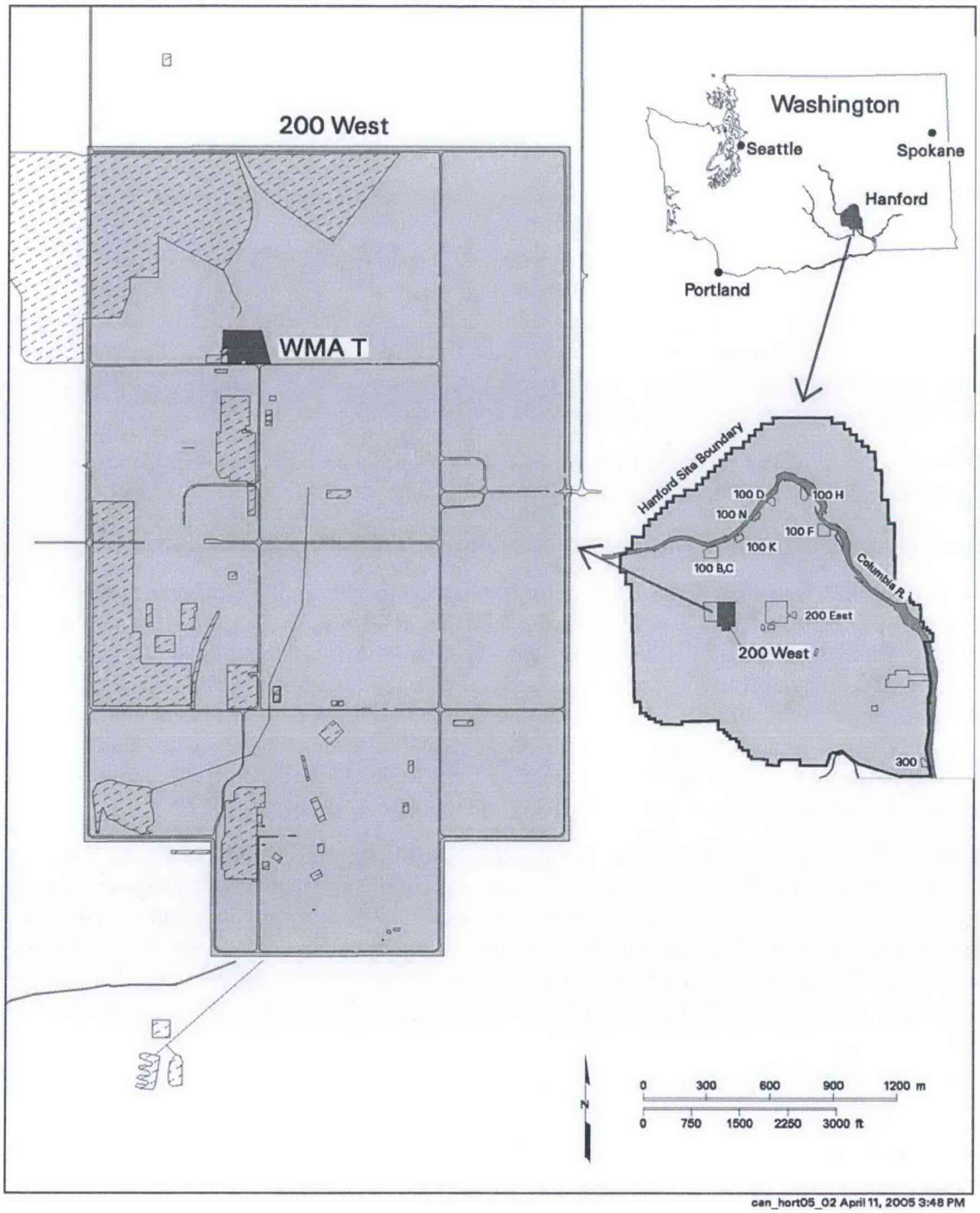



**Figure 1-1. Location Map for WMA T**

# 2 Background

This chapter describes WMA T facility and its operating history. Discussion is also included on associated waste and waste characteristics at the WMA, local geology and hydrology, a summary of previous monitoring, groundwater and vadose zone contamination at the WMA, and a conceptual model.

The discussions in this chapter are summarized from previous documents, including the following:

- PNNL-13929, *RCRA Groundwater Quality Assessment Report for Single-Shell Tank Waste Management Area T (January 1998 Through December 2001)*
- PNNL-15301, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area T*
- PNNL-15837, *Data Package for Past and Current Groundwater Flow and Contamination Beneath Single-Shell Tank Waste Management Areas*
- RPP-23752, *Field Investigation Report for Waste Management Areas T and TX-Y*

## 2.1 Facility Description and Operating History

The WMA T is located in the northern portion of the 200 West Area (Figure 1-1). The WMA T contains 16 underground single-shell tanks (SSTs) that were constructed in 1943 and 1944. Twelve tanks (T-101 through T-112) have capacities of 2,000,000 L (530,000 gal), and four tanks (T-201 through T-204) have capacities of 208,000 L (55,000 gal). In addition to the tanks, six diversion boxes and ancillary pumps, valves, and pipes are included in the Dangerous Waste Permit Application Part A form (WA7890008967) for the T Tank Farm SST system.

The tanks in WMA T began receiving waste in 1944 and were mostly in continual use from that time until 1980, at which time all tanks in the WMA were removed from service. The SSTs received predominantly high-level metal and first-cycle waste from chemical processing of uranium-bearing, irradiated reactor fuel rods. Lesser amounts of other waste types were also stored in the tanks at WMA T.

Waste management operations created a complex intermingling of tank wastes. Nonradioactive chemicals have been added to the tanks, and varying amounts of waste and heat-producing radionuclides have been removed. In addition, natural processes have caused settling, stratification, and segregation of waste components. As a result, it is difficult to estimate the composition of the waste remaining in the tanks through operational records. A detailed history of tank farm operations is provided in *A History of the 200 Area Tank Farms* (WHC-MR-0132).

All pumpable liquid has been removed from the WMA T SSTs, and the tanks have been interim stabilized. Each tank currently contains less than 189,250 L (50,000 gal) of drainable interstitial liquid and less than 18,925 L (5,000 gal) of supernatant liquid (HNF-EP-0182, *Waste Tank Summary Report for Month Ending September 30, 2004*, Rev. 198).

Initial corrective actions have been implemented at WMA T. Berms were constructed around the T Tank Farm in 2001 to stop run-on of natural precipitation, and all known water lines have been tested or cut off. Finally, an interim surface barrier was placed over tank T-106 and nearby tanks to inhibit infiltration from mobilizing wastes that leaked from the tank in 1973. An interim measures maintenance plan consisting of annual inspections of drywell covers and visual inspections of run-off collection areas and culverts is in place and documented in the *Interim Measures Maintenance Plan* (WRPS-0900388).

Seven of the tanks at WMA T have been declared as leakers (see Figure 3-1 in Chapter 3) based on liquid losses (HNF-EP-0182). Although HNF-EP-0182 provides estimated leak volumes for tanks T-107, T-108, T-109, and T-111 based on observed liquid levels in the tanks, neither the spectral gamma logging data (GJO-99-101-TAR/GJO-HAN-27, *Vadose Zone Characterization Project at the Hanford Tank Farms, T Tank Farm Report*) nor tank waste transfer records provide evidence of leaks from these tanks (RPP-7218, *Preliminary Inventory Estimates for Single-Shell Tank Leaks in T, TX, and TY Tank Farms*; RPP-23405, *Tank Farm Vadose Zone Contamination Volume Estimates*). It must be noted that spectral gamma logging in dry wells is only used to interrogate to a radius of 30.5 cm (12 in.) and, therefore, depends on the placement of the initial borehole. Contamination associated with these tanks may be the result of waste pipeline leaks or nearby tanks that are known to have leaked. The three largest leaks or releases from tanks in WMA T were from T-101, T-103, and T-106:

- Overfill of tank T-101 in 1969, with a loss of 38,000 L (10,000 gal) of reduction-oxidation (REDOX) cladding waste
- Overfill of tank T-103 in 1972 and 1973, with a loss of approximately 11,400 L (3,000 gal) of B Plant waste
- Leak of approximately 435,300 L (115,000 gal) of B Plant isotope recovery waste from tank T-106 in 1973

In addition to these releases, nine other unplanned releases have been documented in the area of WMA T. These unplanned releases are described in *T Plant Source Aggregate Area Management Study Report* (DOE/RL-91-61) and PNNL-15301.

## 2.2 Regulatory Basis

In May 1987, the U.S. Department of Energy (DOE) issued a final rule (10 CFR 962, "Byproduct Material") stating that the hazardous waste components of mixed waste are subject to RCRA regulations. In November 1987, the U.S. Environmental Protection Agency (EPA) authorized the Washington State Department of Ecology (Ecology) to regulate these hazardous waste components within the state of Washington ("EPA Clarification of Regulatory Authority Over Radioactive Mixed Waste" [51 FR 24504]). In 1996, the Washington State Attorney General determined that the effective date of mixed waste in Washington State was August 19, 1987.

Groundwater monitoring is conducted at WMA T in accordance with 40 CFR 265, Subpart F (as referenced by WAC 173-303-400[3]). A detection-level RCRA groundwater monitoring program for WMA T was initiated in 1989 (WHC-SD-EN-AP-012, *Interim Status Groundwater Monitoring Plan for the Single-Shell Tanks* [Rev. 0, followed by Rev. 1 in 1991]). The WMA was placed in assessment monitoring in 1993 because specific conductance values in downgradient well 299-W10-15 exceeded the upgradient background (critical mean) value (WHC-SA-1124-FP, *Statistical Approach on RCRA Groundwater Monitoring Projects at the Hanford Site*; WHC-SD-EN-AP-132, *Interim-Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Areas T and TX-TY*). The elevated specific conductance values dropped below the critical mean in 1994, but before the WMA could be returned to a detection-level monitoring program, specific conductance in another well increased and exceeded the critical mean in 1996. The presence of chromium, a dangerous waste constituent in groundwater, requires continued groundwater assessment. Subsequent assessment reports (PNNL-11809, *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Areas T and TX-TY at the Hanford Site*; PNNL-13929) have not identified an upgradient source for the contamination observed in monitoring WMA T but have provided evidence linking some contaminants (including chromium) in groundwater to the WMA. Based on 40 CFR 265.93(d)(7),

the owner/operator must continue to make the minimum required determinations of contaminant level and rate/extent of migration on a quarterly basis until final facility closure. Accordingly, continued groundwater assessment is required, and this plan describes the activities for the continued assessment.

## 2.3 Waste Characteristics

Three basic chemical-processing operations were the source of most of the hazardous waste transferred to the T Tank Farm, including the bismuth phosphate process, tributyl phosphate process, and REDOX process. The bismuth phosphate and REDOX processes were chemical separations programs for recovering plutonium from irradiated reactor fuels. The tributyl phosphate process recovered uranium metal in waste generated by the bismuth phosphate process. Waste from all three processes was made alkaline for storage in the tanks (WHC-MR-0132). WHC-MR-0132 provides the approximate chemical compositions for the major waste types sent to the T Tank Farm SSTs, and the *Hanford Soil Inventory Model, Rev. 1* (RPP-26744) provides detailed estimates for chemical and radioisotope concentrations for each tank leak in the WMA.

Table 2-1 lists the dangerous wastes specified in the Dangerous Waste Permit Application Part A form (WA7890008967).

**Table 2-1. Dangerous Wastes in the Single-Shell Tank System (Dangerous Waste Permit Application Part A Form)**

| Dangerous Waste Code | Contaminant Description | Dangerous Waste Code | Contaminant Description |
|---|---|---|---|
| D001 | Ignitable waste | D030 | 2,4-Dinitrotoluene |
| D002 | Corrosive waste | D033 | Hexachlorobutadiene |
| D003 | Reactive waste | D034 | Hexachloroethane |
| D004 | Arsenic | D035 | Methyl ethyl ketone |
| D005 | Barium | D036 | Nitrobenzene |
| D006 | Cadmium | D040 | Trichloroethylene (TCE) |
| D007 | Chromium | D041 | 2,4,5-Trichlorophenol |
| D008 | Lead | D043 | Vinyl chloride |
| D009 | Mercury | F001 | 1,1,1-Trichloroethane |
| D010 | Selenium | F002 | Methylene chloride |
| D011 | Silver | F003 | Acetone, methyl isobutyl ketone |
| D018 | Benzene | F004 | Cresol-m, -o, -p |
| D019 | Carbon tetrachloride | F005 | Methyl ethyl ketone |
| D022 | Chloroform | WP01 | Extremely hazardous waste/ persistent dangerous waste |
| D028 | 1,2-Dichloroethane | WP02 | Dangerous waste/ persistent dangerous waste |

**Table 2-1. Dangerous Wastes in the Single-Shell Tank System (Dangerous Waste Permit Application Part A Form)**

| Dangerous Waste Code | Contaminant Description | Dangerous Waste Code | Contaminant Description |
|---|---|---|---|
| D038 | Pyridine | WT01 | Extremely hazardous waste/ toxic dangerous waste |
| D029 | 1,1-Dichloroethylene | WT02 | Dangerous waste/toxic dangerous waste |
| D039 | Tetrachloroethylene | | |

Notes:

1. This table is based on the Dangerous Waste Permit Application Part A form (WA789000896).
2. Analytes associated with the "F001" through "F005" waste codes are from WHC-MR-0517, *Listed Waste History at Hanford Facility TSD Units*.

## 2.4 Geology and Hydrogeology

This section describes the geology and hydrology beneath the SST WMA T. The geology specific to WMA T was first described in *Geology of the 241-T Tank Farm* (ARH-LD-135) and later in WHC-SD-EN-AP-012. Summaries of the geology at WMA T are also provided in *A Summary and Evaluation of Hanford Site Tank Farm Subsurface Contamination* (HNF-2603) and *Subsurface Conditions Description of the T and TX-TY Waste Management Areas* (RPP-7123).

More recently, the *Geology, Hydrogeology, Geochemistry, and Mineralogy Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site* (RPP-23748); *Geology Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site* (PNNL-15955); PNNL-15301; and PNNL-15837 provided updated information on the geology and hydrology at WMA T, including the most recent observations from new wells.

The vadose zone beneath WMA T is between approximately 70 and 76 m (229 and 249 ft) thick and consists of the Hanford formation, the Cold Creek unit, the Taylor Flat member of the Ringold Formation, and the upper portion of Unit E of the Wooded Island member of the Ringold Formation. The water table is at approximately 134.5 m (441.3 ft) in elevation (March 2009). The unconfined aquifer beneath WMA T is estimated to be approximately 48 to 51 m (157 to 167 ft) thick based on water levels and the depth of the Ringold Formation lower mud unit, which serves as a confining or semiconfining layer separating the unconfined aquifer from a confined, or partly confined, aquifer in the underlying Ringold Formation Unit A. Figure 2-1 shows a generalized hydrostratigraphic column for the WMA T area.

Water levels in the unconfined aquifer increased as much as 13.5 m (44.3 ft) (above the pre-Hanford natural water table) beneath WMA T due to artificial recharge from liquid waste disposal operations between the mid-1940s and 1995. During that time, the groundwater flow direction changed from eastward (the pre-Hanford direction) to southward, then northward, and finally back toward the east as a result of changes in waste management practices. More recently, two monitoring wells east of WMA T were converted to extraction wells for the removal of technetium-99 at the 200-ZP-1 OU, which will likely enhance the eastward flow of groundwater. The large shifts in groundwater flow direction have large implications for contaminant distribution in the uppermost aquifer beneath WMA T.

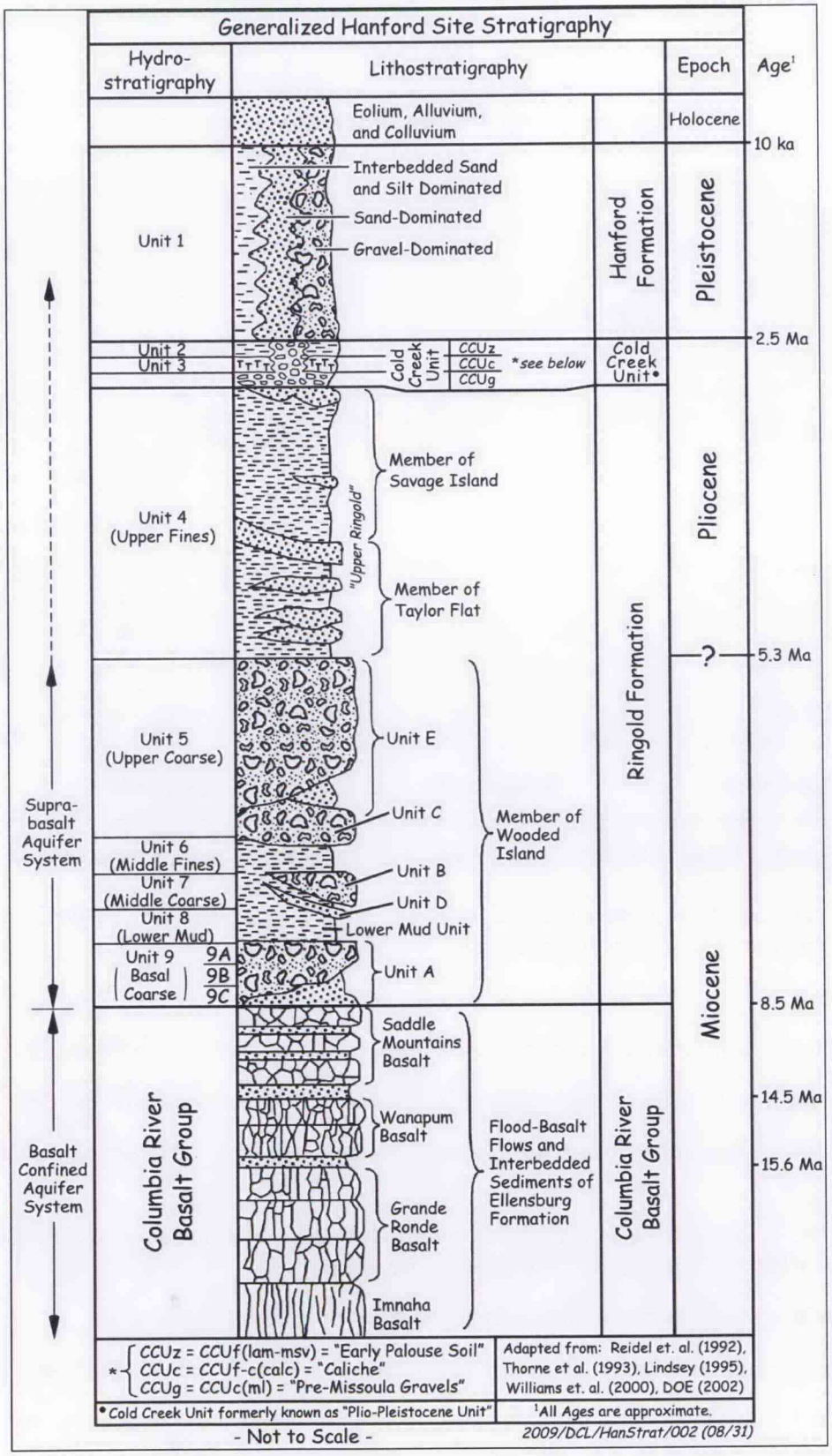



**Figure 2-1. Generalized Stratigraphy of the Hanford Site**

Groundwater levels continue to decline due to cessation of artificial recharge from liquid waste disposal operations in the area, as shown in Figure 2-2.

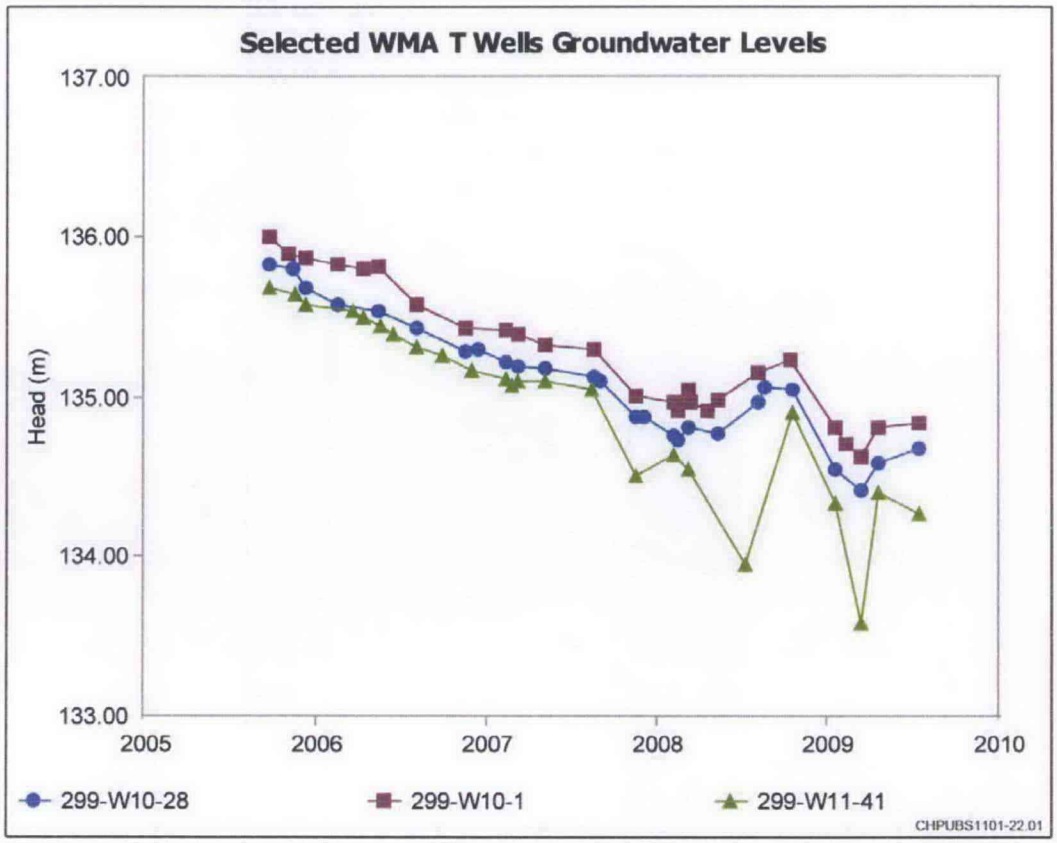



**Figure 2-2. Selected Monitoring Wells Showing Groundwater Level Declines in WMA T**

Since 1999, several aquifer tests have been performed at the new wells at WMA T. Details of the tests, data analyses, and test results are provided in the following documents:

- PNNL-13378, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 1999*
- PNNL-14113, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2001*
- PNNL-14186, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2002*
- PNNL-17348, *Results of Detailed Hydrologic Characterization Tests – Fiscal and Calendar Year 2005*
- PNNL-17732, *Analysis of the Hydrologic Response Associated with Shutdown and Restart of the 200-ZP-1 WMA T Tank Farm Pump-and-Treat System*

The salient results of the aquifer tests are summarized below:

- Local hydraulic conductivities are between approximately 6.1 and 9.7 m/d (20 and 31.8 ft/d).
- The vertical in-well flow rates range from 0.001 to 0.017 m/m (downward), determined during testing in two wells in the WMA well network.

- Vertical heterogeneities in hydraulic conductivity were recognized among wells and within individual well screens.

Prior to conversion of wells 299-W11-45 and 299-W11-46 to 200-ZP-1 OU pump-and-treat extraction wells, the water table gradient beneath WMA T was approximately 0.001 (PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*). After conversion of the extraction wells, the gradient increased to approximately 0.0024 (based on March 2009 water levels). Using a water table gradient of 0.002, an effective porosity of 0.1, and the range of hydraulic conductivities obtained from aquifer tests, the groundwater flow rate beneath WMA T is between 0.12 and 0.19 m/d (0.39 and 0.62 ft/d). A current 2010 groundwater map for WMA T is provided in Figure 2-3.

## 2.5 Summary of Previous Groundwater Monitoring

This section summarizes the current and historical groundwater contamination at WMA T. Vadose zone contamination is also summarized because any residual vadose zone contamination is a potential source for future groundwater contamination.

### 2.5.1 Groundwater Contamination

The primary RCRA dangerous constituents found beneath WMA T in 2008 were chromium, carbon tetrachloride, and trichloroethylene (TCE). The source for the carbon tetrachloride and TCE was attributed to liquid disposal associated with processes at the Plutonium Finishing Plant (PFP) and not WMA T. These constituents are monitored as part of the 200-ZP-1 Groundwater OU. Nitrate and fluoride are also found in the groundwater beneath the WMA. Plume maps for all of these constituents are included in the *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2* (DOE/RL-2010-11).

#### *2.5.1.1 Chromium*

Chromium concentrations exceeded the drinking water standard (DWS) (100 µg/L) in seven wells during routine sampling at WMA T during the last quarter of 2009. The highest chromium concentrations in wells screened at the water table have historically been in well 299-W10-4, which is located south of the WMA. Recent chromium contamination at WMA T is discussed further in DOE/RL-2010-11.

#### *2.5.1.2 Nitrate*

Within the regional 200 West Area nitrate plume, a local, high-concentration nitrate plume is found beneath WMA T, centered southwest and west (upgradient) and extending east (downgradient) of the WMA. The nitrate concentration was above the DWS in all wells (except 299-W11-12) in the WMA during 2009. The local, high-concentration nitrate plume exceeds 10 times the DWS in some upgradient and downgradient wells. Recent nitrate contamination at WMA T is discussed further in DOE/RL-2010-11.

### 2.5.2 Vadose Zone Contamination

Three investigation techniques provided evidence regarding the extent of contamination in the vadose zone at WMA T:

- Geophysical logging of dry wells associated with each SST (GJO-99-101-TAR/GJO-HAN-27; GJO-99-101-TARA/GJO-HAN-27, *Addendum to the T Tank Farm Report*)
- Coring through the leak plume from tank T-106 (PNNL-14849, *Characterization of Vadose Zone Sediments Below the T Tank Farm: Boreholes C4104, C4105, 299-W10-196, and RCRA Borehole 299-W-11-39*)

- High-resolution resistivity geophysical surveys (RPP-RPT-28955, *Surface Geophysical Exploration of T Tank Farm at the Hanford Site*)

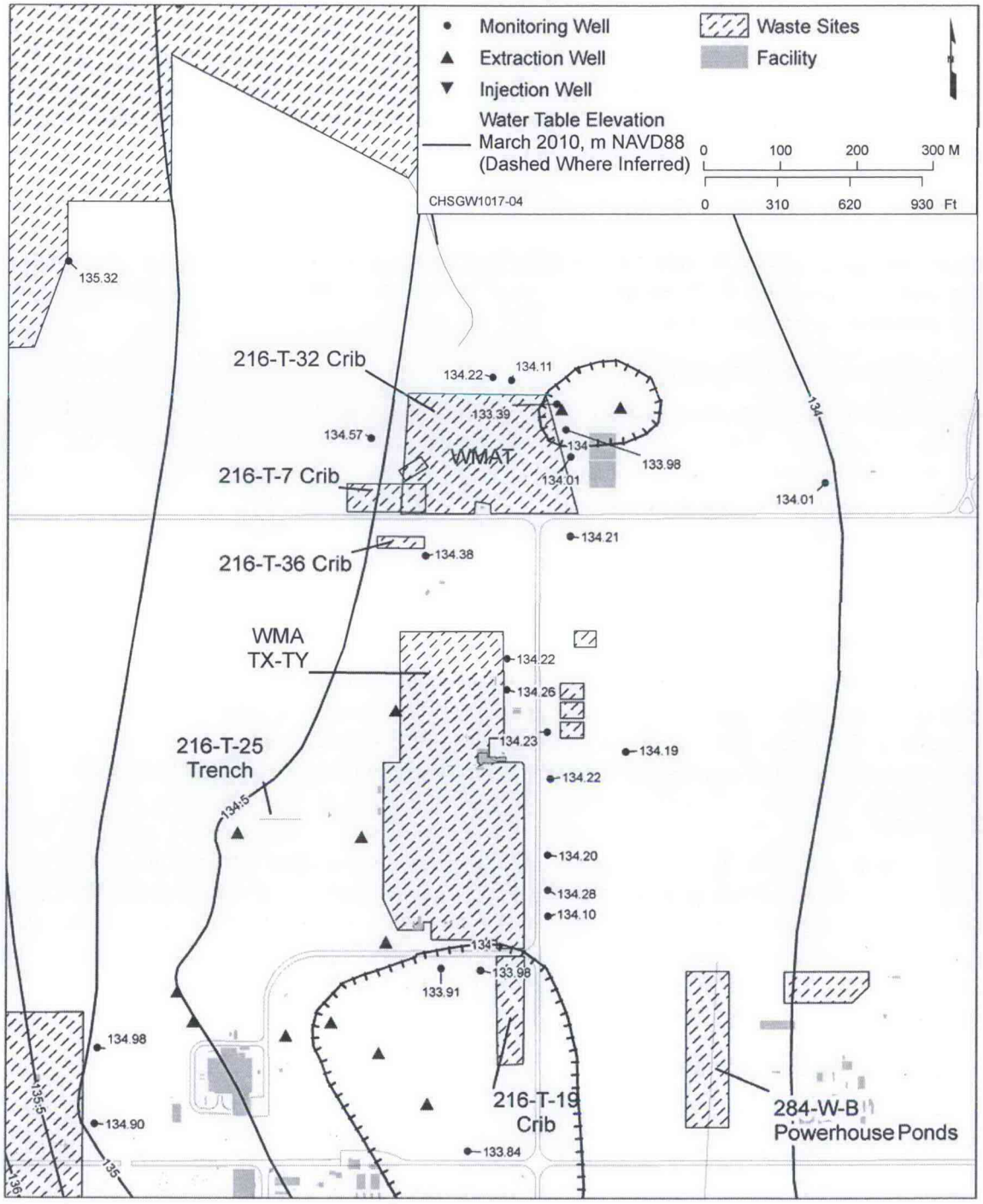



**Figure 2-3. Water Table Map for the Area Surrounding WMA T, March 2010**

Pertinent conclusions from the vadose zone investigations include the following:

- Significant levels of contamination exist within the vadose zone to depths of at least 37 m (123 ft). The vertical extent of contaminant plumes is not fully defined because a number of boreholes are contaminated to total depth (GJO-99-101-TARA/GJO-HAN-27).
- Evidence from boreholes C4104 and C4105, drilled through the T-106 tank leak vadose zone plume, suggests that contaminants from the tank T-106 leak have reached a depth of at least 39 m (127 ft) (PNNL-14849).
- High-resolution resistivity surveys suggest that vadose zone contamination extends from the bottom of the 216-T-7 Crib and Tile Field to the water table.
- Evidence from high-resolution resistivity surveys suggests that vadose zone contamination beneath the 216-T-14 through 216-T-17 Trenches is contained within the upper portion of the vadose zone (RPP-RPT-28955). However, these trenches are not within the WMA T treatment, storage, and disposal unit boundary and are only referred to as a nearby source of vadose zone contamination immediately northeast of the treatment, storage, and disposal unit.

## 2.6 Conceptual Model

PNNL-15301 describes the conceptual model for WMA T. The conceptual model illustrates the complexity and the spatial and temporal relationships of five important parameters, which are outlined in this section:

- Contaminant sources
- Driving forces
- Migration pathways to groundwater
- Changes in groundwater flow direction and flow rate
- Current contaminant distributions in the aquifer

### 2.6.1 Contaminant Sources

Several potential sources for groundwater contamination exist in the WMA T area, including tank leaks; liquid wastes disposed to past-practice facilities (located northeast, west, and southwest of WMA T); unplanned releases (including leaking pipelines); and regional contamination from far-field sources (e.g., PFP).

- All tanks in WMA T have been interim stabilized, so no threat exists for future releases from large tank leaks. However, contaminants remaining in the vadose zone from past tank leaks have the potential to reach groundwater. Some evidence suggests that past tank leaks have migrated through the vadose zone to the groundwater (PNNL-15301; PNNL-15837); however, this evidence is not unequivocal.
- Earth resistivity surveys have shown that vadose zone contamination extends from the base of the 216-T-7 Crib and Tile Field to the water table. Thus, at least some of the nearby past-practice disposal facilities have impacted groundwater.
- Pipeline leaks and overfilling of SSTs have been documented at WMA T (RPP-7218). Any remaining contamination in the vadose zone resulting from pipeline leaks or overfill events remains a source for possible future groundwater contamination.

- Regional sources are responsible for most of the carbon tetrachloride, and much of the nitrate, found in groundwater beneath WMA T. An exception exists for a probable nearby source for the extremely high nitrate at WMA T.

### 2.6.2 Driving Forces

In general, contaminants are transported to groundwater in two ways: (1) transport associated with very large leaks when the amount of liquid is sufficient to reach groundwater through gravitational forces and capillary action, and (2) transport associated with an external source of water (or other liquid) available to remobilize residual waste in vadose zone plumes. The SSTs in WMA T no longer contain large amounts of liquid waste; thus, large tank leaks emanating from WMA T are not likely.

All intentional disposal of water to non-permitted facilities ceased in 1995; therefore, effluent disposal to nearby ponds, cribs, and ditches is no longer mobilizing vadose zone contamination to the groundwater. Figure 2-4 shows the historical conceptual model depicting how contamination entered the vadose zone and possibly the groundwater system. All known water lines in WMA T have been tested and cut off (DOE/ORP-2008-01, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*, Tier 1 Chapter 11). It is possible, but unlikely, that a previously unidentified water line will leak and substantially mobilize existing vadose zone contamination to groundwater in the area.

Infiltration of natural precipitation remains the likely principal driver to mobilize vadose zone contamination. Steps have been taken to reduce infiltration or precipitation at WMA T. Berms have been erected around the tank farm to stop run-on of rain and melting snow, and an interim cap has been placed over the largest tank leak in the WMA (T-106) to inhibit remobilization of that leak.

### 2.6.3 Migration

Contaminant migration through the vadose zone is not well understood because it is highly dependent on heterogeneities and anisotropy in the soil properties. Heterogeneities at smaller than formation scale also affect flow and transport, as evidenced by logs of drywells and cone penetrometer logs that reveal moisture rich strata, likely reflecting finer grained units with permeability contrast.

The sediment layers with the most influence on moisture migration through the vadose zone beneath WMA T are the Cold Creek unit and the Taylor Flat member of the Ringold Formation. The relatively low permeability of these units is expected to impede vertical moisture migration. The Cold Creek unit is known to pond water locally in several places in the 200 West Area.

Improperly sealed wells can act as a preferential pathway through the vadose zone. Documentation in *Hanford Wells* (PNL-8800) indicates that 45 of the 67 dry wells in the T Tank Farm (used for secondary leak detection) have been modified to retrofit an annular seal. No documentation is provided in PNL-8800, the Hanford Well Information System database, or the Pacific Northwest National Laboratory well library that the remaining 22 dry wells have an annular seal. Therefore, the potential exists for unsealed wells to promote vertical moisture migration in WMA T.

The groundwater flow rate at WMA T is on the order of 0.12 to 0.19 m/d (0.39 to 0.62 ft/d). Some contaminants will travel at a rate slower than this, depending on the chemical properties of specific contaminants. Chromium and nitrate are the most mobile chemical contaminants associated with WMA T.

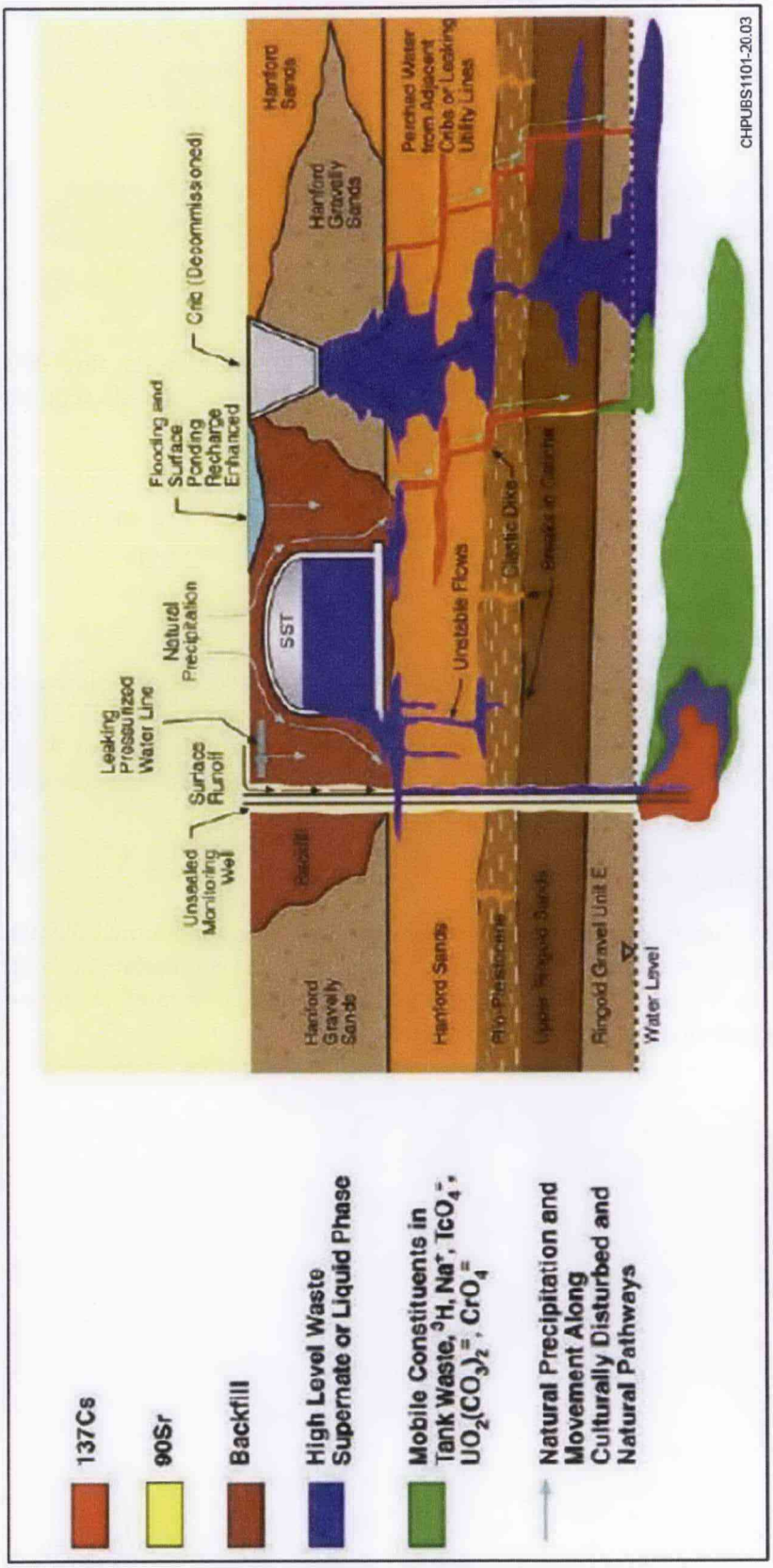



**Figure 2-4. Conceptual Model of Hydraulic Drivers at Single-Shell Tank Farms**

### 2.6.4 Changing Groundwater Flow Direction

Large changes have occurred in the groundwater flow direction beneath WMA T. Analyses of historic hydraulic gradients suggest that groundwater could have traveled and carried contaminants from WMA T and nearby past-practice disposal facilities. Approximate travel directions and distances are as follows (PNNL-15301):

- 34 m (112 ft) toward the south between 1954 and 1957
- 170 m (558 ft) northeast between 1957 and 1982
- 110 m (361 ft) north or northwest between 1983 and 1995
- 32 m (105 ft) toward the east between 1997 and 2004

Although these distances are estimates, they show that changes in the groundwater flow direction could have contributed to relatively widespread contaminant distribution. Water levels also continue to decline in the area since the cessation of liquid waste disposal operations (Figure 2-2).

An expanded, large-scale pump-and-treat system is being installed in the 200 West Area, which is expected to change groundwater flow direction and flow velocity at WMA T in the future. The magnitude and direction of the changes will not be known until after the system becomes operational in 2011 or 2012.

### 2.6.5 Contaminant Distribution

The current understanding of the spatial distribution of contaminants at WMA T is shown in recent plume maps (DOE/RL-2010-11). The eastern extent of contamination is not well defined. Several lines of evidence show that vertical contaminant concentration gradients exist in the area of WMA T. Contaminant concentrations increase with depth in the aquifer in some places and decrease with depth in other places.

## 2.7 Data Quality Objectives

To define the required information for groundwater indicator evaluation monitoring, the data quality objectives (DQO) process is used to ensure that data gathered are of the appropriate quantity and quality to meet specific objectives. The DQO parameters, regulatory interim status requirements, and associated reports supporting the regulatory requirements are outlined in Table 2-2.

**Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA T**

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|
| Scope | **40 CFR 265; incorporated by reference in WAC 173-303-400(3)(a), as modified by WAC 173-303-400(3)(b) and WAC 173-303-400(3)(c)(v)(E)**<br>**40 CFR 265.93, "Preparation, Evaluation, and Response."**<br>(d)(7) If the owner or operator determines…that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator:<br>(i) Must continue to make the determinations required under paragraph (d)(4) of this section…<br>**40 CFR 265.93, "Preparation, Evaluation, and Response."**<br>(d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine:<br>(i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and<br>(ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water.<br>**40 CFR 265.93, "Preparation, Evaluation, and Response."**<br>(d)(3) The plan to be submitted under 40 CFR 265.90(d)(1) or paragraph (d)(2) of this section must specify:<br>(i) The number, location, and depth of wells;<br>(ii) Sampling and analytical methods for those hazardous wastes or hazardous waste constituents in the facility;<br>(iii) Evaluation procedures, including any use of previously gathered ground-water quality information; and<br>(iv) A schedule of implementation. | PNNL-15301, RCRA *Assessment Plan for Single-Shell Tank Waste Management Area T*<br>This plan, Sections 3.1 and 3.2, Chapter 4, and Appendix A |
| Number and location of wells<br>Point(s) of compliance | **40 CFR 265.93, "Preparation, Evaluation, and Response."**<br>(d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine:<br>(i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and<br>(ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water. | PNNL-15301, RCRA *Assessment Plan for Single-Shell Tank Waste Management Area T*<br>This plan, Chapters 1 and 3, and Appendix A |

**Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA T**

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|
| Well configuration (depth and length of screened interval; well construction) | **40 CFR 265.91, "Ground-Water Monitoring System."**<br>(c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water.<br>**Additional Requirements from WAC 173-303-400(3)(c)(v)(C).**<br>Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground water contamination. WAC 173-160 may be used as guidance in the installation of wells. | PNNL-15301, RCRA *Assessment Plan for Single-Shell Tank Waste Management Area T*<br>This plan, Section 3.2 and Appendix A |
| Frequency of sampling<br>Types of analysis or measurement<br>Method detection limits or accuracy and precision<br>Methods used to evaluate the collected data | **40 CFR 265.93, "Preparation, Evaluation, and Response."**<br>(d)(7) If the owner or operator determines…that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator:<br>(i) Must continue to make the determinations required under paragraph (d)(4) of this section on a quarterly basis until final closure of the facility, if the ground-water quality assessment plan was implemented prior to final closure of the facility; or<br>(ii) May cease to make the determinations required under paragraph (d)(4) of this section, if the ground-water quality assessment plan was implemented during the post-closure care period.<br>**40 CFR 265.93, "Preparation, Evaluation, and Response."**<br>(d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) *[see scope in first row of this table]* of this section, and, at a minimum, determine:<br>(i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and<br>(ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water. | PNNL-15301, RCRA *Assessment Plan for Single-Shell Tank Waste Management Area T*<br>This plan, Section 3.1, Chapter 4, and Appendix A |

Notes: The references cited in this table are listed in the reference section (Chapter 5) of this plan.

# 3 Groundwater Monitoring Program

This chapter lists the wells monitored, constituents analyzed, and sampling frequency for WMA T. The quality assurance and quality control requirements are provided in the QAPjP (Appendix A).

## 3.1 Constituent List and Sampling Frequency

The constituent list for groundwater sampling consists of RCRA-regulated analytes that may be present in SST waste. To identify these analytes, the list of primary nonradiological constituents potentially present in SST waste (RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*) was compared to those constituents listed in Appendix 5 of Ecology Publication 97-407 (*Chemical Testing Methods for Designating Dangerous Waste: WAC 173-303-090 & -100*), which references 40 CFR 264, Appendix IX ("Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring List"). Those constituents identified in RPP-23403 that are RCRA-regulated (i.e., listed in Appendix 5 of Ecology Publication 97-407) are included in Table 3-1.

**Table 3-1. RCRA-Regulated Constituents Potentially Present in the Single-Shell Tank Farm System**

| Constituent | CAS ID | Constituent | CAS ID |
|---|---|---|---|
| **Volatile Organic Compounds** | | | |
| 1,1,1-Trichloroethane | 71-55-6 | Chloroform | 67-66-3 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | Ethylbenzene | 100-41-4 |
| 1,1,2-Trichloroethane | 79-00-5 | Isobutanol | 78-83-1 |
| 1,1-Dichloroethene | 75-35-4 | Methylene chloride | 75-09-2 |
| 1,2-Dichloroethane | 107-06-2 | Tetrachloroethene | 127-18-4 |
| 2-Butanone (methyl ethyl ketone) | 78-93-3 | Toluene | 108-88-3 |
| 2-Propanone (acetone) | 67-64-1 | trans-1,3-Dichloropropene | 10061-02-6 |
| 4-Methyl-2-pentanone (MIBK) | 108-10-1 | Trichloroethylene (TCE) | 79-01-6 |
| Benzene | 71-43-2 | Trichlorofluoromethane | 75-69-4 |
| Carbon disulfide | 75-15-0 | Vinyl chloride (chloroethene) | 75-01-4 |
| Carbon tetrachloride | 56-23-5 | Xylenes | 1330-20-7 |
| Chlorobenzene | 108-90-7 | | |
| **Semivolatile Organic Compounds** | | | |
| 1,2,4-Trichlorobenzene | 120-82-1 | Aroclor 1260 | 11096-82-5 |
| 2,4,5-Trichlorophenol | 95-95-4 | Butylbenzylphthalate | 85-68-7 |
| 2,4,6-Trichlorophenol | 88-06-2 | Di-n-butylphthalate | 84-74-2 |
| 2,4-Dinitrotoluene | 121-14-2 | Di-n-octylphthalate | 117-84-0 |

**Table 3-1. RCRA-Regulated Constituents Potentially Present in the Single-Shell Tank Farm System**

| Constituent | CAS ID | Constituent | CAS ID |
|---|---|---|---|
| 2-Chlorophenol | 95-57-8 | Fluoranthene | 206-44-0 |
| 2-Methylphenol (o-cresol) | 95-48-7 | Hexachlorobutadiene | 87-68-3 |
| 3-Methylphenol (m-Cresol) | 108-39-4 | Hexachloroethane | 67-72-1 |
| 4-Chloro-3-methylphenol (p-Chloro-m-cresol) | 59-50-7 | Naphthalene | 91-20-3 |
| 4-Methylphenol (p-cresol) | 106-44-5 | Nitrobenzene | 98-95-3 |
| Acenaphthene | 83-32-9 | n-Nitroso-di-n-propylamine | 621-64-7 |
| Aroclor 1016 | 12674-11-2 | n-Nitrosomorpholine | 59-89-2 |
| Aroclor 1221 | 11104-28-2 | 1,2-Dichlorobenzene (o-Dichlorobenzene) | 95-50-1 |
| Aroclor 1232 | 11141-16-5 | 2-Nitrophenol (o-Nitrophenol) | 88-75-5 |
| Aroclor 1242 | 53469-21-9 | Pyrene | 129-00-0 |
| Aroclor 1248 | 12672-29-6 | Pyridine | 110-86-1 |
| Aroclor 1254 | 11097-69-1 | | |
| **Inorganic Constituents (Nonradiological)** | | | |
| Antimony (Sb) | 7440-36-0 | Mercury (Hg) | 7439-97-6 |
| Arsenic (As) | 7440-38-2 | Nickel (Ni) | 7440-02-0 |
| Barium (Ba) | 7440-39-3 | Selenium (Se) | 7782-49-2 |
| Beryllium (Be) | 7440-41-7 | Silver (Ag) | 7440-22-4 |
| Cadmium (Cd) | 7440-43-9 | Sulfide ($S^{2-}$) | 18496-25-8 |
| Chromium (Cr) | 7440-47-3 | Thallium (Tl) | 7440-28-0 |
| Cobalt (Co) | 7440-48-4 | Vanadium (V) | 7440-62-2 |
| Copper (Cu) | 7440-50-8 | Zinc (Zn) | 7440-66-6 |
| Cyanide ($CN^-$) | 57-12-5 | | |
| Lead (Pb) | 7439-92-1 | | |

Notes: This table lists the primary nonradiological constituents provided in RPP-23403 that are regulated by RCRA (i.e., also listed in Appendix 5 of Ecology Publication 97-407).

Table 3-2 lists the constituents to be analyzed for RCRA monitoring. Wells are to be sampled quarterly or semiannually each year. Maintenance problems and sampling logistics sometimes delay scheduled sampling events. If a sampling event is delayed for more than 6 weeks, that sample will be cancelled because it will be nearly time for the next quarterly sample.

**Table 3-2. Monitoring Network, Constituent List, and Sampling Frequency for WMA T**

| Well Name | Purpose | WAC Compliant | RCRA Dangerous Constituents | Supporting Parameters | | | | Field-Measured Parameters | | | | | Table 3-1 Analytes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Hexavalent Chromium | Nitrate (Anions) | Metals, Unfiltered[a] | Anions[b] | Alkalinity[c] | pH[c] | Specific Conductance[c] | Turbidity[c] | Temperature[c] | Dissolved Oxygen[c] | |
| 299-W10-1 | Upgradient | N | A | A | A | A | A | A | A | A | A | A | Once |
| 299-W10-4 | Assessment[a] | N | SA | SA | SA | SA | A | SA | SA | SA | SA | SA | Once |
| 299-W10-8 | Downgradient | N | A | A | A | A | A | A | A | A | A | A | Once |
| 299-W10-23 | Assessment[e] | Y | A | A | A | A | A | A | A | A | A | A | Once |
| 299-W10-24 | Downgradient | Y | SA | SA | A | SA | A | SA | SA | SA | SA | SA | Once |
| 299-W10-28 | Upgradient | Y | A | A | A | A | A | A | A | A | A | A | Once |
| 299-W11-12 | Downgradient | N | A | A | A | A | A | A | A | A | A | A | Once |
| 299-W11-39 | Downgradient | Y | SA | SA | SA | SA | A | SA | SA | SA | SA | SA | Once |
| 299-W11-40 | Downgradient | Y | Q | SA | SA | SA | A | Q | Q | Q | Q | Q | Once |
| 299-W11-41 | Downgradient | Y | Q | SA | SA | SA | A | Q | Q | Q | Q | Q | Once |
| 299-W11-42 | Downgradient | Y | Q | SA | SA | SA | A | Q | Q | Q | Q | Q | Once |
| 299-W11-45 | Far-field[e] | Y | Q | SA | SA | SA | A | Q | Q | Q | Q | Q | Once |
| 299-W11-46 | Downgradient | Y | Q | SA | SA | SA | A | Q | Q | Q | Q | Q | Once |
| 299-W11-47 | Downgradient | Y | Q | SA | SA | SA | A | Q | Q | Q | Q | Q | Once |

**Table 3-2. Monitoring Network, Constituent List, and Sampling Frequency for WMA T**

| Well Name | Purpose | WAC Compliant | RCRA Dangerous Constituents | Supporting Parameters | | | | Field-Measured Parameters | | | | | Table 3-1 Analytes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Hexavalent Chromium | Nitrate (Anions) | Metals, Unfiltered[a] | Anions[b] | Alkalinity[c] | pH[c] | Specific Conductance[c] | Turbidity[c] | Temperature[c] | Dissolved Oxygen[c] | |

Notes: Abbreviations in this table include the following:

A = to be sampled annually (performed in November)

Q = to be sampled quarterly

SA = to be sampled semiannually

a. Metals; analytes include, but are not limited to, chromium, sodium, magnesium, potassium, and calcium.

b. Anions; analytes include, but are not limited to, nitrate, chloride, sulfate, and fluoride.

c. Field measurement.

d. Far-field wells are wells located far downgradient to determine lateral extent of contamination.

e. Assessment wells are not necessarily directly up or downgradient. Assessment wells are used to help distinguish other contaminant plumes impinging on WMA T.

One of the 72 analytes listed in Table 3-1, chromium has been found in groundwater and is attributed to releases from the WMA only. In addition, nitrate is present in groundwater and is attributed to releases from WMA T (see Section 2.5.1). Carbon tetrachloride and TCE are also found in the groundwater but originate from waste sites associated with the PFP. Thus, chromium and the supporting constituents alkalinity, nitrate, major cations (metals), and major anions are routinely sampled for RCRA in the network monitoring wells (Table 3-2). The supporting constituents provide information on general chemistry and allow for charge-balance computations to assess laboratory performance.

Sampling for the remaining constituents identified in Table 3-1 will be performed once during the first available sample event after this plan is in effect to determine if these constituents have impacted groundwater quality. Sampling will be performed in the upgradient and near-field downgradient monitoring wells (Table 3-2). The constituents not detected in groundwater will be removed from future sampling. If an organic constituent from Table 3-1 is detected in a groundwater sample and is not attributed to contamination from another facility (e.g., carbon tetrachloride from the PFP), a confirmation sample will be collected at the next scheduled sample event, with split samples sent to different analytical laboratories. If the detection is confirmed by positive results from both laboratories, the constituent will be added to the list of analytes for routine sampling to evaluate the extent of contamination. If the detection is not confirmed, the analyte will be removed from future sampling.

Some of the inorganic constituents included in Table 3-1 occur naturally in groundwater (e.g., barium, selenium, vanadium, and zinc). Detections of an inorganic constituent will be evaluated to determine if the constituent is present naturally by comparison to sample results from the upgradient wells and comparison to Hanford Site background values (DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*). If it is determined that an inorganic constituent may be present as a contaminant from the WMA, confirmation samples will be collected (as described for the organic constituents). If contamination is confirmed, then the constituent will be added to the routine sample list to evaluate the extent of contamination. If the contamination is not confirmed, the constituent will be removed from future sampling.

## 3.2 Monitoring Well Network

Some of the wells in the WMA T monitoring network (Figure 3-1) are also sampled for the 200-ZP-1 OU. Sampling for WMA T and the 200-ZP-1 OU is coordinated to eliminate duplicate analyses and well trips.

Table 3-2 indicates the purpose of each well and whether the wells meet WAC requirements. Table 3-3 summarizes well construction information, including the current (March 2009) depth to water in each well. As-built diagrams for the wells showing construction details are available in PNNL-15301 and *Borehole Data Package for Two RCRA Wells 299-W11-25B and 200-W11-46 at Single-Shell Tank Waste Management Area T, Hanford Site, Washington* (PNNL-15776).

Wells installed since the 1980s have been constructed to meet the requirements of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells." These wells have stainless-steel casing and screen, sand pack in the screened interval, and full annular seal above. Other wells in the network are much older and were installed before the requirements of WAC 173-160 were implemented. These wells have carbon-steel casing and perforated intervals rather than screens. In some cases, wells were later retrofit with annular seals at the surface. The use of the older wells allows continuity with historical data. None of the wells in the WMA T groundwater monitoring network are expected to go dry prior to 2011.

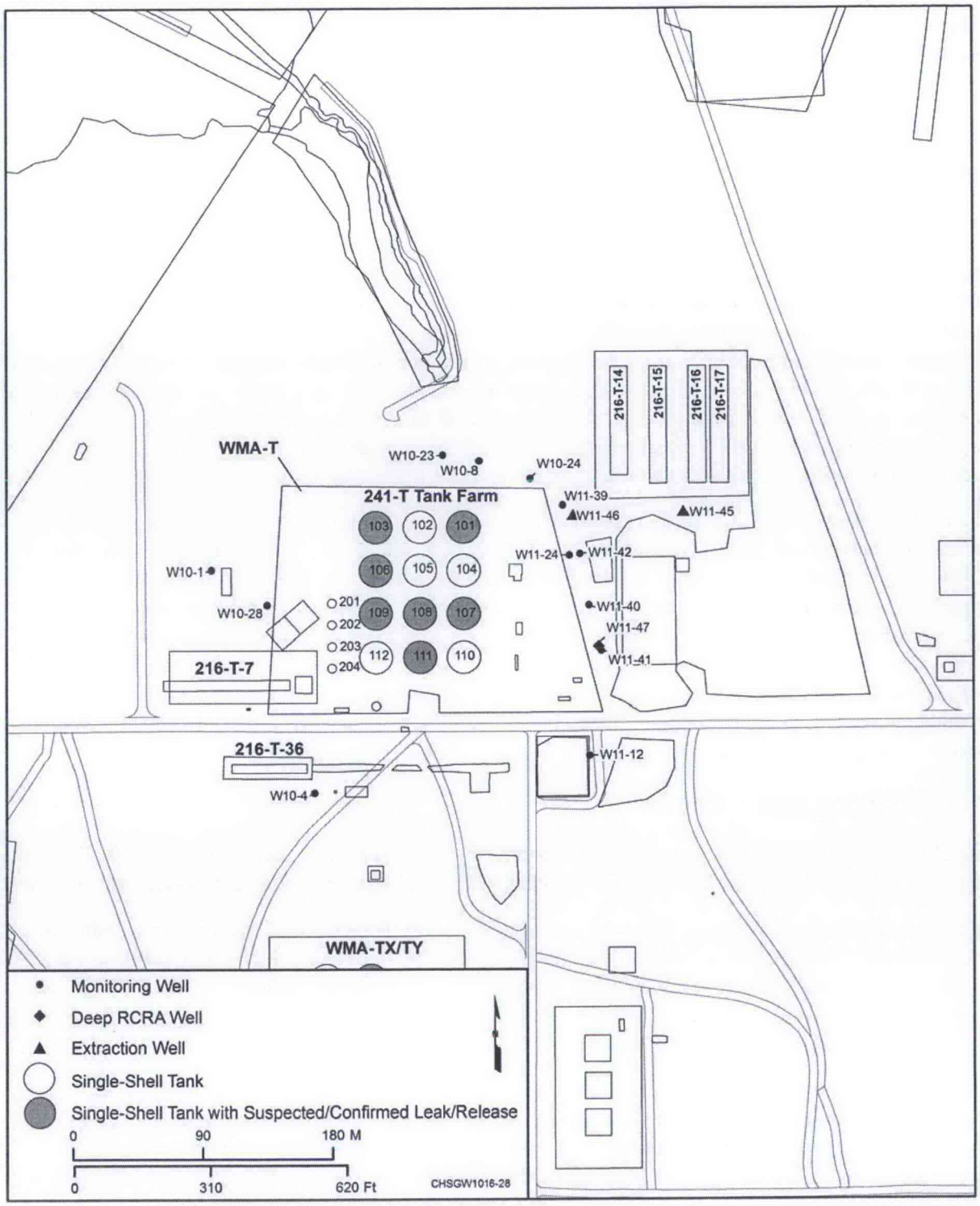



**Figure 3-1. General Layout of WMA T, Including Locations of Nearby Past-Practice Facilities and Monitoring Wells**

**Table 3-3. WMA T Well Depths and Water Table Elevation**

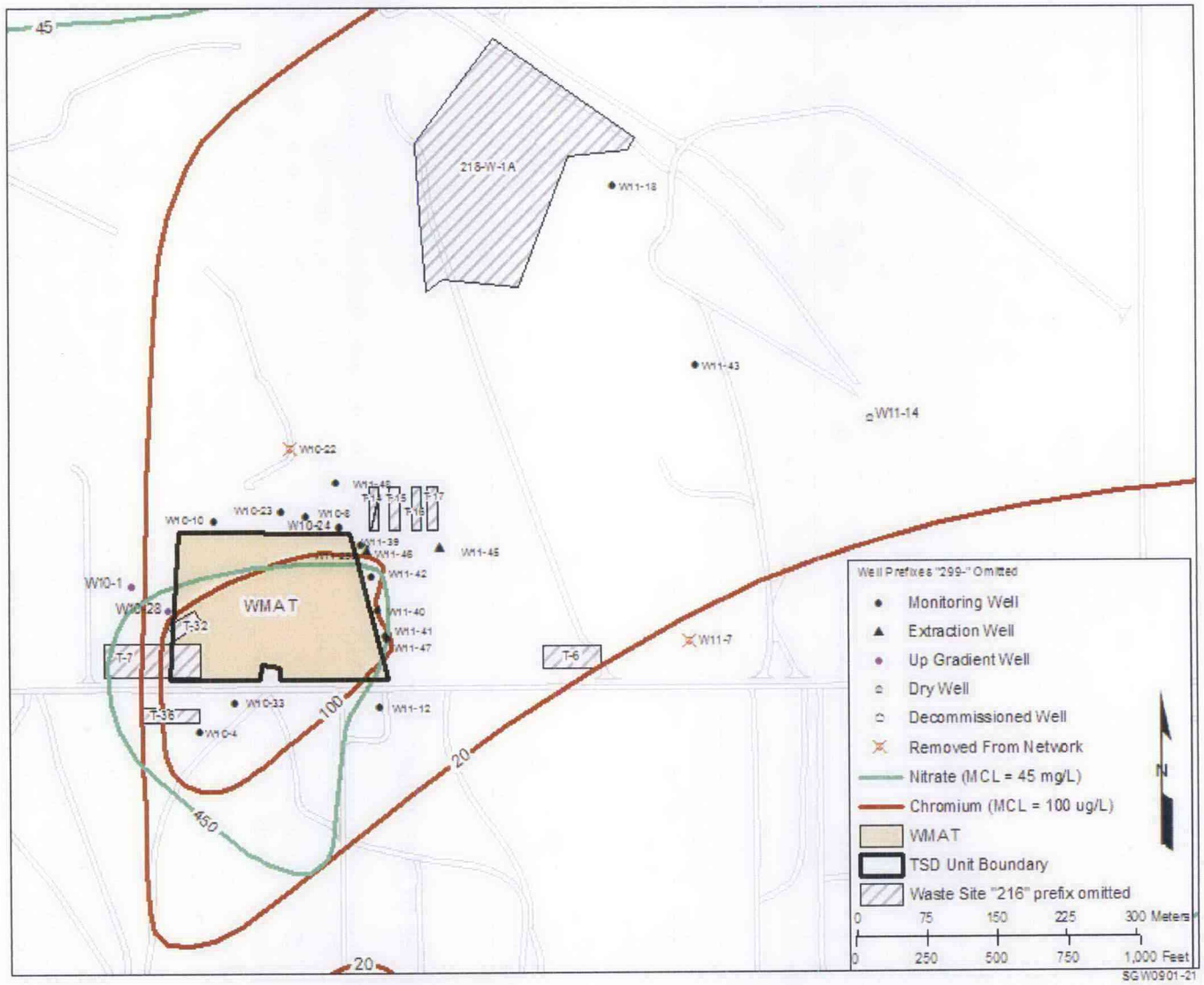
| Well Name | Completion Date | Surface Elevation NAVD88, amsl (m) | Water Table Elevation (m), March 2010 | Open Interval Bottom Elevation (m) | Water Column (m), March 2010 |
|---|---|---|---|---|---|
| ***299-W10-1*** | 1947 | 206.70 | 134.57 | 124.40 | 10.2 |
| 299-W10-4 | 1952 | 205.20 | 134.38 | 130.52 | 3.9 |
| 299-W10-8 | 1973 | 207.50 | 134.11 | 131.00 | 3.1 |
| 299-W10-23 | 1998 | 206.56 | 134.22 | 127.04 | 7.2 |
| 299-W10-24 | 1998 | 208.87 | 133.77 | 127.17 | 6.6 |
| ***299-W10-28*** | 2001 | 205.92 | 134.32 | 126.61 | 7.7 |
| 299-W11-12 | 1953 | 207.96 | 134.21 | 131.76 | 2.5 |
| 299-W11-39 | 2000 | 209.89 | 133.39 | 126.47 | 6.9 |
| 299-W11-40 | 2000 | 209.70 | 134.01 | 126.45 | 7.6 |
| 299-W11-41 | 2000 | 209.67 | 133.97 | 126.86 | 7.1 |
| 299-W11-42 | 2000 | 210.18 | 133.98 | 127.34 | 6.6 |
| 299-W11-45 | 2006 | 212.88 | NA | 122.70 | NA |
| 299-W11-46 | 2005 | 210.12 | NA | 123.74 | NA |
| 299-W11-47 | 2006 | 209.66 | 134.06 | 116.76 | 17.3 |

Notes: Bold/italic print indicates upgradient wells.

## 3.3 Changes to Monitoring Plan

Several changes have been made to the WMA T monitoring schedule since the previous monitoring plan (PNNL-15301) was issued. Two wells have been removed from the monitoring network: well 299-W10-22 was removed because it is no longer downgradient of the facility, and well 299-W11-7 was removed because it was a far-field downgradient well that is not in the direct downgradient path of existing plumes. Figure 3-2 provides data interpreted from PNNL-17732. Using chromium and nitrate concentrations to represent groundwater flow direction, it is apparent that the two wells that were removed from the network are not viable monitoring wells at this time.

The sampling frequency for many constituents has also changed. All upgradient (west) wells and all wells north of WMA T have been changed to an annual or semiannual sampling frequency. Downgradient wells either remain on a quarterly frequency or have been changed to semiannual or annual, depending on the constituents monitored. Hexavalent chromium analyses have been added quarterly at all downgradient wells, with annual or semiannual analysis occurring at upgradient wells. This allows for elimination of filtered metals analyses, so only unfiltered metals will be sampled in the future. Table 3-4 presents the sampling frequencies for all wells in the monitoring network and further describes the rationale for changes in sampling frequency to applicable wells.




Source: PNNL-17732, *Analysis of the Hydrologic Response Associated With Shutdown and Restart of the 200-ZP-1 WMA T Tank Farm Pump-and-Treat System.*

**Figure 3-2. WMA T Water Table Contaminant Plume Map**

**Table 3-4. WMA T Monitoring Well Network Sample Frequencies**

| Well | Sample Frequency | Rationale |
|---|---|---|
| 299-W11-40, 299-W11-41, 299-W11-42, 299-W11-46, and 299-W11-47 | Quarterly | Near-field downgradient monitoring wells located within higher concentration areas of existing contaminant plumes and have exhibited substantial constituent concentration variability. A quarterly frequency is needed to track concentration variations. |
| 299-W10-24 and 299-W11-39 | Semiannually | Near-field downgradient monitoring wells located outside of higher concentration areas of contaminant plumes. These wells are monitored to identify new contaminant plumes or changes in plume direction, depth, etc. A semiannual sampling frequency is used to meet these objectives. This frequency is consistent with the requirements for sites in interim status detection monitoring, which shares the common objective of identifying new contaminant plumes. |
| 299-W10-23 | Annually | Near-field, cross-gradient assessment monitoring well exhibiting very low constituent concentrations. This well is located too far north of existing source areas to be useful for identifying new contaminant plumes; thus, there is no need to sample this well more frequently than annually. |
| 299-W10-4 | Semiannually | Near-field, upgradient assessment monitoring well exhibiting low to medium constituent concentrations. This well is useful for identifying new contaminant plumes, which is a common objective for sites in interim status detection monitoring. |
| 299-W10-8 and 299-W11-12 | Annually | Near-field or intermediate downgradient monitoring wells that exhibit constituent concentrations of low variability and/or low concentrations. Annual sampling is adequate to define the concentration trends in these wells. |
| 299-W11-45 | Quarterly | Far-field downgradient monitoring well located within a high-concentration area of a contaminant plume. This well has had increasing concentrations over a period of several years. |
| ***299-W10-1 and 299-W10-28*** | Annually | Upgradient wells monitored to establish background water quality conditions. An annual sampling frequency is sufficient to meet this objective. |

Notes: Bold/italic print indicates upgradient wells.

## 3.4 Sampling and Analysis Protocol

Sampling and analysis protocols at WMA T follow the conventions of the project and are described in the QAPjP (Appendix A).

# 4 Data Evaluation and Reporting

This chapter discusses data evaluation and reporting for WMA T.

## 4.1 Data Review

Data review, validation, and verification are discussed in the QAPjP in Appendix A.

## 4.2 Interpretation

After data are validated and verified, acceptable data are used to interpret groundwater conditions at WMA T. Interpretive techniques include the following:

- **Hydrographs:** Graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.
- **Water table maps:** Use water table elevations from multiple wells to construct contour maps and to estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential.
- **Trend plots:** Graph concentrations of constituents versus time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water table maps to determine if concentrations relate to changes in water level or in groundwater flow directions.
- **Plume maps:** Map distributions of chemical constituent concentrations in the aquifer to determine extent of contamination. Changes in plume distribution over time assist in determining plume movement and direction of groundwater flow.
- **Contaminant ratios:** Can sometimes be used to distinguish among different sources of contamination.

## 4.3 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements include an annual evaluation of the monitoring well network to determine if it remains adequate to monitor the WMA. The network must include upgradient and downgradient wells in the uppermost aquifer. The groundwater flow direction beneath WMA T is toward the east. The groundwater monitoring network includes upgradient (west) wells, downgradient (east) wells, and wells to the north and south of the WMA.

Water-level measurements will continue to be collected before each sampling event, and more comprehensive measurements will continue to be made in the northern portion of the 200 West Area in March of each year. The measurements are corrected, if needed, to account for borehole deviation from vertical, and the resulting data are plotted on a map. The data are presented in the annual Hanford Site groundwater monitoring report (e.g., DOE/RL-2010-11).

Wells in the WMA T monitoring network are not expected to go dry for several years, and the direction of groundwater flow is not expect to change greatly in the near future, until the 200-ZP-1 OU pump-and-treat system begins operation in 2011 or 2012. Thus, the current monitoring network is expected to remain valid for 2 or 3 more years. This will be confirmed during the annual determination.

The RCRA monitoring will conduct assessment studies and create work plans to install new wells if necessary. Alternatives to new well construction include well network analysis using statistical methods to determine if new wells are needed to replace dry wells. Well-deepening technical evaluations are

ongoing and recommendations are forthcoming. The 200-ZP-1 OU performance monitoring results and recommendations will be evaluated after the pump-and-treat system is operational.

Any new RCRA wells needed at WMA T will be negotiated and prioritized by Ecology, DOE, and EPA and approved under *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989) Milestone M-24-00.

## 4.4 Reporting and Notification

The results of assessment monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in the annual Hanford Site groundwater monitoring report.

# 5 References

10 CFR 962, "Byproduct Material," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/10cfr962_10.html.

40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Appendix IX, "Ground-Water Monitoring List," *Code of Federal Regulations*. Available at: http://edocket.access.gpo.gov/cfr_2010/julqtr/40cfr264AppIX.htm.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/40cfr265_10.html.

265.90, "Applicability."

265.91, "Ground-Water Monitoring System."

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

Subpart F, "Ground-Water Monitoring."

51 FR 24504, 1986, "EPA Clarification of Regulatory Authority Over Radioactive Mixed Waste," *Federal Register*, July 3, 1986.

ARH-LD-135, 1976, *Geology of the 241-T Tank Farm*, Atlantic Richfield Hanford Company, Richland, Washington.

*Atomic Energy Act of 1954*, 42 USC 2011, et seq. Available at: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf.

*Authorized State Hazardous Waste Programs*, 42 USC 6926, et seq. Available at: http://www.law.cornell.edu/uscode/42/6926.html.

*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

DOE/ORP-2008-01, 2008, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0808130005.

DOE/RL-91-61, 1992, *T Plant Source Aggregate Area Management Study Report*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-96-61, 1997, *Hanford Site Background: Part 3, Groundwater Background*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D197226378.

DOE/RL-2010-11, 2010, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0084237.

Ecology Publication 97-407, 2009, *Chemical Testing Methods for Designating Dangerous Waste: WAC 173-303-090 & -100*, Appendix 5, "Appendix IX of 40 CFR 264," Washington State Department of Ecology, Olympia, Washington. Available at: http://www.ecy.wa.gov/pubs/97407.pdf.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

GJO-99-101-TAR/GJO-HAN-27, 1999, *Vadose Zone Characterization Project at the Hanford Tank Farms, T Tank Farm Report*, U.S. Department of Energy, Albuquerque Operations Office, Grand Junction Office, Grand Junction, Colorado.

GJO-99-101-TARA/GJO-HAN-27, 2000, *Addendum to the T Tank Farm Report*, U.S. Department of Energy, Albuquerque Operations Office, Grand Junction Office, Grand Junction, Colorado.

HNF-2603, 1998, *A Summary and Evaluation of Hanford Site Tank Farm Subsurface Contamination*, Lockheed Martin Hanford, Richland, Washington.

HNF-EP-0182, 2004, *Waste Tank Summary Report for Month Ending September 30, 2004*, Rev. 198, CH2M HILL Hanford Group, Inc., Richland, Washington.

PNL-8800, 1993, *Hanford Wells*, Pacific Northwest Laboratory, Richland, Washington. Available at: http://www.osti.gov/energycitations/servlets/purl/10105933-IDcUiY/native/10105933.pdf.

PNNL-11809, 1998, *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Areas T and TX-TY at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.osti.gov/energycitations/servlets/purl/574233-bM1yoU/webviewable/574233.pdf.

PNNL-12057, 2001, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area T at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D1662358.

PNNL-13378, 2001, *Results of Detailed Hydrologic Characterization Tests—Fiscal Year 1999*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13378.PDF.

PNNL-13929, 2002, *RCRA Groundwater Quality Assessment Report for Single-Shell Tank Waste Management Area T (January 1998 Through December 2001)*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13929/PNNL-13929.pdf.

PNNL-14113, 2002, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2001*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14113.pdf.

PNNL-14186, 2003, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2002*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14186.pdf.

PNNL-14849, 2008, *Characterization of Vadose Zone Sediments Below the T Tank Farm: Boreholes C4104, C4105, 299-W10-196, and RCRA Borehole 299-W11-39*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14849rev1.pdf.

PNNL-15301, 2006, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area T*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15301.pdf.

PNNL-15776, 2006, *Borehole Data Package for Two RCRA Wells 299-W11-25B and 299-W11-46 at Single-Shell Tank Waste Management Area T, Hanford Site, Washington*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15776.pdf.

PNNL-15837, 2007, *Data Package for Past and Current Groundwater Flow and Contamination Beneath Single-Shell Tank Waste Management Areas*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0911240061.

PNNL-15955, 2007, *Geology Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15955rev1.pdf.

PNNL-16346, 2007, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-16346.pdf.

PNNL-17348, 2008, *Results of Detailed Hydrologic Characterization Tests – Fiscal and Calendar Year 2005*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-17348.pdf.

PNNL-17732, 2008, *Analysis of the Hydrologic Response Associated with Shutdown and Restart of the 200-ZP-1 WMA T Tank Farm Pump-and-Treat System*, Pacific Northwest National Laboratory, Richland, Washington.

RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*, Olympia, Washington. Available at: http://apps.leg.wa.gov/RCW/default.aspx?cite=70.105.

*Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://epw.senate.gov/rcra.pdf.

RPP 7123, 2001, *Subsurface Conditions Description of the T and TX-TY Waste Management Areas*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0911240297.

RPP 7218, 2000, *Preliminary Inventory Estimates for Single-Shell Tank Leaks in T, TX, and TY Tank Farms*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-23403, 2006, *Single-Shell Tank Component Closure Data Quality Objectives*, Rev. 3, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-23405, 2006, *Tank Farm Vadose Zone Contamination Volume Estimates*, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0911240667.

RPP-23748, 2006, *Geology, Hydrogeology, Geochemistry, and Mineralogy Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*, Rev. 0, CH2M HILL Hanford Group, Inc, Richland, Washington.

RPP-23752, 2005, *Field Investigation Report for Waste Management Areas T and TX-TY*, Rev. 0-A, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-26744, 2005, *Hanford Soil Inventory Model, Rev. 1*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-RPT-28955, 2006, *Surface Geophysical Exploration of T Tank Farm at the Hanford Site*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: http://www2.hanford.gov/ARPIR/?content=findpage&AKey=1001051159.

WA7890008967, 2007, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste*, as amended, Washington State Department of Ecology, Richland, Washington. Available at: http://www.ecy.wa.gov/programs/nwp/piarchive12_07.htm#Hanfords_Site-wide_Permit.

WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-160.

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

303-400, "Interim Status Facility Standards."

WHC-MR-0132, 1990, *A History of 200 Area Tank Farms*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at:
http://www5.hanford.gov/arpir/?content=findpage&AKey=D196015712.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D196015715.

WHC-MR-0517, 1996, *Listed Waste History at Hanford Facility TSD Units*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SA-1124-FP, 1991, *Statistical Approach on RCRA Groundwater Monitoring Projects at the Hanford Site*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-AP-012, 1989, *40 CFR 265 Interim Status Groundwater Monitoring Plan for the Single-Shell Tanks*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D195063122.

WHC-SD-EN-AP-012, 1991, *Interim Status Groundwater Monitoring Plan for the Single-Shell Tanks*, Rev. 1, Westinghouse Hanford Company, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196071250.

WHC-SD-EN-AP-132, 1993, *Interim-Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Areas T and TX-TY*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WRPS-0900388, 2009, *Interim Measures Maintenance Plan*, Rev. 2, Washington River Protection Solutions, Richland, Washington.

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# Quality Assurance Project Plan

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# Terms

| | |
|---|---|
| CRDL | contract-required detection limit |
| DOE | U.S. Department of Energy |
| DQO | data quality objective |
| DUP | laboratory matrix duplicate |
| EB | equipment blank |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| FTB | full trip blank |
| FXR | field transfer blank |
| GC | gas chromatography |
| HASQARD | *Hanford Analytical Services Quality Assurance Requirements Documents* |
| HEIS | Hanford Environmental Information System |
| IC | ion chromatography |
| ICP | inductively coupled plasma |
| ICP/MS | inductively coupled plasma/mass spectrometry |
| LCS | laboratory control sample |
| MB | method blank |
| MDA | minimum detectable activity |
| MDL | method detection limit |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| PCB | polychlorinated biphenyl |
| 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 |
| RPD | relative percent difference |
| RSD | relative standard deviation |
| SUR | surrogate |

| | |
|---|---|
| TOC | total organic carbon |
| TOX | total organic halides |
| TPA | *Hanford Federal Facility Agreement and Consent Order* |
| TSD | treatment, storage, and disposal |
| VOC | volatile organic compound |

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

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* (TPA) (Ecology et al., 1989a), Attachment 2, "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 requirements (DOE/RL-96-68) 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 *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use* (ANSI/ASQ E4-2004). This QAPjP is divided into four sections (as 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, the participants understand the goals and the approaches used, and 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.

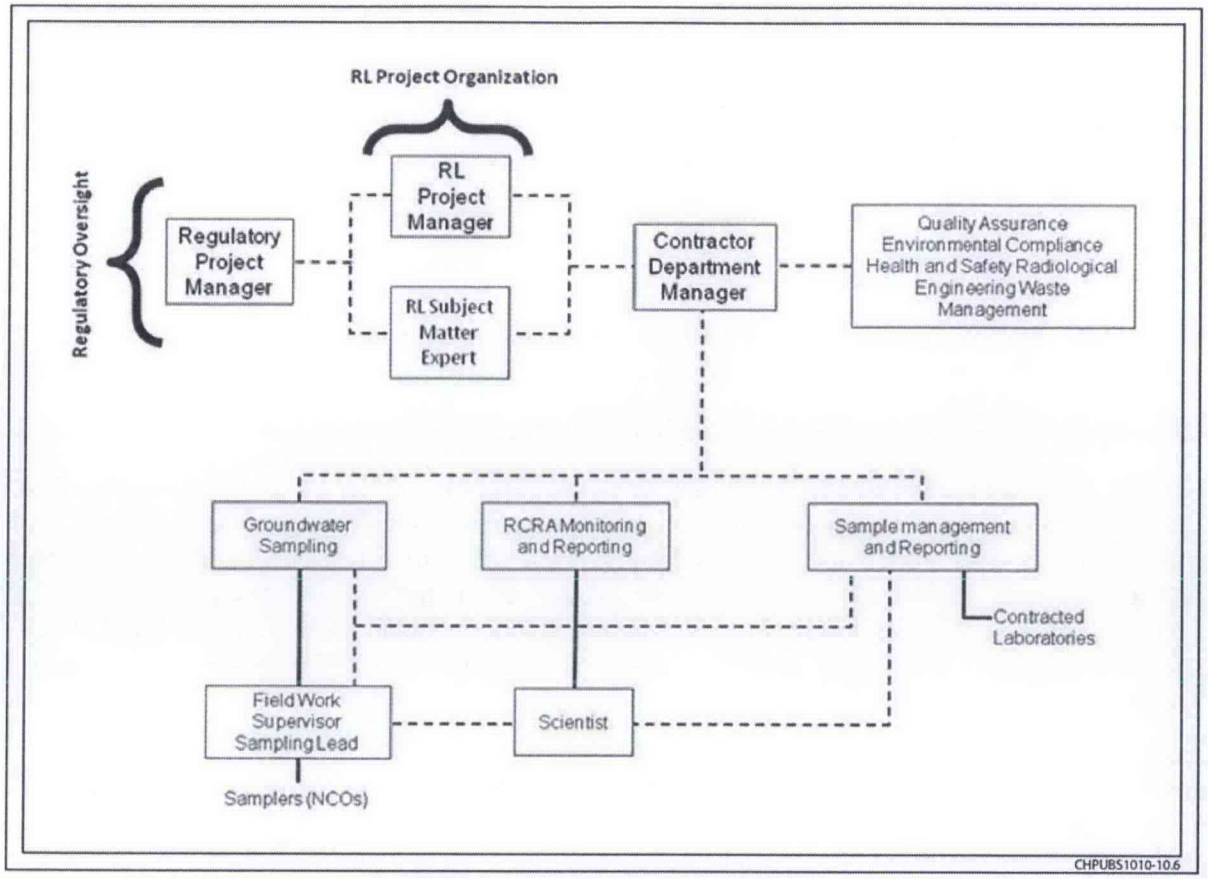


**Figure A-1. Project Organization**

### 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*; the *Resource Conservation and Recovery Act of 1976* (RCRA); the *Atomic Energy Act of 1954*; and the TPA (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 workscope, 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 regulatory agencies, 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 in accordance with corresponding standard procedures and work packages. The samplers also complete field logbooks 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 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 impacts.

### 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, Subpart F ("Interim Status Standards for Owners and

Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "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, and reporting.

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 for 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, "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 prior to implementation. Table A-1 defines the types of changes that may be made to the sampling design and 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 TPA (Ecology et al., 1989a) will be managed in accordance with the requirements therein.

The results of groundwater monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2010-11, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2*).

**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 impact 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 |

# 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 unit 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 impact 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] |
|---|---|---|---|
| **Metals Analyzed by ICP Method – Unfiltered** | | | |
| Calcium | P, $HNO_3$ to pH <2 | SW-846[d] Method 6010B/C, SW-846 Method 6020[e], or EPA/600 Method 200.8[e] | 1,000 |
| Chromium | | | 10 |
| Sodium | | | 500 |

**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] |
|---|---|---|---|
| Potassium | | | 4,000 |
| Magnesium | | | 750 |
| **Trace Metals – Unfiltered** | | | |
| Hexavalent chromium | G/P, cool to 4°C | SW-846 Method 7196 | 10 |
| **Anions by IC** | | | |
| Chloride | P | EPA/600 Method 300.0[f] | 200 |
| Fluoride | | | 500 |
| Nitrate | | | 250 |
| Sulfate | | | 500 |
| **Other** | | | |
| Alkalinity | G/P | Standard Method[g] 2320, EPA/600 Method 310.1 EPA/600 Method 310.2 | 5,000 |
| Conductivity, field | Field measurement | Instrument/meter | 1 µohm |
| Dissolved oxygen, field | Field measurement | Instrument/meter | 0 mg/L |
| pH, field measurement | Field measurement | Instrument/meter | 0.1 |
| Temperature | Field measurement | Instrument/meter | -- |
| Turbidity, field measurement | Field measurement | Instrument/meter | 0.1 NTU |

a. All samples will be collected in plastic (P) or glass (G) containers and will be cooled to 4°C 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 Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

e. SW-846 Method 6010 is the preferred method; however, Method 6020 or EPA/600 Method 200.8 may be used, as long as the method quantitation limit listed is met.

f. Analytical method adapted from Method 300.0 (EPA-600/4-84-017, *Test Methods for Determination of Inorganic Anions in Water by Ion Chromatography*).

g. *Standard Methods for the Examination of Water and Wastewater* (AWWA et al., 2005).

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Metals Analyzed by ICP Method — Unfiltered/Filtered** | | | |
| Barium | P, $HNO_3$ to pH <2 | SW-845[d] Method 6010B/C SW-846 Method 6020[e] or EPA/600 Method 200.8[f] | 20 |
| Beryllium | | | 5 |
| Cadmium | | | 5 |
| Chromium | | | 10 |
| Cobalt | | | 20 |
| Copper | | | 10 |
| Nickel | | | 40 |
| Silver | | | 10 |
| Vanadium | | | 25 |
| Zinc | | | 10 |
| **Trace Metals – Unfiltered/Filtered** | | | |
| Antimony | P, $HNO_3$ to pH <2 | SW-846 Method 6020 or EPA/600 Method 200.8 | 6 |
| Arsenic | | | 10 |
| Lead | | | 5 |
| Selenium | | | 10 |
| Thallium | | | 5 |
| **Trace Metals – Unfiltered/Filtered** | | | |
| Mercury | G, $HNO_3$ to pH <2 | SW-846 Method 7470A, EPA/600 Method 200.8 | 0.5 |
| **Volatiles by GC/MS** | | | |
| 1,1-Dichloroethene | G, no headspace | SW-846 Method 8260B | 10 |
| 1,1,1-Trichloroethane | | | 5 |
| 1,1,2,2-Tetrachloroethane | | | 5 |
| 1,1,2-Trichloroethane | | | 5 |
| 1,2-Dichloroethane | | | 5 |
| 2-Butanone (methyl ethyl ketone) | | | 10 |

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| 2-Propanone (acetone) | | | 20 |
| 4-Methyl-2-petanone (MIBK) | | | 10 |
| Benzene | | | 5 |
| Carbon disulfide | | | 5 |
| Carbon tetrachloride | | | 5 |
| Chlorobenzene | | | 5 |
| Chloroform | | | 5 |
| Ethylbenzene | | | 5 |
| Isobutanol | | | 500 |
| Methylene chloride | | | 5 |
| Tetrachloroethene | | | 5 |
| Toluene | | | 5 |
| trans-1,3-Dichloropropene | | | 5 |
| Trichloroethene | | | 5 |
| Trichlorofluoromethane | | | 10 |
| Vinyl chloride (chloroethene) | | | 10 |
| Xylenes | | | 10 |
| **Semivolatiles by GC/MS** | | | |
| 1,2-Dichlorobenzene (o-Dichlorobenzene) | Amber glass | SW-846 Method 8270D | 10 |
| 1,2,4-Trichlorobenzene | | | 10 |
| 2-Chlorophenol | | | 10 |
| 2-Methylphenol (o-cresol) | | | 10 |
| 2-Nitrophenol (o-Nitrophenol) | | | 20 |
| 2,4-Dinitrotoluene | | | 10 |
| 2,4,5-Trichlorophenol | | | 10 |
| 2,4,6-Trichlorophenol | | | 10 |
| 3-Methylphenol (m-cresol) | | | 20 |

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| 4-Chloro-3-methylphenol (p-Chloro-m-cresol) | | | 10 |
| 4-Methylphenol (p-cresol) | | | 10 |
| Acenaphthene | | | 10 |
| Butylbenzylphthalate | | | 10 |
| Di-n-butylphthalate | | | 10 |
| Di-n-octylphthalate | | | 10 |
| Fluoranthene | | | 10 |
| Hexachlorobutadiene | | | 10 |
| Hexachloroethane | | | 10 |
| n-Nitroso-di-n-propylamine | | | 10 |
| n-Nitrosomorpholine | | | 10 |
| Naphthalene | | | 10 |
| Nitrobenzene | | | 10 |
| Pyrene | | | 10 |
| Pyridine | | | 20 |
| **PCBs** | | | |
| Aroclor 1016 | | | 0.5 |
| Aroclor 1221 | | | 0.5 |
| Aroclor 1232 | | | 0.5 |
| Aroclor 1242 | G | SW-846 Method 8082 | 0.5 |
| Aroclor 1248 | | | 0.5 |
| Aroclor 1254 | | | 0.5 |
| Aroclor 1260 | | | 0.5 |

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Other** | | | |
| Cyanide | P, NaOH to pH >12 | SW-846 Method 9012<br>Standard Method[f] 4500<br>EPA/600 Method 335.2 | 5 |
| Sulfide | G/P, 2 mL, 2N zinc acetate and NaOH pH >9, cool 4°C | Sulfides – 9030 | 500 |

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

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

c. Detection limit units.

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

e. SW-846 Method 6010 is the preferred method; however, Method 6020 or EPA/600 Method 200.8 may be used, as long as the method quantitation limit listed is met.

f. *Standard Methods for the Examination of Water and Wastewater* (AWWA et al., 2005).

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 impacts 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 (EBs). Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table A-4.

### 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.

**Table A-4. Quality Control Samples**

| Sample Type | Primary Characteristics Evaluated | Frequency |
|---|---|---|
| **Field QC** | | |
| Full trip blank (FTB) | Contamination from containers or transportation | One per 20 well trips |
| Field transfer blank (FXR) | Contamination from sampling site | One each day; VOCs sampled |
| Equipment blank (EB) | Contamination from non-dedicated equipment | As needed[a] |
| Replicate/duplicate sample | Reproducibility | One per 20 well trips |
| **Laboratory QC** | | |
| Method blank (MB) | Laboratory contamination | One per batch |
| Laboratory duplicate | Laboratory reproducibility | See footnote b |
| Matrix spike (MS) | Matrix effect and laboratory accuracy | See footnote b |
| Matrix spike duplicate (MSD) | Laboratory reproducibility/accuracy | See footnote b |
| Surrogate (SUR) | Recovery/yield | See footnote b |
| Laboratory control sample (LCS) | Method accuracy | One per batch |

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

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

Full trip blanks (FTBs) are prepared by the sampling team prior to 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 (VOCs) only. The FXRs are used to evaluate potential contamination caused by conditions in the field.

The 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 (MDL) 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 MDL.

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 (RPD). Only field duplicates with at least one result greater than five times the MDL or minimum detectable activity (MDA) 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 [MBs], laboratory control samples [LCSs]/blank spikes, and MSs) are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, 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 concentration limit determined for Hanford Site groundwater. 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.

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 *Methods of Chemical Analysis of Water and Wastes* (EPA/600/4-79/020). 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.

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

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| **General Chemical Parameters** | | | |
| Alkalinity<br>Conductivity<br>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" |

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

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| **Ammonia and Anions** | | | |
| Anions by IC<br>Cyanide<br>Sulfide | MB | <MDL | Flagged with "C" |
| | LCS | 80-120% recovery[c] | Data reviewed[d] |
| | DUP | ≤20% RPD[e] | 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" |
| **Metals** | | | |
| Arsenic<br>Cadmium<br>Chromium<br>Lead<br>Mercury<br>Selenium<br>Thallium<br>ICP metals<br>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[e] | Data reviewed[d] |
| | EB, FTB | <2 times MDL | Flagged with "Q" |
| | Field duplicate | ≤20% RPD[f] | Flagged with "Q" |
| **VOCs** | | | |
| Volatiles by GC/MS | 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" |

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

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| **Semi-VOCs** | | | |
| PCBs by GC<br>Phenols by GC<br>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 TOC and TOX 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.

Data flags:

B, C = possible laboratory contamination (analyte was detected in the associated MB)

N = result may be biased (associated MS 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 (%) | Precision (% RSD)* |
|---|---|---|---|
| Fluoride | Quarterly | ±25% | ≤25% |
| Nitrate | Quarterly | ±25% | ≤25% |
| Chromium | Annually | ±20% | ≤25% |

* 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.

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 the 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 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 prior to 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 *Hanford Federal Facility Agreement and Consent Order 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 (provided in Section A2.5) 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.

# A5 References

10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*. Available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&rgn=div6&view=text&node=10:4.0.2.5.26.1&idno=10.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/40cfr265_10.html.

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

Subpart F, "Ground-Water Monitoring."

ANSI/ASQ E4-2004, 2004, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use*, American National Standards Institute/American Society for Quality, Milwaukee, Wisconsin.

*Atomic Energy Act of 1954*, 42 USC 2011, et seq. Available at: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf.

AWWA, APHA, and WEF, 2005, *Standard Methods for the Examination of Water and Wastewater*, 21st ed., American Water Well Association, Denver, Colorado; American Public Health Association, Washington, D.C.; and Water Environment Federation, Alexandria, Virginia.

*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

DOE O 414.1C, 2005, *Quality Assurance*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/current-directives/414.1-BOrder-c/view.

DOE/RL-96-68, 2007, *Hanford Analytical Services Quality Assurance Requirements Documents*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/orp/?page=141&parent=14.

DOE/RL-2010-11, 2010, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1989a, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

Ecology, EPA, and DOE, 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=82.

EPA/240/B-01/003, 2001, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/QUALITY/qs-docs/r5-final.pdf.

EPA-600/4-79/020, *Methods of Chemical Analysis of Water and Wastes*, U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196018581.

EPA-600/4-84-017, 1984, *Test Methods for Determination of Inorganic Anions in Water by Ion Chromatography*, Method 300.0, U.S. Environmental Protection Agency, Washington, D.C.

*Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://epw.senate.gov/rcra.pdf.

SW-846, 2007, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, as amended, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm.

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

303-330, "Personal Training."

303-400, "Interim Status Facility Standards."

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# Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area TX-TY

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

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Richland Operations Office

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# Executive Summary

Waste Management Area (WMA) TX-TY, which contains the TX and TY Tank Farms, is regulated under RCW 70.105[1] and the implementing requirements in WAC 173-303-400.[2] The Washington State Department of Ecology (Ecology) has been authorized by the U.S. Environmental Protection Agency, in accordance with *Authorized State Hazardous Waste Programs*,[3] to conduct its hazardous waste regulatory program in lieu of the *Resource Conservation and Recovery Act of 1976* (RCRA),[4] including the requirements in 40 CFR 265, Subpart F.[5] The WMA TX-TY is also subject to the requirements of the *Hanford Federal Facility Agreement and Consent Order*,[6] with Ecology identified as the lead regulatory agency for the unit.

The WMA TX-TY was placed in assessment monitoring in 1993 due to elevated specific conductance. A groundwater quality assessment plan was prepared in 1993 (WHC-SD-EN-AP-132)[7] describing the monitoring activities to determine whether WMA TX-TY had affected groundwater. The plan was updated in 2001 (PNNL-12072)[8] for continued RCRA groundwater quality assessment, as required by 40 CFR 265.93(d)(7).[9] The WMA TX-TY assessment plan was updated again in 2007 to include (1) information obtained from eight new wells installed at the WMA after 1999

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[1] RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*, Olympia, Washington. Available at: http://apps.leg.wa.gov/RCW/default.aspx?cite=70.105.

[2] WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303-400.

[3] *Authorized State Hazardous Waste Programs*, 42 USC 6926, et seq. Available at: http://www.law.cornell.edu/uscode/42/6926.html.

[4] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://epw.senate.gov/rcra.pdf.

[5] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring," *Code of Federal Regulations*. Available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=fbf815e6fc70c4b56f27b33a7b919fb6&rgn=div6&view=text&node=40:25.0.1.1.6.6&idno=40.

[6] Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

[7] WHC-SD-EN-AP-132, 1993, *Interim-Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Areas T and TX-TY*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[8] PNNL-12072, 2001, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D1665266.

[9] 40 CFR 265.93, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Preparation, Evaluation, and Response," *Code of Federal Regulations*. Available at: http://edocket.access.gpo.gov/cfr_2010/julqtr/40cfr265.93.htm.

(PNNL-16005),[10] and (2) information from routine quarterly groundwater monitoring during the previous 5 years. This document supersedes the 2007 assessment plan to include significant events that have occurred at WMA TX-TY since that time and to update the groundwater monitoring project management organization description.

This plan describes the WMA TX-TY facility and operating history, waste characteristics, hydrogeology, previous monitoring at the WMA, groundwater and vadose zone contamination associated with the WMA and the conceptual model for the WMA. The plan also addresses the following:

- Number, locations, and attributes of wells in the WMA TX-TY groundwater monitoring network
- Sampling requirements and schedule for monitoring at WMA TX-TY
- Analytes, groundwater parameters, and analytical methods for dangerous wastes or dangerous waste constituents in the groundwater related to historical facility operations
- Procedures for evaluating groundwater quality data and information
- Reporting requirements

This assessment plan is the principal controlling document for conducting groundwater monitoring at WMA TX-TY.

[10] PNNL-16005, 2007, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-16005.pdf.

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# Terms

| | |
|---|---|
| amsl | above mean sea level |
| CAS | Chemical Abstracts Service |
| CERCLA | *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* |
| CY | calendar year |
| DOE | U.S. Department of Energy |
| DQO | data quality objective |
| EBF | electromagnetic borehole flow meter |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| FY | fiscal year |
| ID | identification |
| NA | not available |
| NAVD88 | North American Vertical Datum of 1988 |
| OU | operable unit |
| PFP | Plutonium Finishing Plant |
| PUREX | plutonium-uranium extraction |
| QAPjP | quality assurance project plan |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| REDOX | reduction-oxidation |
| SST | single-shell tank |
| TCE | trichloroethylene |
| WMA | waste management area |

# 1 Introduction

Waste Management Area (WMA) TX-TY, which contains the TX and TY Tank Farms, is located in the northern portion of the 200 West Area of the Hanford Site (Figure 1-1). The WMA was used for interim storage of radioactive waste from chemical processing of reactor fuel for plutonium production. The WMA is regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA) and RCW 70.105 ("Hazardous Waste Management Act"), and its implementing requirements in Washington State dangerous waste regulations (WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards"). This plan implements the requirements of WAC 173-303-400(3), incorporating by reference 40 CFR 265 ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities"). The WMA TX-TY was placed in assessment monitoring in 1993 due to elevated specific conductance (a RCRA indicator parameter) in two downgradient wells. Assessment monitoring has continued at WMA TX-TY since that time due to the presence of chromium, a dangerous constituent. The objectives for the continued assessment of groundwater quality at WMA TX-TY, as required by 40 CFR 265.93(d)(7)(i) ("Preparation, Evaluation, and Response"), are to determine the following:

- Rate and extent of migration of the dangerous waste or dangerous waste constituents in the groundwater
- Concentration of dangerous waste or dangerous waste constituents in the groundwater

The scope of this plan is to obtain the necessary groundwater data to reach these objectives. The objectives are also related to the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) 200-ZP-1 Groundwater Operable Unit (OU) investigations and the vadose zone RCRA facility investigation/corrective measures study at WMA TX-TY. The integration of RCRA groundwater quality assessment with the 200-ZP-1 OU and the vadose zone RCRA facility investigation/corrective measures study requires consideration of certain nondangerous waste constituents and radionuclides, in addition to the dangerous waste constituents regulated under RCRA. Radionuclides are monitored under separate plans to support the objectives of CERCLA and the *Atomic Energy Act of 1954*.

This document is a revision of the previous groundwater assessment plan (PNNL-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*) and includes significant events that have occurred at WMA TX-TY since the previous plan was issued. This monitoring plan is prepared to be consistent, to the extent possible, with the final status monitoring plan that will be incorporated into the *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste* (WA7890008967) in the future.

Chapter 2 of this plan summarizes background information, with references to other documents for more detailed information. Chapter 2 also describes the WMA and the types of waste present, provides a brief history of groundwater monitoring, and describes geology and hydrology pertinent to WMA TX-TY. This information is summarized as a site conceptual model that aids in development of the groundwater monitoring program. Chapter 3 describes the RCRA groundwater monitoring program, including the wells in the monitoring network, constituents analyzed, sampling frequency, and sampling protocols. Chapter 4 describes data evaluation, interpretation, and reporting. A list of the references cited in this document is provided in Chapter 5. Appendix A provides the quality assurance project plan (QAPjP).

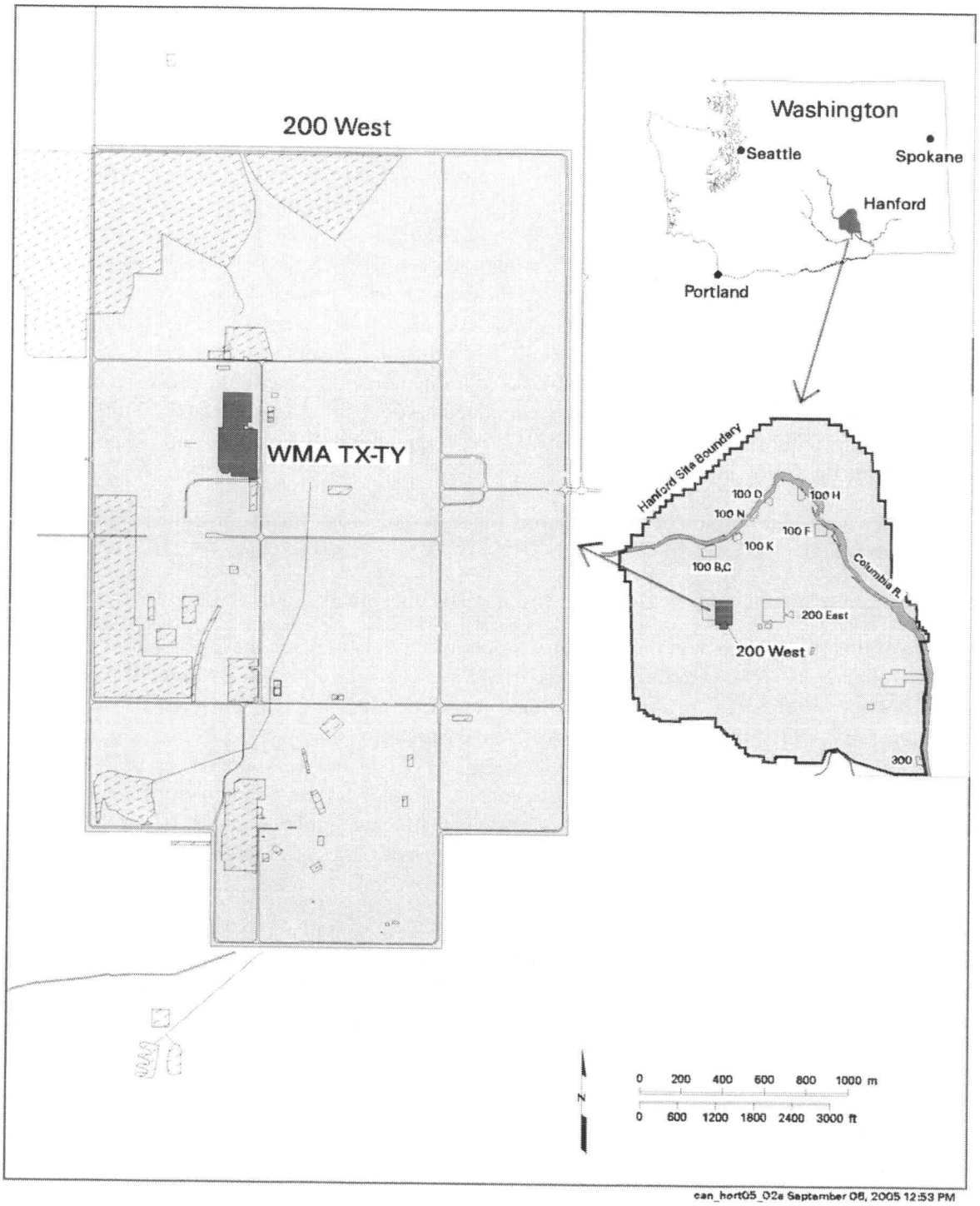



**Figure 1-1. Location Map for WMA TX-TY**

# 2 Background

This chapter describes WMA TX-TY facility and operating history. Discussion is also included on associated waste and waste characteristics at the WMA, local geology and hydrology, a summary of previous monitoring, groundwater and vadose zone contamination at the WMA, and a conceptual model.

The discussions in this chapter are summarized from previous documents, including the following:

- PNNL-11809, *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Areas T and TX-TY at the Hanford Site*
- PNNL-12072, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY at the Hanford Site*
- PNNL-14099, *Groundwater Conditions at Single-Shell Tank Waste Management Area TX-TY (January 1998 Through December 2001)*
- PNNL-15837, *Data Package for Past and Current Groundwater Flow and Contamination Beneath Single-Shell Tank Waste Management Areas*
- PNNL-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*
- RPP-23752, *Field Investigation Report for Waste Management Areas T and TX-Y*
- RPP-RPT-38320, *Surface Geophysical Exploration of the TX and TX Tank Farms at the Hanford Site*

## 2.1 Facility Description and Operating History

The WMA TX-TY is located in the northern portion of the 200 West Area (Figure 1-1). The WMA contains 24 underground single-shell tanks (SSTs), constructed in 1947 and 1948 for the TX Tank Farm and in 1951 and 1952 for the TY Tank Farm. Each tank has a capacity of 2.84 million L (750,000 gal). The 18 tanks in the TX Tank Farm are arranged in three 4-tank cascades and two 3-tank cascades. The six tanks in the TY Tank Farm are arranged in three 2-tank cascades. Tank cascades are sets of tanks that were constructed with elevation differences between tanks, which allow gravity-driven flow (cascading) of the waste stream from one tank to another. This allowed cooling and precipitation of radionuclides and solids to occur in each tank of the cascade. Some of the supernatant from the last tank in the cascade was sent to cribs via surface pipelines because of a shortage in tank storage capacity. As a result, it is difficult to estimate the composition of the waste remaining in the tanks based on operational records. In addition to the tanks, six diversion boxes and ancillary pumps, valves, and pipes are included in the Dangerous Waste Permit Application Part A form (WA7890008967) for the SSTs in the TX-TY Tank Farms system.

The tanks in WMA TX-TY began receiving waste in 1949. The tanks in both the TX and TY Tank Farms were used to support the bismuth phosphate process and the uranium-recovery program. Some of the tanks in WMA TX-TY also received waste from Reduction-Oxidation (REDOX) Plant and Plutonium-Uranium Extraction (PUREX) Plant operations.

Waste management operations have created a complex intermingling of tank wastes. Nonradioactive chemicals have been added to the tanks, and varying amounts of waste and heat-producing radionuclides have been removed. In addition, natural processes have caused settling, stratification, and segregation of waste components. A detailed history of tank farm operations is provided in *A History of the 200 Area Tank Farms* (WHC-MR-0132).

The pumpable liquid has been removed from all of the SSTs in WMA TX-TY, and all tanks have been interim stabilized. Each tank currently contains less than 189,250 L (50,000 gal) of drainable interstitial liquid and less than 18,925 L (5,000 gal) of supernatant liquid (HNF-EP-0182, *Waste Tank Summary Report for Month Ending September 30, 2004*, Rev. 198).

Initial corrective actions have been implemented at WMA TX-TY. Berms were constructed around the TX and TY Tank Farms in 2001 to stop run-on of natural precipitation, and all known water lines leading to the tank farms were cut and capped at that time. Additionally, an interim barrier over the TY Tank Farm was being constructed and expected to be completed in 2010. An interim measures maintenance plan consisting of annual inspections of drywell covers and visual inspections of run-off collection areas and culverts is in place and documented in the *Interim Measures Maintenance Plan* (WRPS-0900388).

HNF-EP-0182 assumed that 13 of the tanks in WMA TX-TY have leaked based on liquid losses; however, little information and no previous leak inventory estimates are available for seven of the tanks (RPP-23405, *Tank Farm Vadose zone Contamination Volume Estimates*). It must be noted that spectral gamma logging in drywells is only used to interrogate to a radius of 30.5 cm (12 in.) and, therefore, depends on the placement of the initial borehole. Contamination associated with the latter seven tanks may be the result of waste pipeline leaks or nearby tanks that are known to have leaked. The tanks with the three largest confirmed leaks from WMA TX-TY are TY-103, TY-105, and TY-106 (RPP-23405, *Tank Farm Vadose Zone Contamination Volume Estimates*).

In 2010, the *Hanford TY-Farm Leak Assessments Report* (RPP-RPT-42296) revised some of the leak estimates from HNF-EP-0182. For instance, RPP-RPT-42296 states that tank TY-101, which was previously identified as a leaker, is not actually a leaker based on the new methodology that shows the liquid level decreases were within the margin of error of equipment. In addition to leaks, 11 unplanned releases have been documented in the area of WMA TX-TY. The unplanned releases are described in the *T Plant Source Aggregate Area Management Study Report* (DOE/RL-91-61) and PNNL-16005.

## 2.2 Regulatory Basis

In May 1987, the U.S. Department of Energy (DOE) issued a final rule (10 CFR 962, "Byproduct Material") stating that the dangerous waste components of mixed waste are subject to RCRA regulations. In November 1987, the U.S. Environmental Protection Agency (EPA) authorized the Washington State Department of Ecology (Ecology) to regulate these dangerous waste components within the State of Washington (51 FR 24504, "EPA Clarification of Regulatory Authority Over Radioactive Mixed Waste"). In 1996, the Washington State Attorney General determined that the effective date of mixed waste in Washington State was August 19, 1987.

Groundwater monitoring is conducted at WMA TX-TY in accordance with 40 CFR 265, Subpart F ("Ground-Water Monitoring") and by reference of WAC 173-303-400(3). An indicator evaluation RCRA groundwater monitoring program for WMA TX-TY was initiated in 1989 (WHC-SD-EN-AP-012, *Interim-Status Groundwater Monitoring Plan for the Single-Shell Tanks* [Rev. 0, followed by Rev. 1 in 1991]). The WMA was placed into assessment monitoring in 1993 because specific conductance values in downgradient wells 299-W10-17 and 299-W14-12 exceeded the upgradient background (critical mean) value (WHC-SD-EN-AP-132, *Interim-Status Groundwater Quality Assessment Plan for the Single-Shell Waste Management Areas T and TX-TY*). The first assessment report (PNNL-11809) concluded the following: (1) elevated contamination in well 299-W14-12 was consistent with a source within the WMA, and (2) an upgradient source (216-T-25 Trench) was possible. Subsequent drilling and sampling of well 299-W15-40 (located between the 216-T-25 Trench and the WMA) eliminated the 216-T-25 Trench as a possible source of contamination downgradient of the WMA. The second assessment report,

*RCRA Groundwater Quality Assessment Report for Single-Shell Tank Waste Management Area TX-TY (January 1998 Through December 2001)* (PNNL-14004), was not able to eliminate the WMA TX-TY as a source for the downgradient contamination. The presence of chromium, a dangerous constituent in groundwater, requires continued groundwater assessment. Accordingly, continued groundwater assessment is required, and this plan describes the activities for continued assessment.

## 2.3 Waste Characteristics

Two basic chemical-processing operations were the source of most of the dangerous waste transferred to the TX and TY Tank Farms: the bismuth phosphate process and the tributyl phosphate process. Lesser quantities of waste from the REDOX and PUREX processes were also sent to the tank farms. The bismuth phosphate, REDOX, and PUREX processes were chemical separations programs used to recover plutonium from irradiated reactor fuels. The tributyl phosphate process recovered uranium metal in waste generated by the bismuth phosphate process. Waste from these processes was made alkaline for storage in the tanks (WHC-MR-0132). WHC-MR-0132 provides approximate chemical compositions for the major waste types sent to the SSTs in the TX and TY Tank Farms, and *Hanford Soil Inventory Model, Rev. 1* (RPP-26744) provides detailed estimates for chemical and radioisotope concentrations in each tank leak in the WMA.

Table 2-1 lists the dangerous wastes specified in the Dangerous Waste Permit Application Part A form (WA7890008967).

**Table 2-1. Dangerous Wastes in the Single-Shell Tank System (Dangerous Waste Permit Application Part A Form)**

| Dangerous Waste Code | Contaminant Description | Dangerous Waste Code | Contaminant Description |
|---|---|---|---|
| D001 | Ignitable waste | D030 | 2,4-Dinitrotoluene |
| D002 | Corrosive waste | D033 | Hexachlorobutadiene |
| D003 | Reactive waste | D034 | Hexachloroethane |
| D004 | Arsenic | D035 | Methyl ethyl ketone |
| D005 | Barium | D036 | Nitrobenzene |
| D006 | Cadmium | D040 | Trichloroethylene (TCE) |
| D007 | Chromium | D041 | 2,4,5-Trichlorophenol |
| D008 | Lead | D043 | Vinyl chloride |
| D009 | Mercury | F001 | 1,1,1-Trichloroethane |
| D010 | Selenium | F002 | Methylene chloride |
| D011 | Silver | F003 | Acetone, methyl isobutyl ketone |
| D018 | Benzene | F004 | Cresol-m, -o, -p |
| D019 | Carbon tetrachloride | F005 | Methyl ethyl ketone |

**Table 2-1. Dangerous Wastes in the Single-Shell Tank System (Dangerous Waste Permit Application Part A Form)**

| Dangerous Waste Code | Contaminant Description | Dangerous Waste Code | Contaminant Description |
|---|---|---|---|
| D022 | Chloroform | WP01 | Extremely hazardous waste/ persistent dangerous waste |
| D028 | 1,2-Dichloroethane | WP02 | Dangerous waste/ persistent dangerous waste |
| D038 | Pyridine | WT01 | Extremely hazardous waste/ toxic dangerous waste |
| D029 | 1,1-Dichloroethylene | WT02 | Dangerous waste/toxic dangerous waste |
| D039 | Tetrachloroethylene | | |

Notes:

1. This table is based on the Dangerous Waste Permit Application Part A form (WA789000896).
2. Analytes associated with the "F001" through "F005" waste codes are from WHC-MR-0517, *Listed Waste History at Hanford Facility TSD Units*.

## 2.4 Geology and Hydrogeology

This section describes of the geology and hydrology beneath WMA TX-TY. The geology specific to WMA TX-TY was first described in *Geology of the 241-TX Tank Farm* (ARH-LD-136) and *Geology of the 241-TY Tank Farm* (ARH-LD-137), and later in WHC-SD-EN-AP-012. More recently, the WMA TX-TY geology has been summarized in the following:

- HNF-2603, *A Summary and Evaluation of Hanford Site Tank Farm Subsurface Contamination*
- RPP-7123, *Subsurface Conditions Description of the T and TX-TY Waste Management Areas*
- RPP-23748, *Geology, Hydrogeology, Geochemistry, and Mineralogy Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*
- PNNL-15955, *Geology Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*
- PNNL-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*

Updated information on the geology and hydrogeology at WMA TX-TY, including the most recent observations from new wells, is included in PNNL-15837.

The vadose zone beneath WMA TX-TY is between approximately 66 and 70 m (216 and 229 ft) thick and consists of the Hanford formation, the Cold Creek unit, the Taylor Flat member of the Ringold Formation, and the upper portion of Unit E of the Wooded Island member of the Ringold Formation. The water table is at approximately 134.5 m (441 ft) elevation based on fiscal year (FY) 2009 water table elevations. The unconfined aquifer beneath WMA TX-TY is estimated to be between 48.5 and 56.5 m (159 to 185 ft) thick based on water levels and the depth of the Ringold Formation lower mud unit, which

serves as a confining or semiconfining layer separating the unconfined aquifer from a confined (or partly confined) aquifer in the underlying Ringold Formation Unit A.

Figure 2-1 shows a generalized hydrostratigraphic column for the Hanford Site. The geology beneath WMA TX-TY consists of a basalt basement overlain by nine sedimentary sequences, which are distinguished mainly by texture (particle size), mineralogy, responses to natural gamma logs, and stratigraphic position.

Water levels in the unconfined aquifer increased as much as 14 m (46 ft) above the pre-Hanford natural water table beneath WMA TX-TY due to artificial recharge from liquid waste disposal operations active between the mid-1940s and 1995. During that time, the groundwater flow direction changed from eastward (the pre-Hanford direction) to southward, then northward, and finally back toward the east as a result of changes in waste management practices. Groundwater levels continue to decline due to cessation of artificial recharge from liquid waste disposal operations in the area (Figure 2-2).

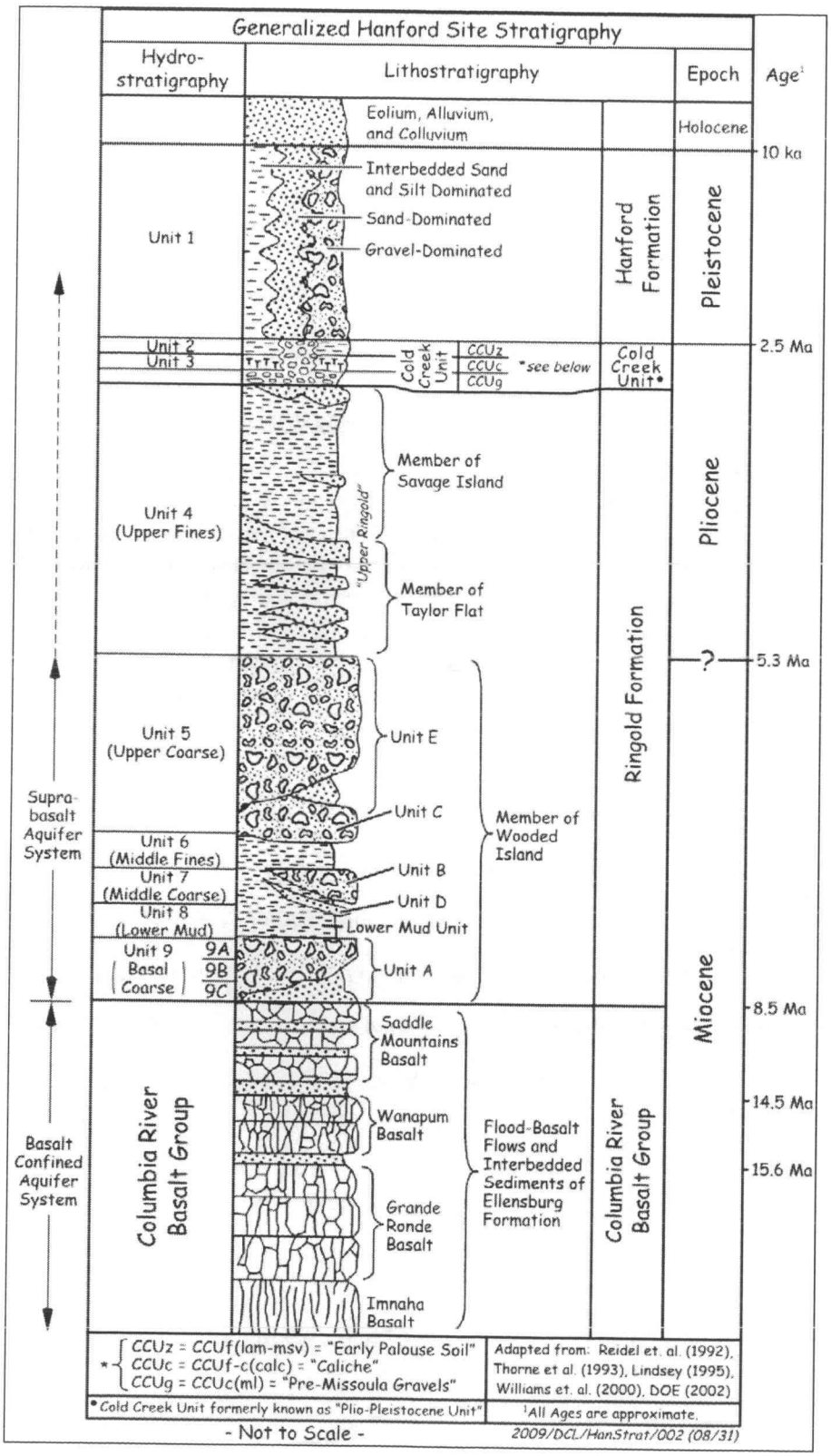
More recently, extraction wells for the 200-ZP-1 OU pump-and-treat system have altered the flow direction. In 2005, upgradient wells were converted to extraction wells, shifting the flow southward in the southern portion of the WMA and likely shifting flow toward the northwest in the northern portion of the WMA. Possible stagnation points exist in the middle portion of the WMA east of the extraction wells, and some flow is currently eastward in the middle of the WMA. Therefore, it must be assumed that the water table gradient is variable beneath WMA TX-TY due to influences from pump-and-treat system extraction wells. The large shifts in groundwater flow direction have large implications for contaminant distribution in the uppermost aquifer beneath WMA TX-TY. A current groundwater map for WMA TX-TY is provided in Figure 2-3.

Aquifer tests have been performed on new wells at WMA TX-TY since 1999. The details of the tests, data analysis, and test results are provided in the following:

- PNNL-13378, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 1999*
- PNNL-13514, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2000*
- PNNL-14113, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2001*
- PNNL-14186, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2002*
- PNNL-17348, *Results of Detailed Hydrologic Characterization Tests – Fiscal and Calendar Year 2005*
- PNNL-18279, *Aquifer Testing Recommendations for Well 299-W15-225: Supporting Phase 1 of the 200-ZP-1 Groundwater Operable Unit Remedial Design*

The salient results are listed below using the pertinent historical or latest compiled data from the above-listed documents:

- Hydraulic conductivities range between about 0.07 and 19.9 m/d (0.23 and 65.3 ft/d), with a geometric mean of 2.20 m/d (7.22 ft/d).
- Vertical heterogeneities in hydraulic conductivity exist among wells and within individual well screens.




Note: The member of Savage Island, the member of Wooded Island units C, B, and D, and the Snipes Mountain conglomerate are not present at WMA TX-TY.

**Figure 2-1. Generalized Stratigraphy of the Hanford Site**

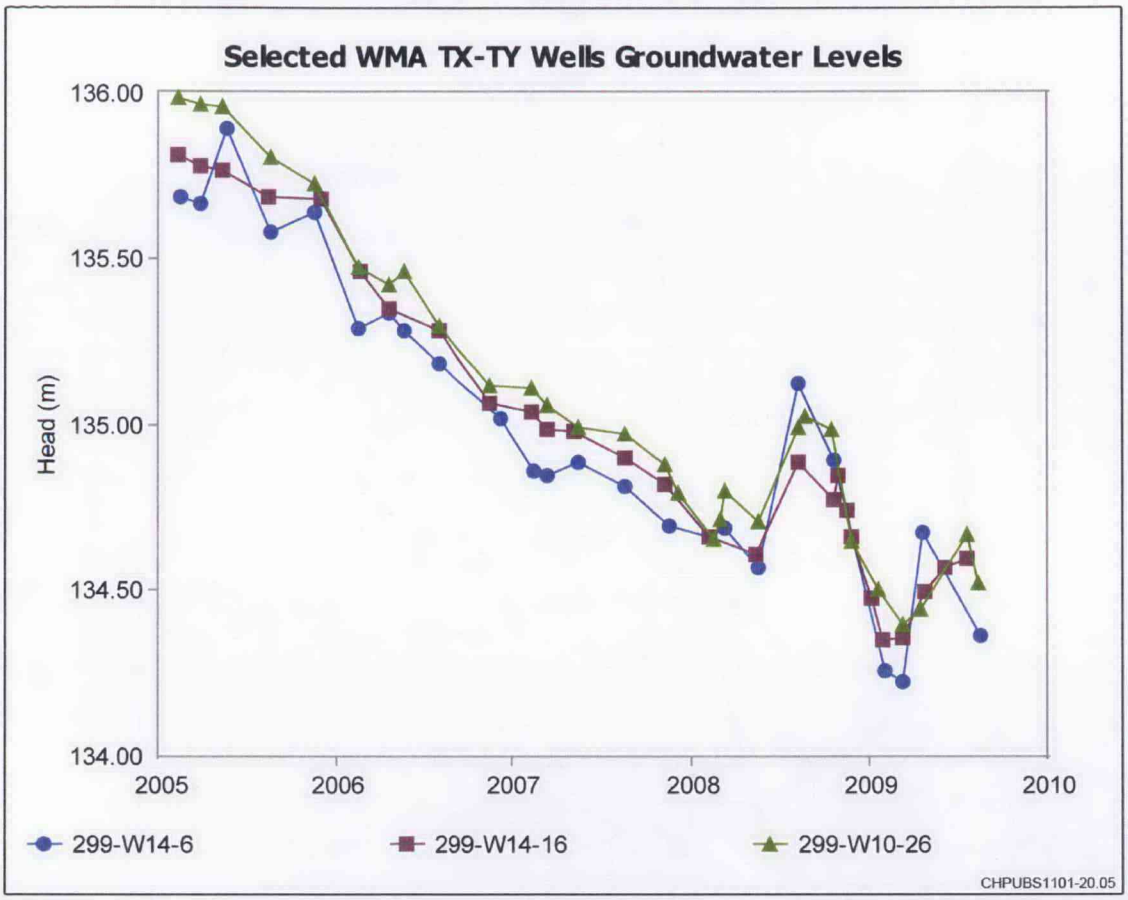



**Figure 2-2. Selected Monitoring Wells Showing Groundwater Level Declines in WMA TX-TY**

- The in-well, upward, vertical groundwater flow conditions were measured in 2005 within monitoring well 299-W14-11, which has a screened interval of 3 m (10 ft) and is located approximately 14 m (46 ft) below the water table. Vertical flow was measured in the borehole using electromagnetic borehole flow meter (EBF) surveys. Maximum vertical flow velocity recorded by the EBF was 0.014 to 0.027 m/m.

- In-well, downward vertical groundwater flow conditions were measured in well 299-W14-13 in 1999 and 2000 using vertical-flow tracer tests and EBF surveys. This well is screened across the water table, and the bottom of the screened interval is currently approximately 7 m (23 ft) below the water table. Well 299-W14-13 is located 6 m (19 ft) south of well 299-W14-11. Average vertical downward flow velocities were 0.011 to 0.012 m/m and were reproducible over a 9-month period during testing.

It is important to note that the existence of vertical flow is not necessarily reflective of the actual groundwater flow conditions within the surrounding aquifer. However, the presence of vertical flow implies a vertical flow gradient and has implications pertaining to the representativeness of groundwater samples collected from such monitoring wells near the WMA.

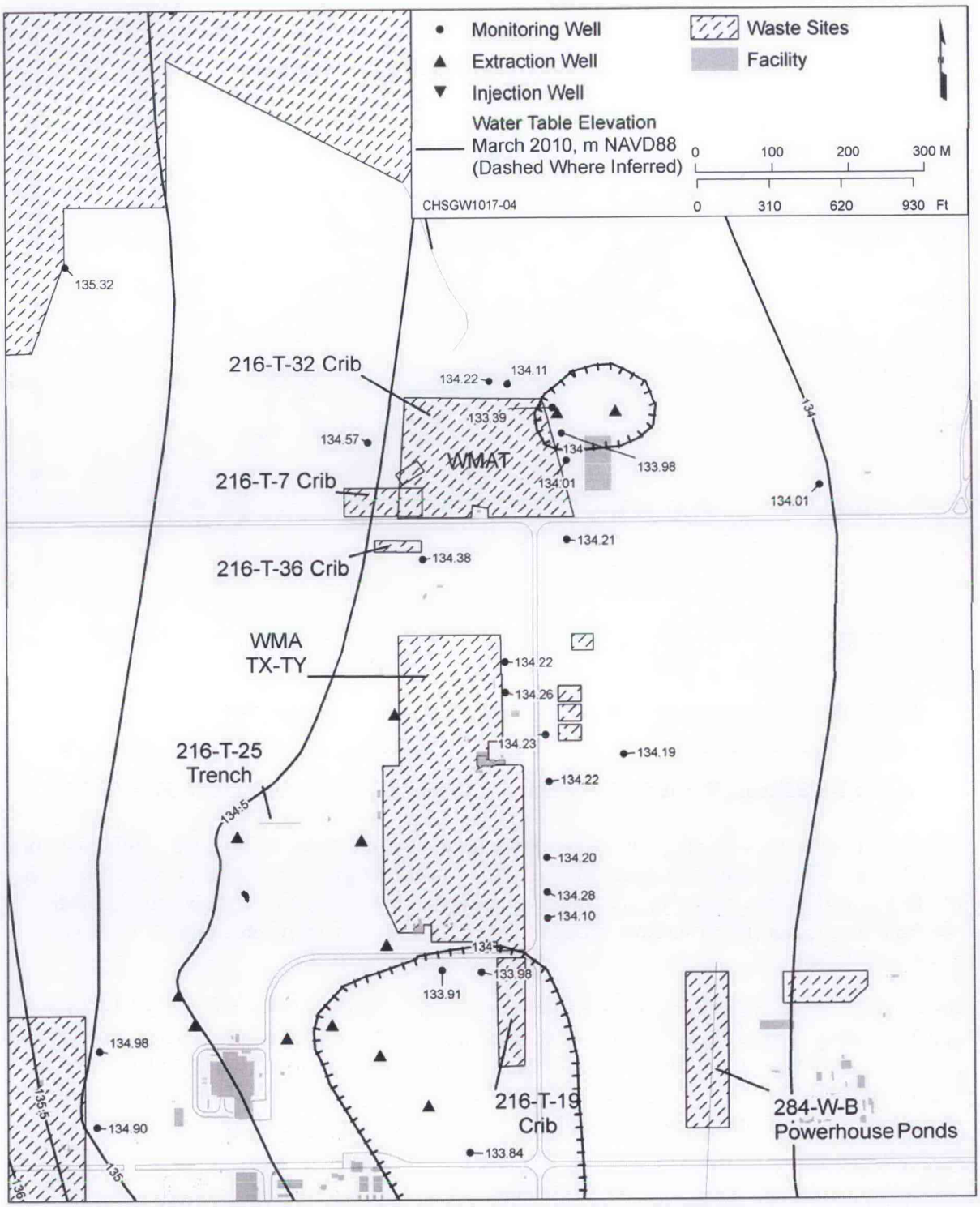



**Figure 2-3. Water Table Map for Area Around WMA TX-TY, March 2010**

## 2.5 Summary of Previous Groundwater Monitoring

This section summarizes the current and historical groundwater contamination at WMA TX-TY. The vadose zone contamination is also summarized because any residual vadose zone contamination is a potential source for future groundwater contamination.

### 2.5.1 Groundwater Contamination

Chromium is the sole RCRA dangerous constituent found beneath WMA TX-TY, with an associated source in the WMA. Carbon tetrachloride and trichloroethylene (TCE) are also present, but the source of these constituents was liquid disposal associated with processes at the Plutonium Finishing Plant (PFP) and not WMA TX-TY. These constituents are monitored as part of the 200-ZP-1 Groundwater OU. Nitrate is also found in the groundwater beneath the WMA. Plume maps for all of these constituents are provided in *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2* (DOE/RL-2010-11).

#### *2.5.1.1 Chromium*

Chromium concentrations exceeded the drinking water standard (100 µg/L) in two wells during routine sampling at WMA TX-TY during 2009. The highest chromium concentrations have historically been in well 299-W14-13, screened at the water table and located downgradient of the WMA. This well is located between nearby past-practice liquid disposal designated waste sites (216-TX/TY Cribs and 241-153-TX diversion box unplanned release). The concentration in January 2009 was 744 µg/L; by October 2009, the concentration in this well was 397 µg/L. The chromium concentration in adjacent well 299-W14-11, screened 11.6 to 14.6 m (38.1 to 47.9 ft) below the water table, was 194 µg/L in October 2009. The chromium concentrations in these two wells suggest that the highest concentrations occur near the water table in this area. Concentrations have historically fluctuated in the two wells and were exhibiting a decreasing trend at the end of calendar year (CY) 2009.

#### *2.5.1.2 Nitrate*

The WMA TX-TY lies within the regional 200 West Area nitrate plume. Nitrate exceeds the drinking water standard of 45 mg/L in all wells at the WMA. Most of the nitrate beneath the WMA is believed to have resulted from disposal to past-practice liquid disposal facilities in the area, although some contribution from WMA TX-TY is possible.

The highest nitrate concentration during 2009 was in well 299-W10-27, located at the northern portion of the downgradient side of the WMA. Nitrate concentrations began increasing rapidly in this well beginning in 2006 and peaked in 2007. Nitrate concentrations were exhibiting an overall gradual decreasing trend in this well during CY 2009, ranging from a high of 677 mg/L to a low of 452 mg/L near the end of the year. The 2009 annual average concentration for the well was 521 mg/L, which is a slight increase from the previous year's average.

### 2.5.2 Vadose Zone Contamination

Geophysical logging of drywells adjacent to SSTs in the TX and TY Tank Farms has delineated the extent of gamma-emitting vadose zone contamination, as presented in the following reports:

- GJO-97-13-TAR, *Hanford Tank Farms Vadose Zone – TX Tank Farm Report*
- GJO-97-13-TARA, *Hanford Tank Farms Vadose Zone – Addendum to the TX Tank Farm Report*
- GJO-97-30-TAR, *Hanford Tank Farms Vadose Zone – TY Tank Farm Report*
- GJO-97-30-TARA, *Hanford Tank Farms Vadose Zone – Addendum to the TY Tank Farm Report*

The maximum depth of vadose zone contamination is not known because the contamination extends deeper than the deepest vadose zone wells in the tank farms, as determined by sampling results obtained during drilling of the vadose zone wells.

More recently, a geophysical investigation at the WMA TX-TY (RPP-RPT-38320) used a well-to-well, long electrode resistivity measurement method. The well-to-well measurements were made using 105 steel-cased vadose zone wells, 30 groundwater wells, and 27 point electrodes. This study further defined the distribution of low-resistivity anomalies associated with the specific retention trenches and cribs, as well as along the pipelines that cross the WMA. The distribution of low-resistivity anomalies that are usually related to tank-process contamination should be of particular interest in regard to assessment and remediation of the WMA and associated facilities.

Figures 2-4 and 2-5 show geophysical anomalies detected during surface geophysical characterization performed at WMA TX-TY during FY 2008. The objective of the investigation was to collect and analyze electrical resistivity data in order to identify and locate discrete, low-resistivity regions in the subsurface to guide future sampling and analysis efforts. The figures show the results from the well-to-well, long electrode electrical resistivity measurement method. Tanks assumed to have leaked are colored differently in the figures for reference.

An in-depth summary and discussion of the investigation results is presented in RPP-RPT-38320. A brief description of the investigation findings is provided below:

- For the TY Tank Farm, the resistivity inversion model results indicate several low-resistivity targets, which are located in close proximity to underground storage tanks that are assumed to have leaked.
  - In contrast, no significant low-resistivity targets were located near tank TY-102, which is not known to have leaked.
  - The well-to-well results suggest that infrastructure within the TY Tank Farm does not control the distribution of low-resistivity targets found in association with the tanks that are assumed to have leaked.
- For the TX Tank Farm, the resistivity inversion model results within the tank farm show more dispersed low-resistivity targets, which are in some cases linear-shaped along locations of known pipelines.
  - The shape and position of the low-resistivity targets with respect to known infrastructure suggest that the numerous pipelines may be influencing the size, shape, and locations of the low-resistivity targets within the TX Tank Farm.
  - Although the more numerous buried infrastructure may be affecting the low-resistivity targets when compared to the TY Tank Farm results, a clustering of low-resistivity targets exist around tanks 107, 108, 111, and 112.

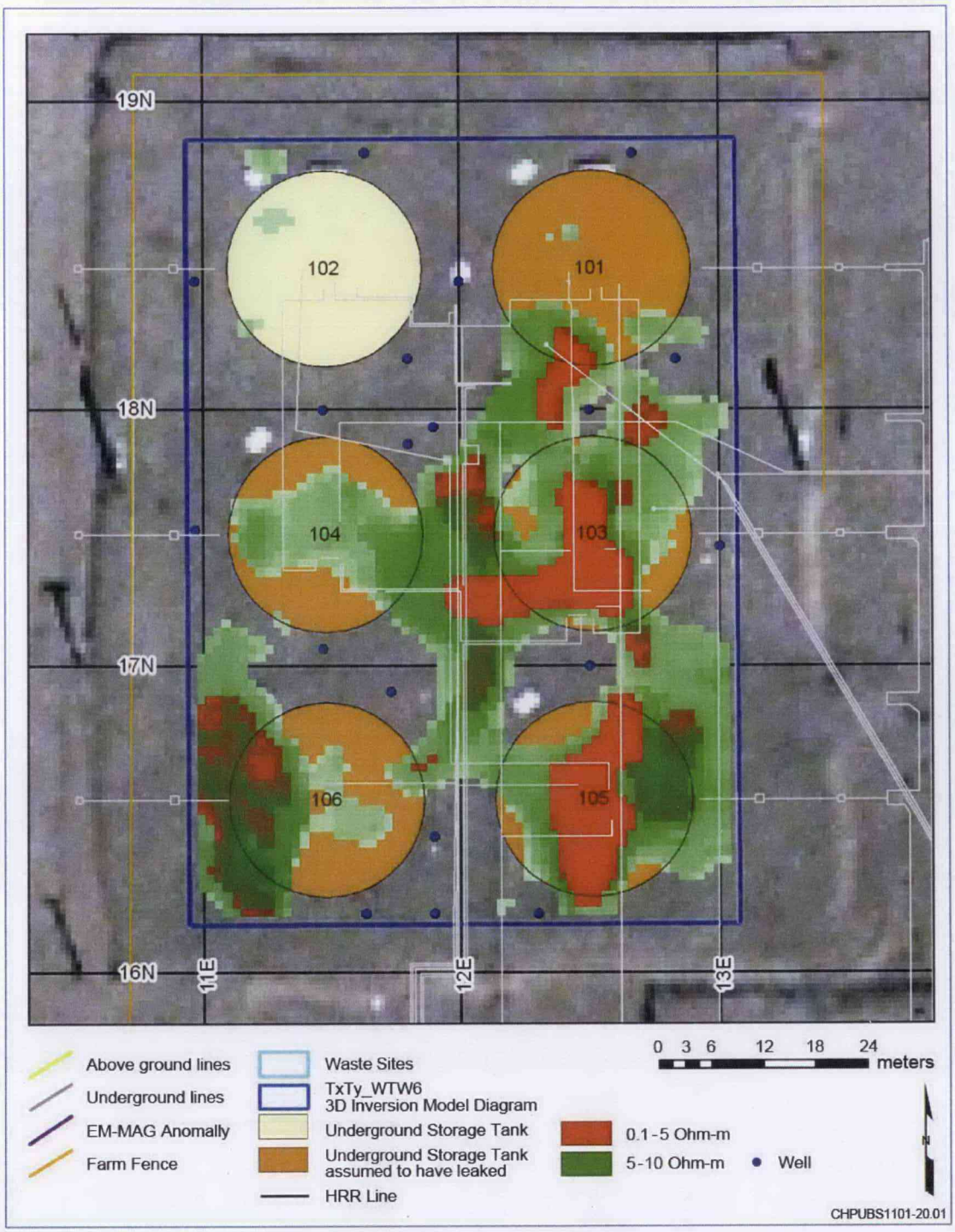



**Figure 2-4. Well-to-Well Resistivity Inversion Model Results for the TY Tank Farm**

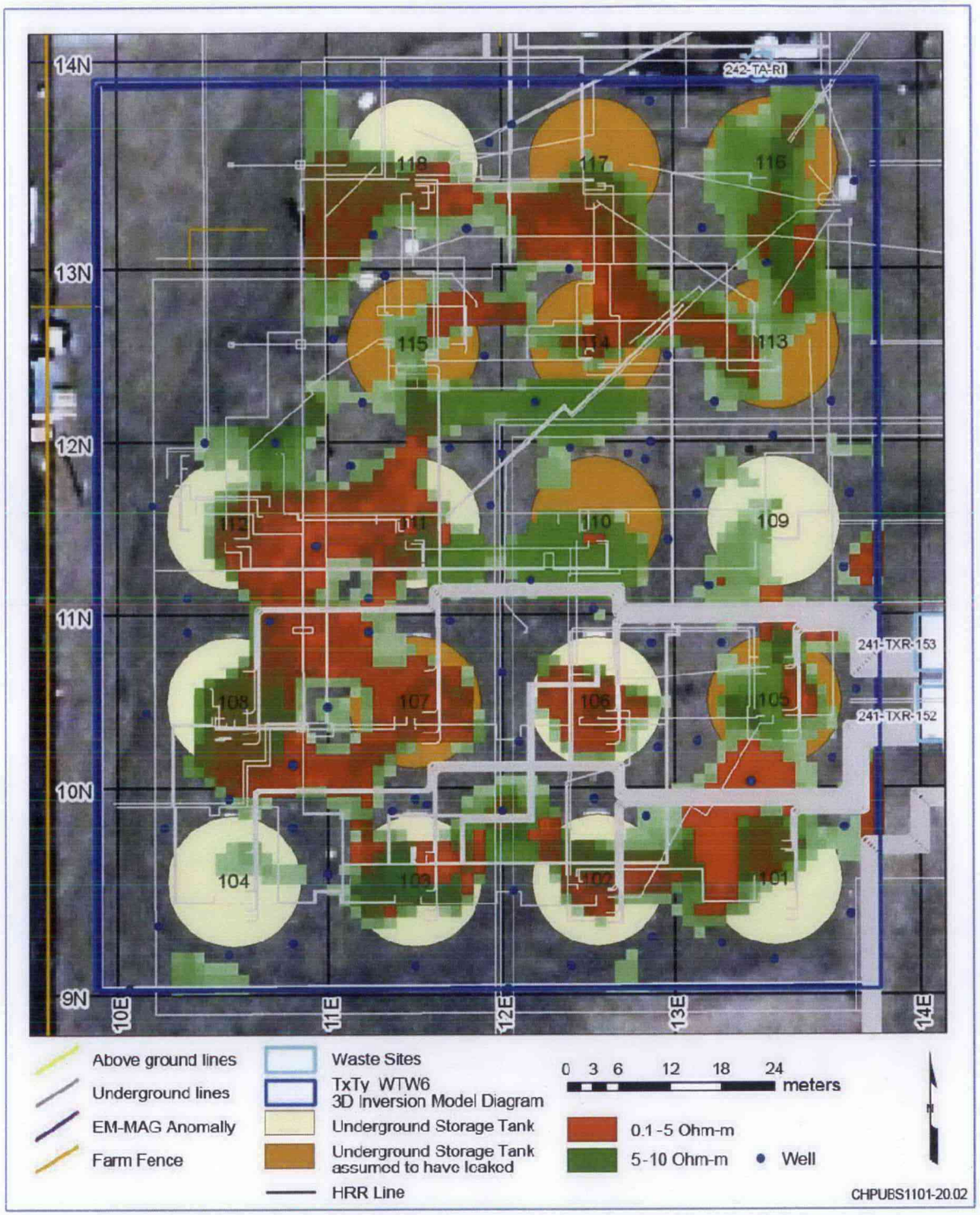



**Figure 2-5. Well-to-Well Resistivity Inversion Model Results for the TX Tank Farm**

## 2.6 Conceptual Model

PNNL-16005 describes the conceptual model for WMA TX-TY. The conceptual model illustrates the complexity and the spatial and temporal relationships of five important parameters, which are outlined in this section:

- Contaminant sources
- Driving forces
- Migration pathways to groundwater
- Changes in groundwater flow direction and flow rate
- Current contaminant distributions in the aquifer

### 2.6.1 Contaminant Sources

Several potential sources for groundwater contamination exist in WMA TX-TY, including tank leaks; liquid wastes disposed to past-practice facilities (located east, west, and south of the WMA); unplanned releases, including leaking pipelines; and regional contamination from far-field sources (e.g., PFP).

- All tanks in WMA TX-TY have been interim stabilized; thus, the impact of future, large tank leaks on groundwater is not a threat. However, contaminants remaining in the vadose zone from past tank leaks have the potential to migrate to the groundwater.

- Pipeline leaks have been suggested to account for some near-surface and deeper vadose zone contamination in WMA TX-TY (RPP-7218, *Preliminary Inventory Estimates for Single-Shell Tank Leaks in T, TX, and TY Tank Farms*). Any contamination remaining in the vadose zone from past pipeline leaks or overfill events remains a possible source for future groundwater contamination.

- Regional sources are responsible for most of the carbon tetrachloride and much of the nitrate found in groundwater beneath WMA TX-TY. An exception exists for a probable nearby source for the extremely high contamination immediately east of the WMA.

### 2.6.2 Driving Forces

In general, contaminants are transported to groundwater in two ways: (1) transport associated with very large leaks, when the amount of liquid is sufficient to reach groundwater through gravitational forces and capillary action; and (2) transport associated with an external source of water (or other liquid) available to remobilize residual waste in vadose zone plumes. The SSTs in WMA TX-TY no longer contain large amounts of liquid waste; thus, large tank leaks emanating from WMA TX-TY are not likely.

All intentional disposal of water to non-permitted facilities ceased in 1995; therefore, effluent disposal to nearby ponds, cribs, and ditches is no longer available to mobilize vadose zone contamination to the groundwater. Figure 2-6 provides the historical conceptual model showing how contamination entered the vadose zone and possibly entered the groundwater system. All known water lines at WMA TX-TY have been tested and cut off (DOE/ORP-2008-01, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*). It is possible, but unlikely, that a previously unidentified water line will leak and substantially mobilize the existing vadose zone contamination to groundwater in the area.

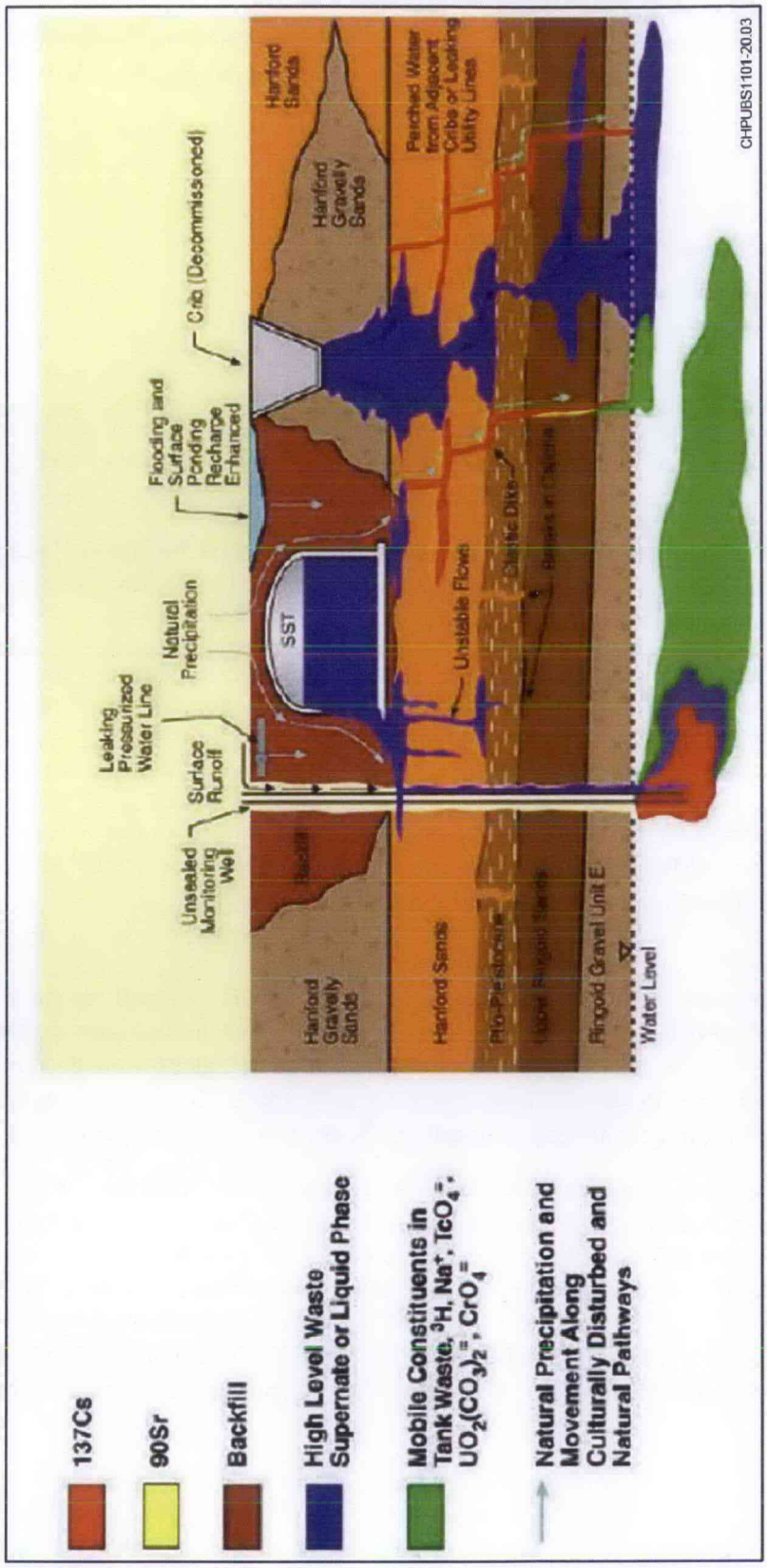



Figure 2-6. Conceptual Model of Hydraulic Drivers at Single-Shell Tank Farms

Infiltration of natural precipitation remains the likely principal driver to mobilize vadose zone contamination. Steps have been taken to reduce infiltration or precipitation at WMA TX-TY. Berms have been erected around the tank farm to stop run-on of rain and melting snow. In CY 2009, a design for an interim surface barrier for the TY Tank Farm was completed. The *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989) Milestone M-045-92 requires that interim surface barrier be completed by the end of FY 2010. As of December 2010, the interim surface barrier was operational.

### 2.6.3 Migration

Contaminant migration through the vadose zone is not well understood because it is highly dependent on heterogeneities and anisotropy in the soil properties. Heterogeneities at smaller than formation scale also affect flow and transport, as evidenced by logs of drywells and cone penetrometer logs that reveal moisture-rich strata, likely reflecting finer grained units with permeability contrast.

The most influential sediment layer for moisture migration through the vadose zone beneath WMA TX-TY is the Cold Creek unit. The relatively low permeability of the Cold Creek unit is expected to impede vertical moisture migration. The Cold Creek unit is known to pond water locally in several places in the 200 West Area.

Improperly sealed wells can act as a preferential pathway through the vadose zone. Documentation provided in *Hanford Wells* (PNL-8800) identified that only 6 of the 95 vadose zone wells in the TX Tank Farm and none of the vadose zone wells in the TY Tank Farm used for secondary leak detection have been modified to retrofit an annular seal. Therefore, the potential exists for unsealed wells to promote vertical moisture migration in WMA TX-TY.

Lateral migration of effluent beneath past-practice liquid disposal facilities has been documented east of WMA TX-TY at the 216-T-26 through 216-T-28 Cribs (ARH-ST-156, *Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells: Volume I*).

The groundwater flow direction and rate at WMA TX-TY is variable, depending on location relative to the 200-ZP-1 OU pump-and-treat extraction wells.

### 2.6.4 Changing Groundwater Flow Direction

Prior to startup of the 200-ZP-1 OU pump-and-treat system, large changes occurred in groundwater flow direction beneath WMA TX-TY during Hanford Site operations. Groundwater could have traveled and carried contaminants from WMA TX-TY and nearby past-practice disposal facilities. The approximate travel directions identified in PNNL-16005 are south (between 1954 and 1956), northeast (between 1957 and 1982), and north or northwest (between 1983 and 1995). Since 1995, groundwater flow direction has been primarily toward the east, except where influenced by the 200-ZP-1 OU pump-and-treat system. These changes in the groundwater flow direction could have contributed to relatively widespread contaminant distribution.

An expanded, large-scale pump-and-treat system is being installed in the 200 West Area. The expanded system is expected to change the groundwater flow direction and flow velocity at WMA TX-TY in the future. However, the magnitude and direction of the changes will not be known until after the system becomes operational in 2011 or 2012.

### 2.6.5 Contaminant Distribution

The current understanding of the spatial distribution of contaminants at WMA TX-TY is shown in recent plume maps (DOE/RL-2010-11). Several lines of evidence show that vertical contaminant concentration gradients exist in the area of downgradient wells 299-W14-11 and 299-W14-13.

## 2.7 Data Quality Objectives

To define the required information for groundwater indicator evaluation monitoring, the data quality objectives (DQO) process is used to ensure that data gathered are of the appropriate quantity and quality to meet specific objectives. The DQOs for the groundwater quality assessment at WMA TX-TY are presented in PNNL-16005.

The current groundwater monitoring network for WMA TX-TY is a result of previous investigations and DQO processes. Assessment monitoring is now ongoing at the WMA in accordance with interim status regulations. Table 2-2 provides a matrix of data requirements that are typically determined by the DQO process, the associated interim status regulations applicable to these requirements, and the current and historical documentation specifying how the monitoring program for WMA TX-TY complies with the requirements.

**Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA TX-TY**

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|
| Scope | **40 CFR 265; incorporated by reference in WAC 173-303-400(3)(a), as modified by WAC 173-303-400(3)(b) and WAC 173-303-400(3)(c)(v)(E).**<br>**40 CFR 265.93, "Preparation, Evaluation, and Response."**<br>(d)(7) If the owner or operator determines…that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator:<br>(i) Must continue to make the determinations required under paragraph (d)(4) of this section…<br>**40 CFR 265.93, Preparation, Evaluation, and Response."**<br>(d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine:<br>(i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and<br>(ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water.<br>**40 CFR 265.93, "Preparation, Evaluation, and Response."**<br>(d)(3) The plan to be submitted under 40 CFR 265.90(d)(1) or paragraph (d)(2) of this section must specify:<br>(i) The number, location, and depth of wells;<br>(ii) Sampling and analytical methods for those hazardous wastes or hazardous waste constituents in the facility;<br>(iii) Evaluation procedures, including any use of previously gathered ground-water quality information; and<br>(iv) A schedule of implementation. | This plan, Sections 3.1 and 3.2, Chapter 4, and Appendix A<br><br>PNNL-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY* |

**Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA TX-TY**

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|
| Number and location of wells<br>Point(s) of compliance | **40 CFR 265.93, "Preparation, Evaluation, and Response."**<br>(d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine:<br>(i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and<br>(ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water. | This plan, Chapters 1 and 3, and Appendix A<br><br>PNNL--16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY* |
| Well configuration (depth and length of screened interval; well construction) | **40 CFR 265.91, "Ground-Water Monitoring System."**<br>(c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary; to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water.<br>**Additional Requirements from WAC 173-303-400(3)(c)(v)(C).**<br>Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground water contamination. WAC 173-160 may be used as guidance in the installation of wells. | This plan, Section 3.2 and Appendix A<br><br>PNNL-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY* |
| Frequency of sampling<br>Types of analysis or measurement<br>Method detection limits or accuracy and precision<br>Methods used to evaluate the collected data | **40 CFR 265.93, "Preparation, Evaluation, and Response."**<br>(d)(7) If the owner or operator determines…that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator:<br>(i) Must continue to make the determinations required under paragraph (d)(4) of this section <u>on a quarterly basis</u> until final closure of the facility, if the ground-water quality assessment plan was implemented prior to final closure of the facility; or<br>(ii) May cease to make the determinations required under paragraph (d)(4) of this section, if the ground-water quality assessment plan was implemented during the post-closure care period. | This plan, Section 3.1, Chapter 4, and Appendix A<br><br>PNNL-16005, *RCRA Assessment Plan for Single-Shell Tank Waste management Area TX-TY* |

**Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA TX-TY**

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|
| | **40 CFR 265.93, "Preparation, Evaluation, and Response."**<br>(d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) *[see scope in first row of this table]* of this section, and, at a minimum, determine:<br>(i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and<br>(ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water. | |

Notes: The references cited in this table are listed in the reference section (Chapter 5) of this plan.

# 3 Groundwater Monitoring Program

This chapter lists the wells monitored, constituents analyzed, and sampling frequency for WMA TX-TY. The quality assurance and quality control requirements are provided in the QAPjP (Appendix A).

## 3.1 Constituent List and Sampling Frequency

The constituent list for groundwater sampling consists of RCRA-regulated analytes that may be present in SST waste. To identify these analytes, the list of primary nonradiological constituents potentially present in SST waste (RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*) was compared to those constituents listed in Appendix 5 of Ecology Publication 97-407 (*Chemical Testing Methods for Designating Dangerous Waste: WAC 173-303-090 & -100*), which references 40 CFR 264, Appendix IX ("Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring List"). Those constituents identified in RPP-23403 that are RCRA-regulated (i.e., listed in Appendix 5 of Ecology Publication 97-407) are included in Table 3-1.

**Table 3-1. RCRA-Regulated Constituents Potentially Present in the Single-Shell Tank Farm System**

| Constituent | CAS ID | Constituent | CAS ID |
|---|---|---|---|
| **Volatile Organic Compounds** | | | |
| 1,1,1-Trichloroethane | 71-55-6 | Chloroform | 67-66-3 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | Ethylbenzene | 100-41-4 |
| 1,1,2-Trichloroethane | 79-00-5 | Isobutanol | 78-83-1 |
| 1,1-Dichloroethene | 75-35-4 | Methylene chloride | 75-09-2 |
| 1,2-Dichloroethane | 107-06-2 | Tetrachloroethene | 127-18-4 |
| 2-Butanone (methyl ethyl ketone) | 78-93-3 | Toluene | 108-88-3 |
| 2-Propanone (acetone) | 67-64-1 | trans-1,3-Dichloropropene | 10061-02-6 |
| 4-Methyl-2-pentanone (MIBK) | 108-10-1 | Trichloroethylene (TCE) | 79-01-6 |
| Benzene | 71-43-2 | Trichlorofluoromethane | 75-69-4 |
| Carbon disulfide | 75-15-0 | Vinyl chloride (chloroethene) | 75-01-4 |
| Carbon tetrachloride | 56-23-5 | Xylenes | 1330-20-7 |
| Chlorobenzene | 108-90-7 | | |
| **Semivolatile Organic Compounds** | | | |
| 1,2,4-Trichlorobenzene | 120-82-1 | Aroclor 1260 | 11096-82-5 |
| 2,4,5-Trichlorophenol | 95-95-4 | Butylbenzylphthalate | 85-68-7 |
| 2,4,6-Trichlorophenol | 88-06-2 | Di-n-butylphthalate | 84-74-2 |
| 2,4-Dinitrotoluene | 121-14-2 | Di-n-octylphthalate | 117-84-0 |

**Table 3-1. RCRA-Regulated Constituents Potentially Present in the Single-Shell Tank Farm System**

| Constituent | CAS ID | Constituent | CAS ID |
|---|---|---|---|
| 2-Chlorophenol | 95-57-8 | Fluoranthene | 206-44-0 |
| 2-Methylphenol (o-cresol) | 95-48-7 | Hexachlorobutadiene | 87-68-3 |
| 3-Methylphenol (m-Cresol) | 108-39-4 | Hexachloroethane | 67-72-1 |
| 4-Chloro-3-methylphenol (p-Chloro-m-cresol) | 59-50-7 | Naphthalene | 91-20-3 |
| 4-Methylphenol (p-cresol) | 106-44-5 | Nitrobenzene | 98-95-3 |
| Acenaphthene | 83-32-9 | n-Nitroso-di-n-propylamine | 621-64-7 |
| Aroclor 1016 | 12674-11-2 | n-Nitrosomorpholine | 59-89-2 |
| Aroclor 1221 | 11104-28-2 | 1,2-Dichlorobenzene (o-Dichlorobenzene) | 95-50-1 |
| Aroclor 1232 | 11141-16-5 | 2-Nitrophenol (o-Nitrophenol) | 88-75-5 |
| Aroclor 1242 | 53469-21-9 | Pyrene | 129-00-0 |
| Aroclor 1248 | 12672-29-6 | Pyridine | 110-86-1 |
| Aroclor 1254 | 11097-69-1 | | |
| **Inorganic Constituents (Nonradiological)** | | | |
| Antimony (Sb) | 7440-36-0 | Mercury (Hg) | 7439-97-6 |
| Arsenic (As) | 7440-38-2 | Nickel (Ni) | 7440-02-0 |
| Barium (Ba) | 7440-39-3 | Selenium (Se) | 7782-49-2 |
| Beryllium (Be) | 7440-41-7 | Silver (Ag) | 7440-22-4 |
| Cadmium (Cd) | 7440-43-9 | Sulfide ($S^{2-}$) | 18496-25-8 |
| Chromium (Cr) | 7440-47-3 | Thallium (Tl) | 7440-28-0 |
| Cobalt (Co) | 7440-48-4 | Vanadium (V) | 7440-62-2 |
| Copper (Cu) | 7440-50-8 | Zinc (Zn) | 7440-66-6 |
| Cyanide ($CN^-$) | 57-12-5 | | |
| Lead (Pb) | 7439-92-1 | | |

Notes: This table lists the primary nonradiological constituents provided in RPP-23403 that are regulated by RCRA (i.e., also listed in Appendix 5 of Ecology Publication 97-407).

One of the 72 analytes listed in Table 3-1, chromium, has been found in groundwater and is attributed to releases from the WMA only; in addition, nitrate is present in groundwater and a portion is attributed to WMA TX-TY (see Section 2.5.1). Carbon tetrachloride and TCE are also found in the groundwater but originate from waste sites associated with the PFP. Thus, chromium and the supporting constituents

alkalinity, nitrate, major cations (metals), and major anions are routinely sampled for RCRA in the network monitoring wells (Table 3-2). The supporting constituents provide information on general chemistry and allow for charge-balance computations to assess laboratory performance.

Sampling for the remaining constituents identified in Table 3-1 will be performed once during the first available sample event after this plan is in effect to determine if these constituents have impacted groundwater quality. Sampling will be performed in the recent historical upgradient and near-field downgradient monitoring wells (Table 3-2). The constituents not detected in groundwater will be removed from future sampling. If an organic constituent from Table 3-1 is detected in a groundwater sample and it is not attributed to contamination from another facility (e.g., carbon tetrachloride from the PFP), a confirmation sample will be collected at the next scheduled sample event, with split samples sent to different analytical laboratories. If the detection is confirmed by positive results from both laboratories, the constituent will be added to the list of analytes for routine sampling to evaluate the extent of contamination. If the detection is not confirmed, the analyte will be removed from future sampling.

Some of the inorganic constituents included in Table 3-1 occur naturally in groundwater (e.g., barium, selenium, vanadium, and zinc). Detections of an inorganic constituent will be evaluated to determine if the constituent is present naturally by comparison to sample results from the upgradient wells and comparisons to Hanford Site background values (DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*). If it is determined that an inorganic constituent may be present as a contaminant from the WMA, confirmation samples will be collected (as described for the organic constituents). If contamination is confirmed, then the constituent will be added to the routine sample list to evaluate the extent of contamination. If the contamination is not confirmed, the constituent will be removed from future sampling.

## 3.2 Monitoring Well Network

Figure 3-1 shows the groundwater monitoring well network for WMA TX-TY. Table 3-2 lists the wells in the groundwater monitoring network, including the constituents and sampling frequency. Some of the wells in the WMA TX-TY monitoring network are also sampled for the 200-ZP-1 OU. Sampling for WMA TX-TY and the 200-ZP-1 OU is coordinated to eliminate duplicate analyses and well trips. Wells are to be sampled quarterly or semiannually each year. Maintenance problems and sampling logistics sometimes delay scheduled sampling events. If a sampling event is delayed more than 6 weeks, that sample may be cancelled because it is nearly time for the next quarterly sampling.

Table 3-2 indicates the purpose of each well and whether the wells meet WAC requirements. Table 3-3 summarizes well construction information, including the current (March 2010) water table elevations in each well. As-built diagrams for the wells showing construction details are available in PNNL-16005. Wells installed since the 1980s are constructed to meet the requirements of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells." These wells have stainless-steel casing and screen, sand pack in the screened interval, and full annular seal above. Other wells in the network are much older and were installed before the requirements of WAC 173-160 were implemented. These wells have carbon-steel casings and perforated intervals rather than screens. In some cases, wells were later retrofit with annular seals at the surface. The use of the older wells permits continuity with historical data. Given the current rate of water table decline (0.3 to 0.4 m/yr [0.98 to 1.3 ft/yr]), well 299-W14-6 went dry in 2010, and well 299-15-41 will be dry in 2011 or 2012 (Table 3-3).

Table 3-2. Monitoring Network, Constituent List, and Sampling Frequency for WMA TX-TY

| Well Name | Purpose[a] | WAC-Compliant | Water Level[b] | RCRA Dangerous Constituents | Supporting Parameters | | | | Field-Measured Parameters | | | | | Table 3-1 Analytes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Hexavalent Chromium | Nitrate (Anions) | Metals, Unfiltered[c] | Anions[d] | Alkalinity | pH[b] | Specific Conductance[b] | Turbidity[b] | Temperature[b] | Dissolved Oxygen[b] | |
| 299-W10-26 | Downgradient | Y | Q | Q | SA | SA | SA | SA | Q | Q | Q | Q | Q | Once |
| 299-W10-27 | Downgradient | Y | Q | Q | SA | SA | SA | SA | Q | Q | Q | Q | Q | Once |
| 299-W14-11 | Downgradient | Y | Q | Q | SA | SA | SA | SA | Q | Q | Q | Q | Q | Once |
| 299-W14-13 | Downgradient | Y | Q | Q | SA | SA | SA | SA | Q | Q | Q | Q | Q | Once |
| 299-W14-14 | Downgradient | Y | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | Once |
| 299-W14-15 | Downgradient | Y | Q | Q | SA | SA | SA | SA | Q | Q | Q | Q | Q | Once |
| 299-W14-16 | Far-field[a] | Y | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | Once |
| 299-W14-17 | Far-field[a] | Y | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | Once |
| 299-W14-18 | Downgradient | Y | Q | Q | SA | SA | SA | SA | Q | Q | Q | Q | Q | Once |
| 299-W14-19 | Downgradient | Y | SA | SA | SA | A | SA | SA | SA | SA | SA | SA | SA | Once |
| ***299-W15-40*** | Upgradient | Y | NA[e] | Q | SA | SA | SA | SA | Q | Q | Q | Q | Q | Once |
| 299-W15-41 | Downgradient | Y | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | Once |
| 299-W15-44 | Downgradient | Y | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | Once |
| 299-W15-763 | Downgradient | Y | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | Once |
| ***299-W15-765*** | Upgradient | Y | NA[e] | Q | SA | SA | SA | SA | Q | Q | Q | Q | Q | Once |

**Table 3-2. Monitoring Network, Constituent List, and Sampling Frequency for WMA TX-TY**

| Well Name | Purpose[a] | WAC-Compliant | Water Level[b] | RCRA Dangerous Constituents | Supporting Parameters | | | | Field-Measured Parameters | | | | | Table 3-1 Analytes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Hexavalent Chromium | Nitrate (Anions) | Metals, Unfiltered[c] | Anions[d] | Alkalinity | pH[b] | Specific Conductance[b] | Turbidity[b] | Temperature[b] | Dissolved Oxygen[b] | |

Notes:

1. Bold/italic print indicates upgradient monitored extraction wells.
2. Abbreviations in this table include the following:
   - A = to be sampled annually (performed in November)
   - Q = to be sampled quarterly
   - SA = to be sampled semiannually

a. Far-field wells are wells located farther downgradient and used to determine lateral extent of contamination.

b. Field measurement.

c. Metals; analytes include, but are not limited to, aluminum, chromium, sodium, magnesium, potassium, and calcium.

d. Anions; analytes include, but are not limited to, nitrate, chloride, sulfate, and fluoride.

e. Water levels are not measured in extraction wells.

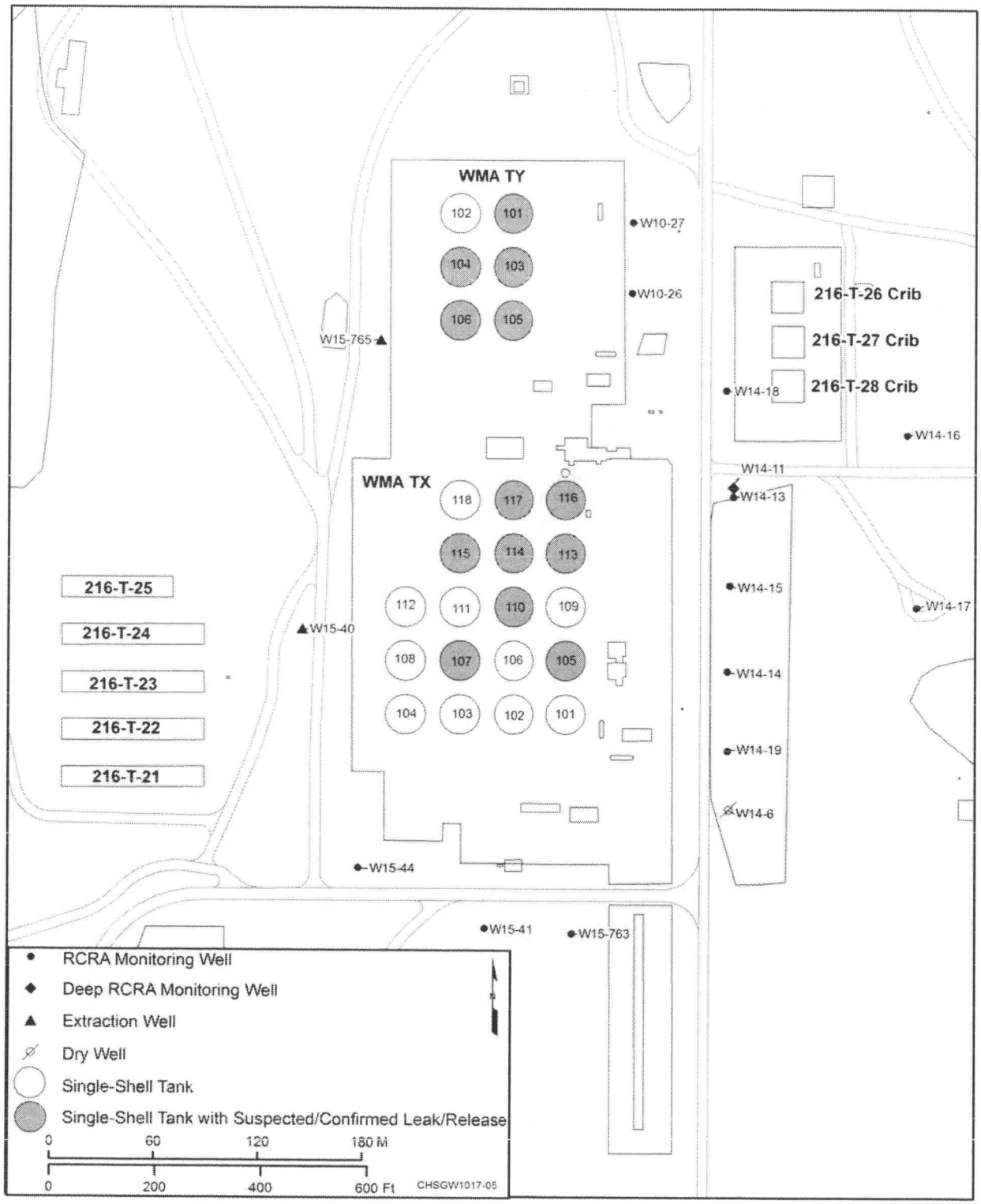



**Figure 3-1. General Layout of WMA TX-TY, Including Locations of Nearby Past-Practice Facilities and Monitoring Wells**

**Table 3-3. WMA TX-TY Well Depths and Water Table Elevations**

| Well Name | Completion Date | Surface Elevation NAVD88, amsl (m) | Water Table Elevation (m), March 2010 | Open Interval Bottom Elevation (m) | Water Column (m), March 2010 |
|---|---|---|---|---|---|
| 299-W10-26 | 1998 | 204.63 | 134.26 | 127.78 | 6.48 |
| 299-W10-27 | 2001 | 204.90 | 134.22 | 126.90 | 7.32 |
| 299-W14-11 | 2005 | 203.00 | 134.21 | 120.20 | 14.01 |
| 299-W14-13 | 1998 | 204.35 | 134.22 | 127.62 | 6.60 |
| 299-W14-14 | 1998 | 204.62 | 134.20 | 127.81 | 6.39 |
| 299-W14-15 | 2000 | 204.58 | 134.15 | 126.97 | 7.18 |
| 299-W14-16 | 2000 | 205.37 | 134.19 | 126.77 | 7.42 |
| 299-W14-17 | 2000 | 205.08 | 134.10 | 126.76 | 7.34 |
| 299-W14-18 | 2000 | 204.26 | 134.23 | 127.13 | 7.10 |
| 299-W14-19 | 2002 | 204.90 | 134.28 | 126.11 | 8.18 |
| ***299-W15-40*** | 1998 | 205.06 | NA | 127.92 | NA |
| 299-W15-41 | 1999 | 202.79 | 133.91 | 132.40 | 1.51 |
| 299-W15-44* | 2002 | 204.17 | 134.2 | 127.59 | 6.51 |
| 299-W15-763 | 2001 | 202.18 | 133.98 | 126.95 | 7.03 |
| ***299-W15-765*** | 2001 | 204.51 | NA | 126.79 | NA |

Notes:

1. Bold/italic print indicates upgradient wells.

2. Used water level measurement taken during sampling after well was converted from extraction to monitoring well in August 2010.

* Water-level measurement used was from measurement taken during sampling after well was converted from extraction to monitoring well in August 2010.

Wells 299-W15-40 and 299-W15-765 were considered true upgradient monitoring wells prior to their conversion to pump-and-treat extraction wells in 2005. No other wells are currently upgradient for RCRA compliance. Due to fluctuating local groundwater gradients and flow directions, as well as capture zones created by extraction wells in the area, the addition or construction of compliant upgradient monitoring wells will be difficult. As previously discussed, the expansion of the 200-ZP-1 OU pump-and-treat system is scheduled for completion in 2011 or 2012. After the expanded pump-and-treat system is operational, the system will further impact the hydrologic conditions near WMA TX-TY.

It can be assumed that contamination upgradient of the WMA would be captured by the current extraction wells. Plumes localized to WMA TX-TY will either be captured by the current extraction wells or will continue to migrate via groundwater downgradient and be detected by the downgradient monitoring wells. This assumption will be part of the ongoing analysis of groundwater sampling data and

pump-and-treat system performance until data from the larger scale, expanded system can be analyzed once the system is operational.

## 3.3 Changes to Monitoring Plan

Several changes have been made to the sampling frequency at WMA TX-TY since the previous plan (PNNL-16005) was issued. Well 299-W14-6 has been removed from the network because became dry in 2010 due to decreasing water levels (Section 3.2). Hexavalent chromium analyses have been added quarterly or semiannually at all downgradient wells and semiannually to upgradient wells. This allows elimination of filtered metals analyses so only unfiltered metals will be sampled in the future. The sampling frequency for many constituents has been changed as follows:

- Former upgradient (west) wells 299-W15-40 and 299-W15-765 are no longer considered upgradient of the WMA. These wells are currently 200-ZP-1 OU pump-and-treat extraction wells and will remain on a quarterly sampling frequency.
- Near-field downgradient wells 299-W14-14 and 299-W14-19 have been changed from quarterly to semiannual sampling.
- Mid-field downgradient wells 299-W14-16 and 299-W14-17 have been changed from quarterly to semiannual sampling.
- Near-field downgradient wells 299-W15-41, 299-W15-44, and 299-W15-763 south of WMA TX-TY have been changed from quarterly to semiannual sampling.

Table 3-4 presents the sampling frequencies for all wells in the monitoring network and further describes the rationale for changes in frequency to applicable wells.

**Table 3-4. WMA TX-TY Monitoring Well Network Sample Frequencies**

| Well | Sample Frequency | Rationale |
|---|---|---|
| 299-W10-26, 299-W10-27, 299-14-11, 299-W14-13, 299-W14-15, and 299-14-18 | Quarterly | Near-field downgradient monitoring wells located within higher concentration areas of existing dangerous constituent chromium and supporting constituent nitrate (RCRA) contaminant plumes that have exhibited substantial constituent concentration variability. A quarterly frequency is needed to track concentration variations near edges of contaminant plumes. |
| 299-W14-14 and 299-W14-19 | Semiannually | Near-field downgradient monitoring wells located outside of higher concentration areas of RCRA contaminant plumes. |
| 299-W14-16 and 299-W14-17, | Semiannually | Far-field downgradient monitoring wells located outside RCRA contaminant plumes. |
| 299-W15-41, 299-W15-44, and 299-W15-763 | Semiannually | Near-field downgradient monitoring wells south of the WMA in low- to medium-concentration areas of existing RCRA contaminant plumes. |

**Table 3-4. WMA TX-TY Monitoring Well Network Sample Frequencies**

| Well | Sample Frequency | Rationale |
|---|---|---|
| ***299-W15-40*** and ***299-W15-765*** | Quarterly | Former upgradient wells previously monitored to establish background water quality conditions.<br>The wells are currently also used as extraction wells for the 200-ZP-1 OU pump-and-treat system and are sampled semiannually under CERCLA decision requirements (DOE/RL-2002-17). |

Notes: Bold/italic print indicates upgradient monitoring wells that have been converted to remedial extraction wells.

## 3.4 Sampling and Analysis Protocol

Sampling and analysis protocols at WMA TX-TY follow the conventions of the project and are described in the QAPjP (Appendix A).

# 4 Data Evaluation and Reporting

This chapter discusses data evaluation and reporting for WMA TX-TY.

## 4.1 Data Review

Data review, validation, and verification are discussed in the QAPjP in Appendix A.

## 4.2 Interpretation

After data are validated and verified, acceptable data are used to interpret groundwater conditions at WMA TX-TY. Interpretive techniques include the following:

- **Hydrographs:** Graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.
- **Water table maps:** Use water table elevations from multiple wells to construct contour maps and to estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential.
- **Trend plots:** Graph concentrations of constituents versus time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water table maps to determine if concentrations relate to changes in water level or in groundwater flow directions.
- **Plume maps:** Map distributions of chemical constituent concentrations in the aquifer to determine extent of contamination. Changes in plume distribution over time assist in determining plume movement and direction of groundwater flow.
- **Contaminant ratios:** Can sometimes be used to distinguish among different sources of contamination.

## 4.3 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements include an annual evaluation of the monitoring well network to determine if it remains adequate to monitor the WMA. The groundwater flow direction beneath WMA TX-TY is variable, depending on the location and proximity to extraction wells.

Water-level measurements will continue to be collected before each sampling event, and more comprehensive measurements will continue to be made in the northern portion of the 200 West Area in March of each year. The measurements are corrected, if needed, to account for borehole deviation from vertical, and the resulting data are plotted on a map. The data are presented in the annual Hanford Site groundwater monitoring report (e.g., DOE/RL-2010-11).

Well 299-W14-6 went dry in 2010 and has been removed from the network. Most other wells in the WMA TX-TY monitoring network are not expected to go dry for several years; however, well 266-W15-41 has less than 2 m (6.6 ft) of water remaining and may be dry for sampling purposes within 3 years. Impact from the expanded 200-ZP-1 OU pump-and-treat system may cause an increase in the rate of water-level declines in all wells, which will continue to be evaluated.

The RCRA monitoring will conduct assessment studies and create work plans to install new wells if necessary. Alternatives to new well construction include well network analysis using statistical methods to determine if new wells are needed to replace drywells. Well-deepening technical evaluations are

ongoing and recommendations are forthcoming. The 200-ZP-1 OU performance monitoring results and recommendations will be evaluated after the pump-and-treat system is operational.

Any new RCRA wells needed at WMA T will be negotiated and prioritized by Ecology, DOE, and EPA and approved under *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989) Milestone M-24-00.

## 4.4 Reporting and Notification

Results of assessment monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be in the annual Hanford Site groundwater monitoring report.

# 5 References

10 CFR 962, "Byproduct Material," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/10cfr962_10.html.

40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Appendix IX, "Ground-Water Monitoring List," *Code of Federal Regulations*. Available at: http://edocket.access.gpo.gov/cfr_2010/julqtr/40cfr264AppIX.htm.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/40cfr265_10.html.

265.90, "Applicability."

265.91, "Ground-Water Monitoring System."

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

Subpart F, "Ground-Water Monitoring."

51 FR 24504, 1986, "EPA Clarification of Regulatory Authority Over Radioactive Mixed Waste," *Federal Register*, July 3, 1986.

ARH-LD-136, 1976, *Geology of the 241-TX Tank Farm*, Informal Report, Atlantic Richfield Hanford Company, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=E0009072/

ARH-LD-137, 1976, *Geology of the 241-TY Tank Farm*, Informal Report, Atlantic Richfield Hanford Company, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=E0009073.

ARH-ST-156, 1977, *Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells: Volume I*, Atlantic Richfield Hanford Company, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D195064660.

*Atomic Energy Act of 1954*, 42 USC 2011, et seq. Available at: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf.

*Authorized State Hazardous Waste Programs*, 42 USC 6926, et seq. Available at: http://www.law.cornell.edu/uscode/42/6926.html.

*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

DOE/ORP-2008-01, 2008, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0808130005.

DOE/RL-91-61, 1992, *T Plant Source Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=D196124788.

DOE/RL-96-61, 1997, *Hanford Site Background: Part 3, Groundwater Background*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D197226378.

DOE/RL-2002-17, 2002, *Sampling and Analysis Plan for the 200-ZP-1 Groundwater Monitoring Well Network*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D9103853.

DOE/RL-2010-11, 2010, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0084237.

Ecology Publication 97-407, 2009, *Chemical Testing Methods for Designating Dangerous Waste: WAC 173-303-090 & -100*, Appendix 5, "Appendix IX of 40 CFR 264," Washington State Department of Ecology, Olympia, Washington. Available at: http://www.ecy.wa.gov/pubs/97407.pdf.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

GJO-97-13-TAR, 1998, *Hanford Tank Farms Vadose Zone – TX Tank Farm Report*, U.S. Department of Energy, Grand Junction Office, Grand Junction, Colorado.

GJO-97-13-TARA, 2000, *Hanford Tank Farms Vadose Zone – Addendum to the TX Tank Farm Report*, U.S. Department of Energy, Grand Junction Office, Grand Junction, Colorado.

GJO-97-30-TAR, 1998, *Hanford Tank Farms Vadose Zone – TY Tank Farm Report*, U.S. Department of Energy, Grand Junction Office, Grand Junction, Colorado.

GJO-97-30-TARA, 2000, *Hanford Tank Farms Vadose Zone – Addendum to the TY Tank Farm Report*, U.S. Department of Energy, Grand Junction Office, Grand Junction, Colorado.

HNF-2603, 1998, *A Summary and Evaluation of Hanford Site Tank Farm Subsurface Contamination*, Rev. 0, Lockheed Martin Hanford, Richland, Washington.

HNF-EP-0182, 2004, *Waste Tank Summary Report for Month Ending September 30, 2004*, Rev. 198, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D6698895.

PNL-8800, 1993, *Hanford Wells*, Pacific Northwest Laboratory, Richland, Washington. Available at: http://www.osti.gov/energycitations/servlets/purl/10105933-IDcUiY/native/10105933.pdf.

PNNL-11809, 1998, *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Areas T and TX-TY at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D198175199.

PNNL-12072, 2001, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D1665266.

PNNL-13378, 2001, *Results of Detailed Hydrologic Characterization Tests—Fiscal Year 1999*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13378.PDF.

PNNL-13514, 2001, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2000*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13514.pdf.

PNNL-14004, 2002, *RCRA Groundwater Quality Assessment Report for Single-Shell Tank Waste Management Area TX-TY (January 1998 Through December 2001)*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D2756624.

PNNL-14099, 2002, *Groundwater Conditions at Single-Shell Tank Waste Management Area TX-TY (January 1998 Through December 2001)*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D2756417.

PNNL-14113, 2002, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2001*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14113.pdf.

PNNL-14186, 2003, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2002*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14186.pdf.

PNNL-15837, 2007, *Data Package for Past and Current Groundwater Flow and Contamination Beneath Single-Shell Tank Waste Management Areas*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0911240061.

PNNL-15955, 2007, *Geology Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15955rev1.pdf.

PNNL-16005, 2007, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-16005.pdf.

PNNL-17348, 2008, *Results of Detailed Hydrologic Characterization Tests – Fiscal and Calendar Year 2005*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-17348.pdf.

PNNL-18279, 2009, *Aquifer Testing Recommendations for Well 299-W15-225: Supporting Phase 1 of the 200-ZP-1 Groundwater Operable Unit Remedial Design*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-18279.pdf.

RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*, Olympia, Washington. Available at: http://apps.leg.wa.gov/RCW/default.aspx?cite=70.105.

*Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://epw.senate.gov/rcra.pdf.

RPP-7123, 2001, *Subsurface Conditions Description of the T and TX-TY Waste Management Areas*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0911240297.

RPP-7218, 2000, *Preliminary Inventory Estimates for Single-Shell Tank Leaks in T, TX, and TY Tank Farms*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-23403, 2006, *Single-Shell Tank Component Closure Data Quality Objectives*, Rev. 3, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-23405, 2006, *Tank Farm Vadose Zone Contamination Volume Estimates*, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0911240667.

RPP-23748, 2006, *Geology, Hydrogeology, Geochemistry, and Mineralogy Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*, Rev. 0, CH2M HILL Hanford Group, Inc, Richland, Washington.

RPP-23752, 2005, *Field Investigation Report for Waste Management Areas T and TX-TY*, Rev. 0-A, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at:
http://www5.hanford.gov/arpir/?content=findpage&AKey=1001051156.
http://www5.hanford.gov/arpir/?content=findpage&AKey=1001051157.
http://www5.hanford.gov/arpir/?content=findpage&AKey=0911240516.

RPP-26744, 2005, *Hanford Soil Inventory Model, Rev. 1*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-RPT-38320, 2008, *Surface Geophysical Exploration of the TX and TY Tank Farms at the Hanford Site*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-RPT-42296, 2010, *Hanford TY-Farm Leak Assessments Report*, Rev. 0, Washington River Protection Solutions, Richland, Washington.

WA7890008967, 2007, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste*, as amended, Washington State Department of Ecology, Richland, Washington. Available at: http://www.ecy.wa.gov/programs/nwp/piarchive12_07.htm#Hanfords_Site-wide_Permit.

WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-160.

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

303-400, "Interim Status Facility Standards."

WHC-MR-0132, 1990, *A History of 200 Area Tank Farms*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at:
http://www5.hanford.gov/arpir/?content=findpage&AKey=D196015712.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D196015715.

WHC-MR-0517, *Listed Waste History at Hanford Facility TSD Units*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://www.osti.gov/bridge/purl.cover.jsp;jsessionid=50C51B867565B8CB842258EE602E031F?purl=/341253-znDhFj/webviewable/

WHC-SD-EN-AP-012, 1989, *40 CFR 265 Interim-Status Ground-Water Monitoring Plan for the Single-Shell Tanks*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D195063122.

WHC-SD-EN-AP-012, 1991, *Interim Status Groundwater Monitoring Plan for the Single-Shell Tanks*, Rev. 1, Westinghouse Hanford Company, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196071250.

WHC-SD-EN-AP-132, 1993, *Interim-Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Areas T and TX-TY*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WRPS-0900388, 2009, *Interim Measures Maintenance Plan*, Rev. 2, Washington River Protection Solutions, Richland, Washington.

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# Quality Assurance Project Plan

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# Terms

| | |
|---|---|
| CRDL | contract-required detection limit |
| DOE | U.S. Department of Energy |
| DQO | data quality objective |
| DUP | laboratory matrix duplicate |
| EB | equipment blank |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| FTB | full trip blank |
| FXR | field transfer blank |
| GC | gas chromatography |
| HASQARD | *Hanford Analytical Services Quality Assurance Requirements Documents* |
| HEIS | Hanford Environmental Information System |
| IC | ion chromatography |
| ICP | inductively coupled plasma |
| ICP/MS | inductively coupled plasma/mass spectrometry |
| LCS | laboratory control sample |
| MB | method blank |
| MDA | minimum detectable activity |
| MDL | method detection limit |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| PCB | polychlorinated biphenyl |
| 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 |
| RPD | relative percent difference |
| RSD | relative standard deviation |
| SUR | surrogate |

| | |
|---|---|
| TOC | total organic carbon |
| TOX | total organic halides |
| TPA | *Hanford Federal Facility Agreement and Consent Order* |
| TSD | treatment, storage, and disposal |
| VOC | volatile organic compound |

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

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. Section 6.5 and 7.8 of the *Hanford Federal Facility Agreement and Consent Order* (TPA) (Ecology et al., 1989a), Attachment 2, "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 requirements (DOE/RL-96-68) 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 *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use* (ANSI/ASQ E4-2004). This QAPjP is divided into four sections (as 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, the participants understand the goals and the approaches used, and 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.

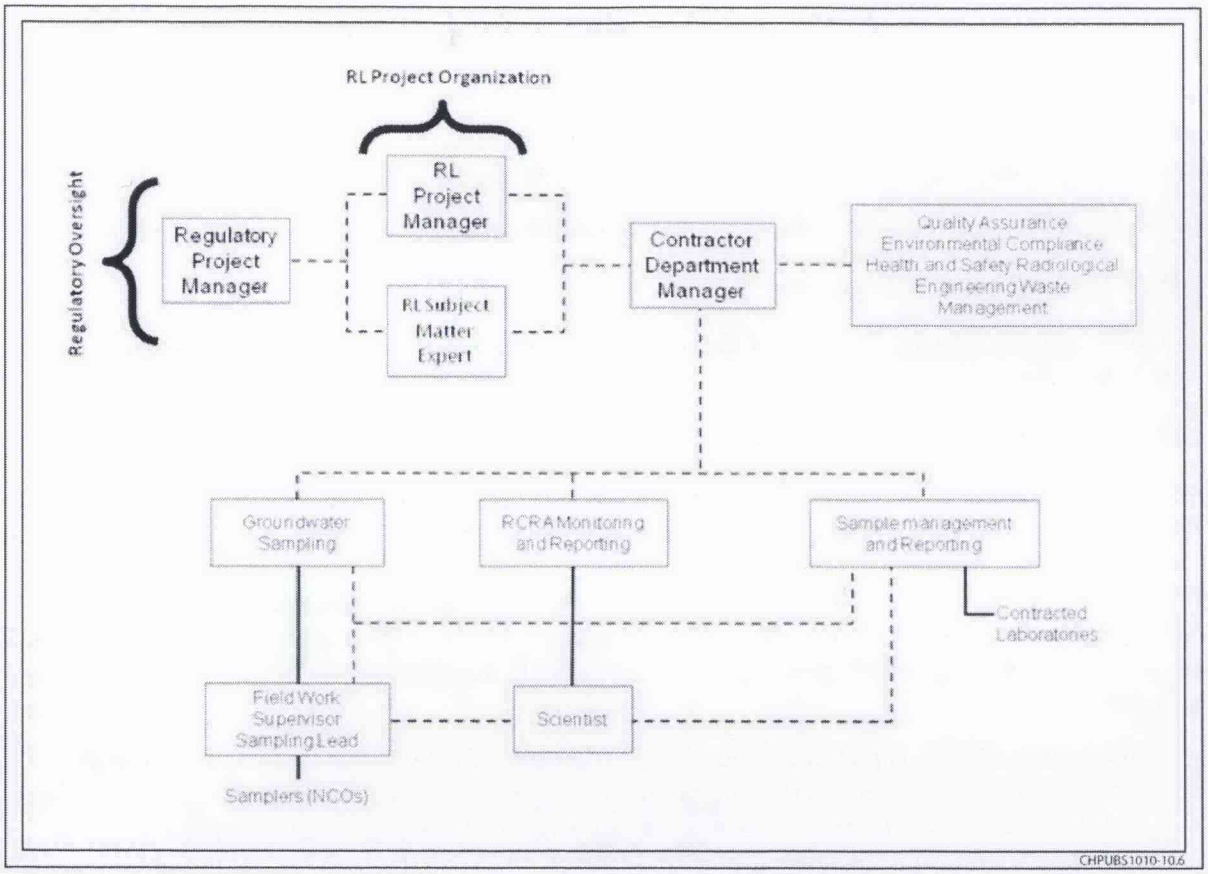


**Figure A-1. Project Organization**

### 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*; the *Resource Conservation and Recovery Act of 1976* (RCRA); the *Atomic Energy Act of 1954*; and the TPA (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 workscope, 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 regulatory agencies, 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 in accordance with corresponding standard procedures and work packages. The samplers also complete field logbooks 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 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 impacts.

### 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, Subpart F ("Interim Status Standards for Owners and

Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "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, and reporting.

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 for 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, "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 prior to implementation. Table A-1 defines the types of changes that may be made to the sampling design and 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 TPA (Ecology et al., 1989a) will be managed in accordance with the requirements therein.

The results of groundwater monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2010-11, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2*).

**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 impact 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 |

# 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 unit 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 impact 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] |
|---|---|---|---|
| **Metals Analyzed by ICP Method – Unfiltered** | | | |
| Calcium | P, $HNO_3$ to pH <2 | SW-846[d] Method 6010B/C, SW-846 Method 6020[e], or EPA/600 Method 200.8[e] | 1,000 |
| Chromium | | | 10 |
| Sodium | | | 500 |

**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] |
|---|---|---|---|
| Potassium | | | 4,000 |
| Magnesium | | | 750 |
| **Trace Metals – Unfiltered** | | | |
| Hexavalent chromium | G/P, cool to 4°C | SW-846 Method 7196 | 10 |
| **Anions by IC** | | | |
| Chloride | P | EPA/600 Method 300.0[f] | 200 |
| Fluoride | | | 500 |
| Nitrate | | | 250 |
| Sulfate | | | 500 |
| **Other** | | | |
| Alkalinity | G/P | Standard Method[g] 2320, EPA/600 Method 310.1 EPA/600 Method 310.2 | 5,000 |
| Conductivity, field | Field measurement | Instrument/meter | 1 µohm |
| Dissolved oxygen, field | Field measurement | Instrument/meter | 0 mg/L |
| pH, field measurement | Field measurement | Instrument/meter | 0.1 |
| Temperature | Field measurement | Instrument/meter | -- |
| Turbidity, field measurement | Field measurement | Instrument/meter | 0.1 NTU |

a. All samples will be collected in plastic (P) or glass (G) containers and will be cooled to 4°C 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 Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

e. SW-846 Method 6010 is the preferred method; however, Method 6020 or EPA/600 Method 200.8 may be used, as long as the method quantitation limit listed is met.

f. Analytical method adapted from Method 300.0 (EPA-600/4-84-017, *Test Methods for Determination of Inorganic Anions in Water by Ion Chromatography*).

g. *Standard Methods for the Examination of Water and Wastewater* (AWWA et al., 2005).

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Metals Analyzed by ICP Method — Unfiltered/Filtered** | | | |
| Barium | P, $HNO_3$ to pH <2 | SW-845[d] Method 6010B/C SW-846 Method 6020[e] or EPA/600 Method 200.8[f] | 20 |
| Beryllium | | | 5 |
| Cadmium | | | 5 |
| Chromium | | | 10 |
| Cobalt | | | 20 |
| Copper | | | 10 |
| Nickel | | | 40 |
| Silver | | | 10 |
| Vanadium | | | 25 |
| Zinc | | | 10 |
| **Trace Metals – Unfiltered/Filtered** | | | |
| Antimony | P, $HNO_3$ to pH <2 | SW-846 Method 6020 or EPA/600 Method 200.8 | 6 |
| Arsenic | | | 10 |
| Lead | | | 5 |
| Selenium | | | 10 |
| Thallium | | | 5 |
| **Trace Metals – Unfiltered/Filtered** | | | |
| Mercury | G, $HNO_3$ to pH <2 | SW-846 Method 7470A, EPA/600 Method 200.8 | 0.5 |
| **Volatiles by GC/MS** | | | |
| 1,1-Dichloroethene | G, no headspace | SW-846 Method 8260B | 10 |
| 1,1,1-Trichloroethane | | | 5 |
| 1,1,2,2-Tetrachloroethane | | | 5 |
| 1,1,2-Trichloroethane | | | 5 |
| 1,2-Dichloroethane | | | 5 |
| 2-Butanone (methyl ethyl ketone) | | | 10 |

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| 2-Propanone (acetone) | | | 20 |
| 4-Methyl-2-petanone (MIBK) | | | 10 |
| Benzene | | | 5 |
| Carbon disulfide | | | 5 |
| Carbon tetrachloride | | | 5 |
| Chlorobenzene | | | 5 |
| Chloroform | | | 5 |
| Ethylbenzene | | | 5 |
| Isobutanol | | | 500 |
| Methylene chloride | | | 5 |
| Tetrachloroethene | | | 5 |
| Toluene | | | 5 |
| trans-1,3-Dichloropropene | | | 5 |
| Trichloroethene | | | 5 |
| Trichlorofluoromethane | | | 10 |
| Vinyl chloride (chloroethene) | | | 10 |
| Xylenes | | | 10 |
| **Semivolatiles by GC/MS** | | | |
| 1,2-Dichlorobenzene (o-Dichlorobenzene) | Amber glass | SW-846 Method 8270D | 10 |
| 1,2,4-Trichlorobenzene | | | 10 |
| 2-Chlorophenol | | | 10 |
| 2-Methylphenol (o-cresol) | | | 10 |
| 2-Nitrophenol (o-Nitrophenol) | | | 20 |
| 2,4-Dinitrotoluene | | | 10 |
| 2,4,5-Trichlorophenol | | | 10 |
| 2,4,6-Trichlorophenol | | | 10 |

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| 3-Methylphenol (m-cresol) | | | 20 |
| 4-Chloro-3-methylphenol (p-Chloro-m-cresol) | | | 10 |
| 4-Methylphenol (p-cresol) | | | 10 |
| Acenaphthene | | | 10 |
| Butylbenzylphthalate | | | 10 |
| Di-n-butylphthalate | | | 10 |
| Di-n-octylphthalate | | | 10 |
| Fluoranthene | | | 10 |
| Hexachlorobutadiene | | | 10 |
| Hexachloroethane | | | 10 |
| n-Nitroso-di-n-propylamine | | | 10 |
| n-Nitrosomorpholine | | | 10 |
| Naphthalene | | | 10 |
| Nitrobenzene | | | 10 |
| Pyrene | | | 10 |
| Pyridine | | | 20 |
| **PCBs** | | | |
| Aroclor 1016 | | | 0.5 |
| Aroclor 1221 | | | 0.5 |
| Aroclor 1232 | | | 0.5 |
| Aroclor 1242 | G | SW-846 Method 8082 | 0.5 |
| Aroclor 1248 | | | 0.5 |
| Aroclor 1254 | | | 0.5 |
| Aroclor 1260 | | | 0.5 |

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Other** | | | |
| Cyanide | P, NaOH to pH >12 | SW-846 Method 9012<br>Standard Method[f] 4500<br>EPA/600 Method 335.2 | 5 |
| Sulfide | G/P, 2 mL, 2N zinc acetate and NaOH pH >9, cool 4°C | Sulfides – 9030 | 500 |

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

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

c. Detection limit units.

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

e. SW-846 Method 6010 is the preferred method; however, Method 6020 or EPA/600 Method 200.8 may be used, as long as the method quantitation limit listed is met.

f. *Standard Methods for the Examination of Water and Wastewater* (AWWA et al., 2005).

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 impacts 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 (EBs). Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table A-4.

### 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.

**Table A-4. Quality Control Samples**

| Sample Type | Primary Characteristics Evaluated | Frequency |
|---|---|---|
| **Field QC** | | |
| Full trip blank (FTB) | Contamination from containers or transportation | One per 20 well trips |
| Field transfer blank (FXR) | Contamination from sampling site | One each day; VOCs sampled |
| Equipment blank (EB) | Contamination from non-dedicated equipment | As needed[a] |
| Replicate/duplicate sample | Reproducibility | One per 20 well trips |
| **Laboratory QC** | | |
| Method blank (MB) | Laboratory contamination | One per batch |
| Laboratory duplicate | Laboratory reproducibility | See footnote b |
| Matrix spike (MS) | Matrix effect and laboratory accuracy | See footnote b |
| Matrix spike duplicate (MSD) | Laboratory reproducibility/accuracy | See footnote b |
| Surrogate (SUR) | Recovery/yield | See footnote b |
| Laboratory control sample (LCS) | Method accuracy | One per batch |

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

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

Full trip blanks (FTBs) are prepared by the sampling team prior to 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 (VOCs) only. The FXRs are used to evaluate potential contamination caused by conditions in the field.

The 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 (MDL) 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 MDL.

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 (RPD). Only field duplicates with at least one result greater than five times the MDL or minimum detectable activity (MDA) 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 [MBs], laboratory control samples [LCSs]/blank spikes, and MSs) are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, 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 concentration limit determined for Hanford Site groundwater. 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.

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 *Methods of Chemical Analysis of Water and Wastes* (EPA/600/4-79/020). 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.

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

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| **General Chemical Parameters** | | | |
| Alkalinity<br>Conductivity<br>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" |

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

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| **Ammonia and Anions** | | | |
| Anions by IC<br>Cyanide<br>Sulfide | 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" |
| **Metals** | | | |
| Arsenic<br>Cadmium<br>Chromium<br>Lead<br>Mercury<br>Selenium<br>Thallium<br>ICP metals<br>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" |
| **VOCs** | | | |
| Volatiles by GC/MS | 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" |

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

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| **Semi-VOCs** | | | |
| PCBs by GC<br>Phenols by GC<br>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 TOC and TOX 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.

Data flags:

B, C = possible laboratory contamination (analyte was detected in the associated MB)

N = result may be biased (associated MS 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 (%) | Precision (% RSD)* |
|---|---|---|---|
| Fluoride | Quarterly | ±25% | ≤25% |
| Nitrate | Quarterly | ±25% | ≤25% |
| Chromium | Annually | ±20% | ≤25% |

* 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.

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 the 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 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 prior to 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 *Hanford Federal Facility Agreement and Consent Order 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 (provided in Section A2.5) 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.

# A5 References

10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*. Available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&rgn=div6&view=text&node=10:4.0.2.5.26.1&idno=10.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/40cfr265_10.html.

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

Subpart F, "Ground-Water Monitoring."

ANSI/ASQ E4-2004, 2004, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use*, American National Standards Institute/American Society for Quality, Milwaukee, Wisconsin.

*Atomic Energy Act of 1954*, 42 USC 2011, et seq. Available at: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf.

AWWA, APHA, and WEF, 2005, *Standard Methods for the Examination of Water and Wastewater*, 21st ed., American Water Well Association, Denver, Colorado; American Public Health Association, Washington, D.C.; and Water Environment Federation, Alexandria, Virginia.

*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

DOE O 414.1C, 2005, *Quality Assurance*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/current-directives/414.1-BOrder-c/view.

DOE/RL-96-68, 2007, *Hanford Analytical Services Quality Assurance Requirements Documents*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/orp/?page=141&parent=14.

DOE/RL-2010-11, 2010, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1989a, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

Ecology, EPA, and DOE, 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=82.

EPA/240/B-01/003, 2001, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/QUALITY/qs-docs/r5-final.pdf.

EPA-600/4-79/020, *Methods of Chemical Analysis of Water and Wastes*, U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196018581.

EPA-600/4-84-017, 1984, *Test Methods for Determination of Inorganic Anions in Water by Ion Chromatography*, Method 300.0, U.S. Environmental Protection Agency, Washington, D.C.

*Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://epw.senate.gov/rcra.pdf.

SW-846, 2007, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, as amended, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm.

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

303-330, "Personal Training."

303-400, "Interim Status Facility Standards."

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# Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area S-SX

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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# Executive Summary

Waste Management Area (WMA) S-SX, which incorporates the S and SX Tank Farms, is regulated under Washington State's "Hazardous Waste Management Act" (RCW 70.105) and its implementing requirements in WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards." The Washington State Department of Ecology (Ecology) has been authorized by the U.S. Environmental Protection Agency, in accordance with *Authorized State Hazardous Waste Programs*, to conduct its hazardous waste regulatory program in lieu of the *Resource Conservation and Recovery Act of 1976* (RCRA), including the requirements in 40 CFR 265, Subpart F ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring"). The WMA S-SX is also subject to the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989), with Ecology identified as the lead regulatory agency for the unit.

The WMA S-SX was placed in assessment monitoring in 1996 because of elevated specific conductance, and a groundwater quality assessment plan was implemented (WHC-SD-EN-AP-191, *Assessment Groundwater Monitoring Plan for Single Shell Tank Waste Management Area S-SX*). An assessment report of the initial findings was issued in January 1998 (PNNL-11810, *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Area S-SX at the Hanford Site*), which concluded that multiple source locations exist in the WMA to explain the observed spatial and temporal groundwater contamination patterns.

The assessment plan was updated in 1999 (PNNL-12114, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area S-SX at the Hanford Site*) for continued RCRA groundwater quality assessment, as required by 40 CFR 265.93 ("Preparation, Evaluation, and Response"). Four subsequent interim change notices were issued to PNNL-12114 to address changes to the monitoring well network.

This document supersedes PNNL-12114, includes information from previous routine quarterly groundwater monitoring at WMA S-SX, and updates the groundwater monitoring project management organization.

The plan describes the WMA S-SX facility and operating history, waste characteristics, hydrogeology, previous monitoring at the WMA, groundwater and vadose zone

contamination associated with the WMA, and the conceptual model for the WMA. The plan addresses the following:

- Adequacy of the wells monitoring groundwater at WMA S-SX
- Sampling requirements and schedule
- Analytes, groundwater parameters, and analytical methods necessary to determine extent of contamination from WMA S-SX
- Procedures for evaluating groundwater quality data
- Reporting requirements

This assessment plan is the principal controlling document for conducting groundwater monitoring at WMA S-SX.

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# Terms

| | |
|---|---|
| CAS | Chemical Abstracts Service |
| CERCLA | *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* |
| CY | calendar year |
| DOE | U.S. Department of Energy |
| DQO | data quality objective |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| ID | identification |
| N/A | not applicable |
| NAVD88 | North American Vertical Datum of 1988 |
| OU | operable unit |
| QAPjP | quality assurance project plan |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| SST | single-shell tank |
| WMA | waste management area |

# 1 Introduction

Since 1944, the Hanford Site's single-shell tanks (SSTs) have stored both radioactive and dangerous chemical waste generated from plutonium-production and separation activities. The 149 SSTs are recognized as dangerous waste management units and are regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA), RCW 70.105 ("Hazardous Waste Management"), and its implementing requirements (WAC 173-303, "Dangerous Waste Regulations"). Only dangerous chemical waste is regulated by RCRA; radioactive waste is regulated by the *Atomic Energy Act of 1954*.

Two SST farms in the 200 West Area, the S Tank Farm and the SX Tank Farm, comprise Waste Management Area (WMA) S-SX (Figure 1-1). A RCRA interim status detection groundwater monitoring program for the SSTs was implemented in 1989 (WHC-SD-EN-AP-012, *Interim Status Groundwater Monitoring Plan for the Single-Shell Tanks*), and monitoring began at WMA S-SX in 1990. The WMA was placed in assessment status monitoring in 1996 due to elevated specific conductance in downgradient monitoring wells (WHC-SD-EN-AP-191, *Assessment Groundwater Monitoring Plan for Single Shell Tank Waste Management Area S-SX*).

This document presents a revised groundwater assessment plan for WMA S-SX that supersedes the previous groundwater assessment plan (PNNL-12114, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area S-SX at the Hanford Site*) and four subsequent interim change notices. Background information is summarized in this document, and references are provided to other documents for additional detail.

The specific objective of this revised groundwater assessment plan is to fulfill the requirements specified in WAC 173-303-400(3) ("Interim Status Facility Standards"), incorporating by reference 40 CFR 265.93 ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Preparation, Evaluation, and Response"). These requirements specify that the concentration, rate, and extent of migration of dangerous waste constituents in the groundwater must be determined. To meet this objective, this plan defines a network of groundwater monitoring wells; specifies the sampling frequency; and lists the dangerous constituents, indicators, and supporting constituents to be monitored in groundwater. This monitoring plan has been prepared to be consistent, to the extent possible, with the final status monitoring plan that will be incorporated into the *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste* (WA7890008967, as amended) in the future.

Chapter 2 of this plan summarizes background information, including a description of the WMA and the types of waste present, a brief history of the groundwater monitoring program, and a description of the geology and hydrogeology of the area. This information is incorporated into the site conceptual model to assist in development of the groundwater monitoring program. Chapter 3 describes the RCRA groundwater monitoring program, including the wells monitored, sampling frequency and protocols, and the constituents analyzed. Chapter 4 describes data evaluation, interpretation, and reporting. A list of the references cited is provided in Chapter 5. Appendix A provides the quality assurance project plan (QAPjP), and Appendix B provides construction information for wells 299-W22-26 and 299-W22-89.

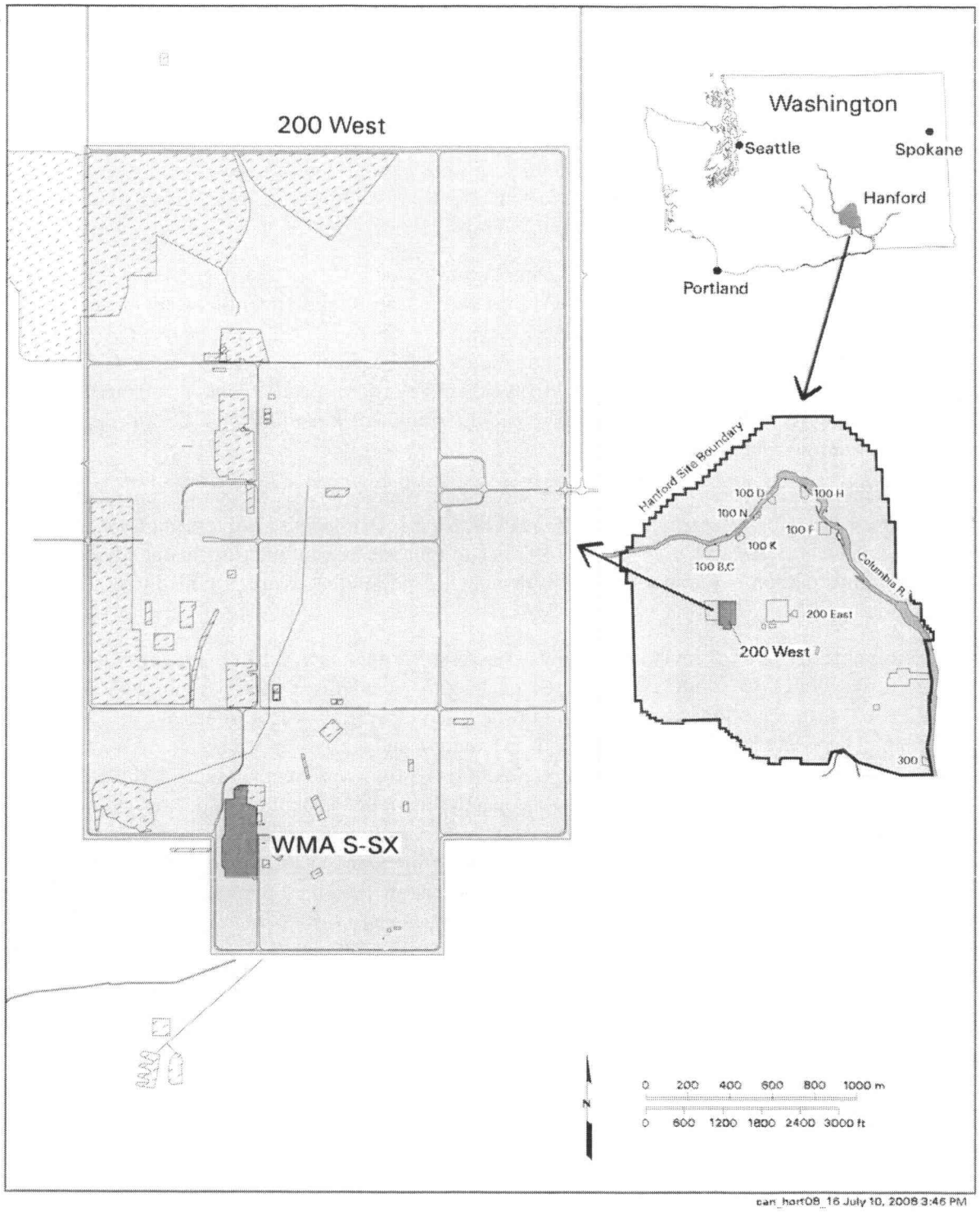


**Figure 1-1. Location of WMA S-SX**

# 2 Background

This chapter describes WMA S-SX, the regulatory requirements for groundwater monitoring, and waste characteristics. It also summarizes the hydrogeology beneath the WMA, outlines a conceptual model for contaminant migration, describes groundwater contamination in the uppermost aquifer, and addresses the data quality objectives (DQOs).

## 2.1 Facility Description and Operational History

The WMA S-SX consists of two tank farms: S Tank Farm and SX Tank Farm (Figure 2-1). The S Tank Farm consists of 12 tanks of 2.9 million L (758,000 gal) capacity each (total of 34.4 million L [9.1 million gal]), and the SX Tank Farm consists of 15 tanks with a capacity of 3.8 million L (1 million gal) each (total of 56.8 million L [15 million gal]) (RPP-7884, *Field Investigation Report for Waste Management Area S-SX*). The WMA also includes ancillary equipment consisting of three catch tanks, one receiver tank, six diversion boxes, associated piping, valve pits, and pumps (RPP-7884; DOE/RL-91-60, *S Plant Aggregate Area Management Study Report*). Both tank farms received waste generated from the reduction-oxidation process in the 1950s and 1960s.

One tank in the S Tank Farm (S-104) and 10 tanks in the SX Tank Farm (SX-104, and SX-107 through SX-115) are known or assumed to have experienced a leak/release (HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2009*, Rev. 261). To minimize future leaks/releases, all of the SSTs at the Hanford Site have been interim stabilized and the drainable liquid in each tank has been removed and transferred to double-shell tanks[1] (DOE/ORP-2008-01, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*). While this reduces the possibility of a future leak/release, releases may still be possible because some residual liquid generally remains in an interim-stabilized tank. Additional details on the operational history of the S and SX Tank Farms are provided in DOE/ORP-2008-01, as well as *Subsurface Conditions Description for the S-SX Waste Management Area* (HNF-4936) and *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Area S-SX at the Hanford Site* (PNNL-11810).

## 2.2 Regulatory Basis

In May 1987, the U.S. Department of Energy (DOE) issued a final rule (10 CFR 962, "Byproduct Material") stating that the hazardous waste components of mixed waste are subject to RCRA regulations. In November 1987, the U.S. Environmental Protection Agency (EPA) authorized the Washington State Department of Ecology (Ecology) to regulate these hazardous waste components within the state of Washington (51 FR 24504, "EPA Clarification of Regulatory Authority Over Radioactive Mixed Waste"). In 1996, the Washington State Attorney General determined that the effective date for regulation of mixed waste in Washington State was August 19, 1987.

Groundwater monitoring is conducted at WMA S-SX in accordance with WAC 173-303-400(3) and, by reference, 40 CFR 265, Subpart F ("Ground-Water Monitoring"), which requires monitoring to determine whether dangerous waste or dangerous waste constituents from the waste site have entered the groundwater. The WMA S-SX was placed in assessment monitoring (40 CFR 265.93[d][4]) after elevated concentrations of waste constituents and indicator parameter measurements (e.g., chromium and specific conductance) in downgradient monitoring wells were observed and confirmed.

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[1] A more precise definition of an interim stabilized tank is one that contains less than 189,000 L (50,000 gal) of drainable interstitial liquid and less than 18,900 L (5,000 gal) of supernatant (HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2009*, Rev. 261).

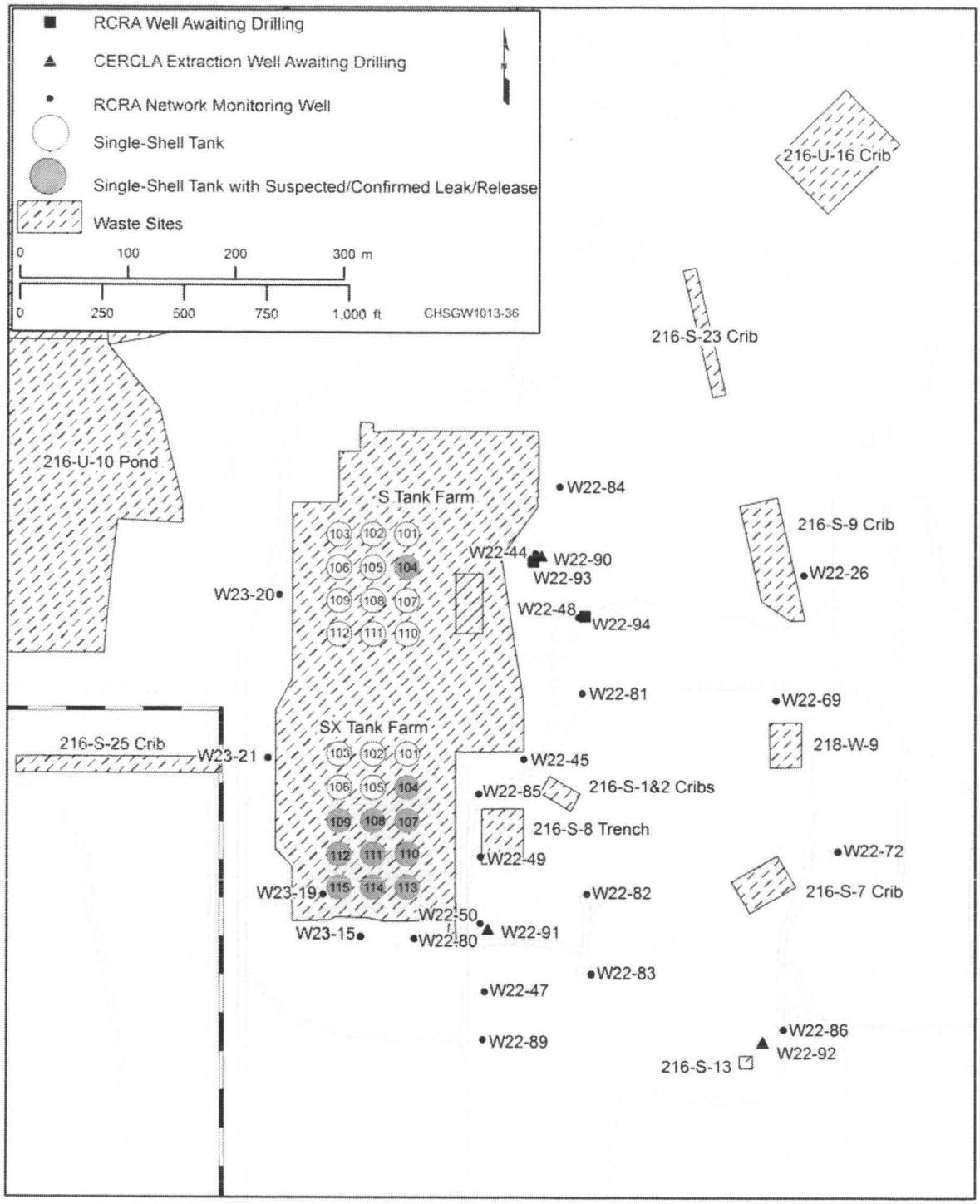


**Figure 2-1. WMA S-SX and Vicinity**

An assessment report of the initial findings was issued in January 1998 (PNNL-11810), which concluded that multiple source locations in the WMA exist to explain the observed spatial and temporal groundwater contamination patterns and that continued investigation was warranted, as required by 40 CFR 265.93(d)(7)(i). The investigation has continued under several updates to the monitoring plan, most recently in PNNL-12114-ICN-4.

## 2.3 Waste Characteristics

Table 2-1 lists the dangerous constituents found in the Dangerous Waste Permit Application Part A form (WA7890008967). Mobile tank waste constituents identified in the groundwater include nitrate and chromium (DOE/RL-2010-11, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2*).

**Table 2-1. Dangerous Wastes in the Single-Shell Tank System (Dangerous Waste Permit Application Part A Form)**

| Dangerous Waste Code | Contaminant Description | Dangerous Waste Code | Contaminant Description |
|---|---|---|---|
| D001 | Ignitable waste | D030 | 2,4-Dinitrotoluene |
| D002 | Corrosive waste | D033 | Hexachlorobutadiene |
| D003 | Reactive waste | D034 | Hexachloroethane |
| D004 | Arsenic | D035 | Methyl ethyl ketone |
| D005 | Barium | D036 | Nitrobenzene |
| D006 | Cadmium | D040 | Trichloroethylene |
| D007 | Chromium | D041 | 2,4,5-Trichlorophenol |
| D008 | Lead | D043 | Vinyl chloride |
| D009 | Mercury | F001 | 1,1,1-Trichloroethane |
| D010 | Selenium | F002 | Methylene chloride |
| D011 | Silver | F003 | Acetone, methyl isobutyl ketone |
| D018 | Benzene | F004 | Cresol-m, -o, -p |
| D019 | Carbon tetrachloride | F005 | Methyl ethyl ketone |
| D022 | Chloroform | WP01 | Extremely hazardous waste/ persistent dangerous waste |
| D028 | 1,2-Dichloroethane | WP02 | Dangerous waste/persistent dangerous waste |
| D038 | Pyridine | WT01 | Extremely hazardous waste/ toxic dangerous waste |
| D029 | 1,1-Dichloroethylene | WT02 | Dangerous waste/toxic dangerous waste |
| D039 | Tetrachloroethylene | | |

Notes:

1. This table is based on the Dangerous Waste Permit Application Part A form (WA789000896).
2. Analytes associated with the "F001" through "F005" waste codes are from WHC-MR-0517, *Listed Waste History at Hanford Facility TSD Units*.

## 2.4 Geology and Hydrology

The generalized stratigraphy of the Hanford Site is shown in Figure 2-2. The local stratigraphy beneath WMA S-SX consists of unconsolidated to semiconsolidated sediments overlying basalt bedrock of the Columbia River Basalt Group. The sedimentary units present, in descending sequence, include the following:

- Sand and gravel backfill
- Sand and gravel of the Hanford formation
- Fine-grained Cold Creek unit
- Sand and gravel of the Ringold Formation Unit E
- Fine-grained Ringold Formation lower mud unit
- Sand and gravel of Ringold Formation Unit A (which overlies the basalt)

Note that the Ringold Formation upper fines (member of Savage Island and member of Taylor Flat) are not present beneath the WMA. The water table occurs within the Ringold Formation Unit E, and the vadose zone beneath the WMA is approximately 68 m (223 ft) thick. The base of the aquifer is the fine-grained Ringold Formation lower mud unit. The water table elevation is approximately 135 m (443 ft) (North American Vertical Datum of 1988 [NAVD88]). The unconfined aquifer is approximately 70 m (230 ft) thick. A more detailed description of the geology of the WMA is provided in HNF-4936 and PNNL-12114. The *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington* (PNNL-13858) describes the hydrogeology of the entire 200 West Area and vicinity.

Figure 2-3 shows the March 2009 water table map for the WMA and vicinity. The groundwater flow direction is toward the east beneath the WMA at an average hydraulic gradient of $1.8 \times 10^{-3}$. The average flow direction beneath the S Tank Farm in the north is almost due east at approximately 85 degrees azimuth, while the average flow direction beneath the SX Tank Farm has a slightly more southerly component at approximately 100 degrees azimuth. Analysis of water-level data indicates that the groundwater flow rate beneath the WMA is between 4 and 104 m/yr (13 and 340 ft/yr) (depending on the hydraulic conductivity and effective porosity), with a best value of 33 m/yr (108 ft/yr) (average hydraulic conductivity of 6.1 m/d [20 ft/d] and effective porosity of 0.12 from constant-rate pumping tests). No significant difference exists in the hydraulic gradient magnitude between the S and SX Tank Farms. Since January 2004, water levels in the monitoring wells have been declining at rates from 0.21 to 0.27 m/yr (0.69 to 0.89 ft/yr), with an average decline of 0.25 m/yr (0.82 ft/yr). Analysis of periodic water-level measurements indicates that the hydraulic gradient magnitude and flow direction have been relatively stable since the late 1990s.

## 2.5 Summary of Previous Groundwater Monitoring

In 1996, the groundwater monitoring program for WMA S-SX was changed from indicator parameter evaluation to groundwater assessment because specific conductance in three downgradient monitoring wells exceeded the critical mean value. Results from the ensuing investigation concluded that waste from the WMA had entered and compromised groundwater quality (PNNL-11810; PNNL-13441, *RCRA Groundwater Quality Assessment Report for Waste Management Area S-SX [November 1997 through April 2000]*; and PNNL-13801, *Groundwater Quality Assessment Report for Waste Management Area S-SX [April 2000 through December 2001]*). Subsequent annual assessment results have been included in the Hanford Site annual groundwater reports (e.g., DOE/RL-2010-11).

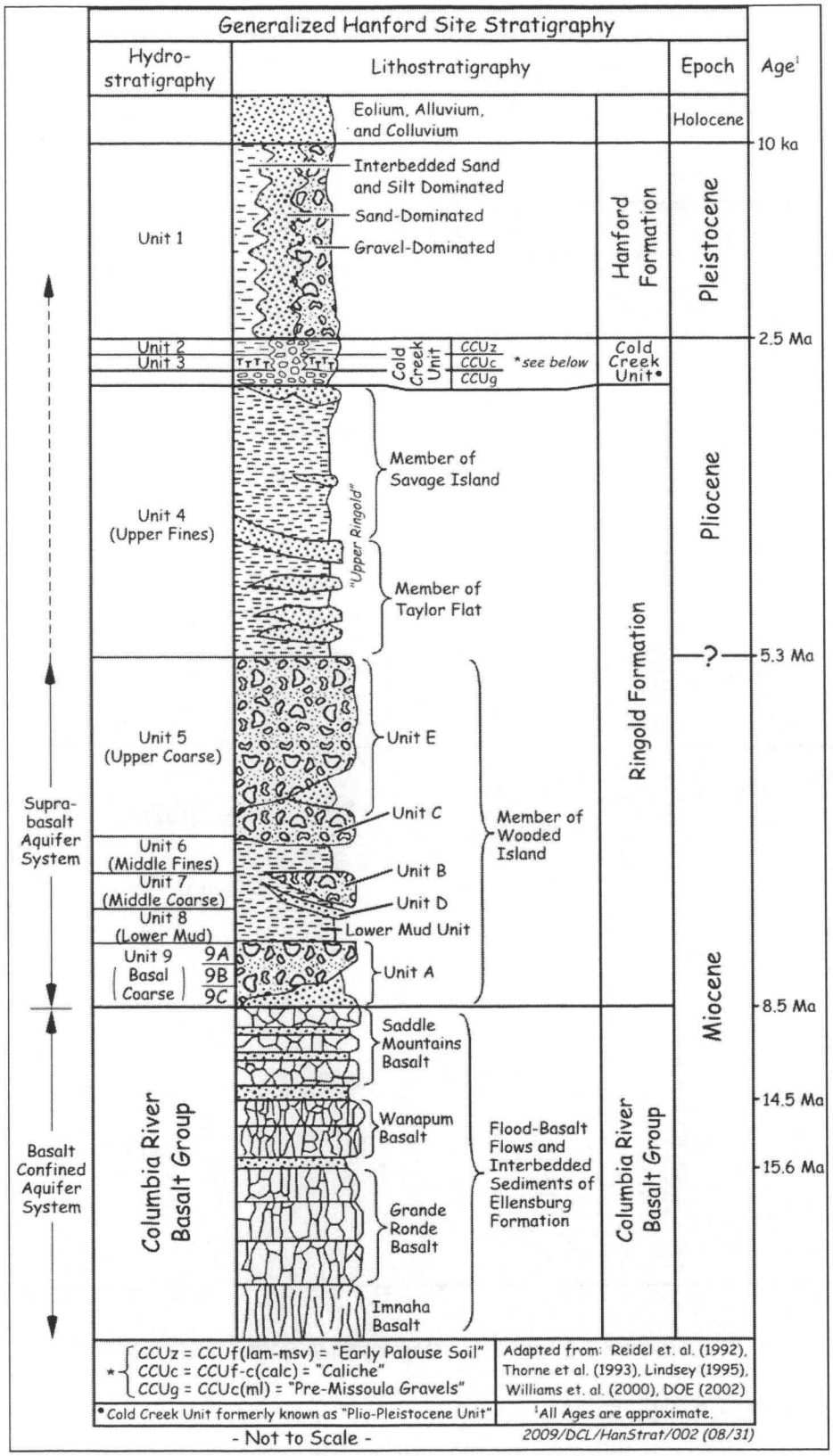


**Figure 2-2. Generalized Stratigraphy of the Hanford Site**

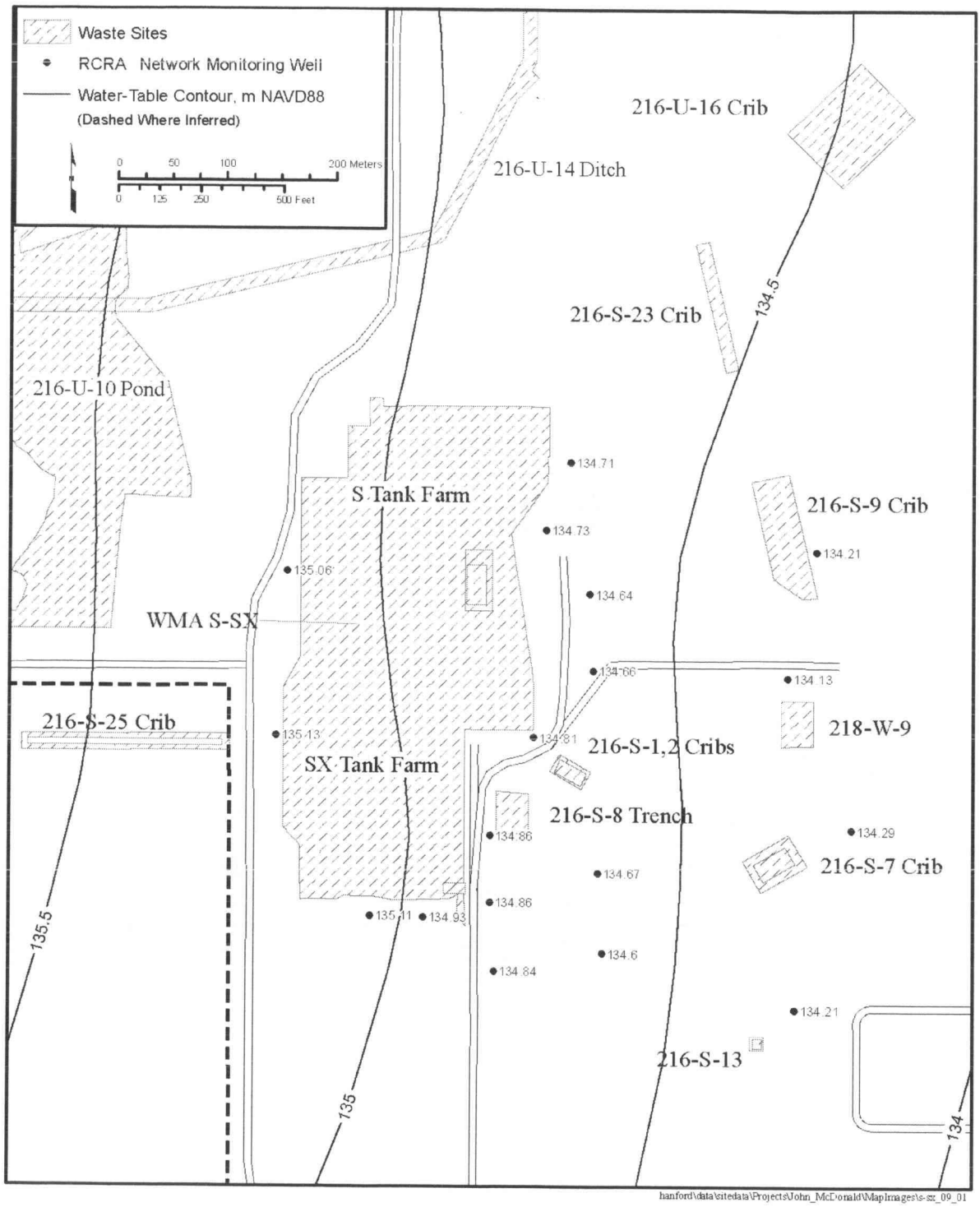


**Figure 2-3. Water Table Map for WMA S-SX, March 2009**

### 2.5.1 Groundwater Contamination

The following discussion is summarized from DOE/RL-2010-11 and represents the conditions present in calendar year (CY) 2009.

Groundwater beneath WMA S-SX is contaminated with nitrate and chromium, which are attributed to two general source areas within the WMA: (1) a source area in the S Tank Farm, and (2) a source area south in the SX Tank Farm. Nitrate contamination also has additional sources in the vicinity, most notably the 216-S-25 Crib. Chromium is the only constituent in groundwater listed in Ecology Publication 97-407, Appendix 5 (*Chemical Test Methods for Designating Dangerous Waste: WAC 173-303-090 & -100*, which references 40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Appendix IX, "Ground-Water Monitoring List") occurring in groundwater that likely originated from WMA S-SX. In the northern portion of the WMA, downgradient from the S Tank Farm, concentrations of the mobile tank waste constituents nitrate and chromium have increased substantially in well 299-W22-44 since late 2006 (Figure 2-4; see Figure 2-1 for well locations). At the end of CY 2009, the dissolved chromium concentration was 579 µg/L and nitrate was 276 mg/L. Concentrations of these constituents in the upgradient well for the S Tank Farm (299-W23-20) were either below the detection limit or well below drinking water standards, indicating that the tank farm is the source.

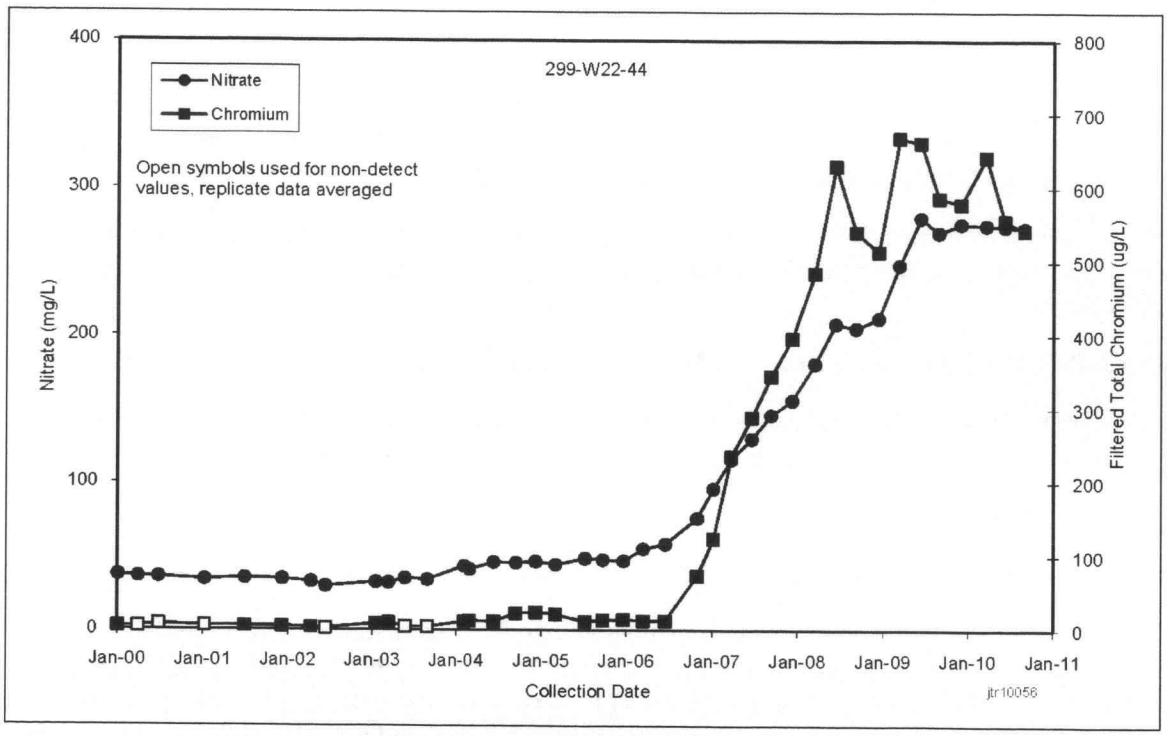


**Figure 2-4. Concentrations of the Nitrate and Dissolved Chromium in Well 299-W22-44, Downgradient from S Tank Farm**

Groundwater beneath the SX Tank Farm in the southern portion of the WMA is also contaminated with nitrate and chromium. The contaminated groundwater extends from the source area near well 299-W23-19 toward the east-southeast approximately 500 m (1,640 ft). Low-concentration areas occur in these plumes around wells 299-W22-80 and 299-W23-15. Concentrations of the major anions and cations in these wells are consistent with groundwater background and are not indicative of a raw water source diluting the aquifer. An in-well tracer test and time-series sampling during extensive purging at well 299-W22-80 indicated that relatively clean water may be migrating into the bottom of the well, moving up the wellbore, and diluting contaminant concentrations in the upper portion of the plume

(PNNL-15070, *Hanford Site Groundwater Monitoring for Fiscal Year 2004*). A similar process is assumed to be occurring at well 299-W23-15. During CY 2009, average concentrations in well 299-W23-19 were 480 mg/L for nitrate and 950 µg/L for dissolved chromium (DOE/RL-2010-11). Some of the nitrate originated from the 216-S-25 Crib. Both nitrate and chromium are migrating eastward, and the concentrations decline with distance from the source.

Other constituents are also found in groundwater beneath the WMA, and some of the constituents are attributed to the WMA while others are not. For current groundwater contamination plume maps at WMA S-SX, refer to the most recent Hanford Site annual groundwater monitoring report (e.g., DOE/RL-2010-11 for CY 2009 plume maps).

### 2.5.2 Vadose Zone Contamination

The threat to groundwater posed by the tanks themselves has been significantly reduced for two reasons:

- All SSTs at the Hanford Site have been interim stabilized.
- Interim measures have been implemented to reduce the forces driving contamination downward to the groundwater, such as the following:
  - Constructing berms around the tank farms to divert surface water runoff away from the facility
  - Testing all nearby water lines and removing the leaking water lines from service
  - Capping all vadose zone monitoring boreholes in the tank farms.

However, past tank leaks/releases have left portions of the vadose zone contaminated with waste. This contamination has the potential to move downward into the groundwater, especially if a driving force is present.

DOE/ORP-2008-01 presents the results of recent tank farm vadose zone studies, including the following:

- Characterization wells installed by drilling or direct-push technology (used for geophysical monitoring, sediment sampling, and, in some cases, installation of down-hole instrumentation)
- Surface geophysical surveys
- Borehole geophysical logging of dry wells adjacent to tanks and lateral access tubes beneath tanks

The results of these studies indicate significant vadose zone contamination in the vicinity of tanks SX-108 and SX-115, which includes the dangerous constituent chromium and the supplemental constituent nitrate (RPP-7884). These contaminants were not found at high concentrations below the Cold Creek unit where boreholes were drilled near tanks SX-108 and SX-115; however, the presence of the mobile tank waste constituents in groundwater adjacent and downgradient to tank SX-115 indicates that breakthrough of these constituents to the groundwater did occur beneath this tank. It is suspected that long-term leaking of utility water lines near the southwestern corner of the WMA provided the driving force for the contaminants to reach groundwater (PNNL-11810; DOE/ORP-2008-01).

A surface geophysical investigation at the S Tank Farm showed a low-resistivity plume (i.e., elevated ions) beneath tank S-104, which is the only tank in the S Tank Farm assumed or known to have experienced a leak/release (RPP-RPT-30976, *Surface Geophysical Exploration of S Tank Farm at the Hanford Site*). This plume is the likely source for the groundwater contamination downgradient of the S Tank Farm.

## 2.6 Conceptual Model

DOE/ORP-2008-01 summarizes a conceptual model of tank leak/release pathways to the groundwater, and Appendix A of the document presents the conceptual model in detail. The following summary is from that document.

### 2.6.1 Contaminant Sources

Tank leak/release events began with rapid discharge of some waste fluid volume into the subsurface from a point of entry likely having a small spatial extent (on the order of inches to rarely feet). This discharge temporarily increased the moisture content of the unsaturated soil, particularly at the point of entry. Points of entry included poorly sealed openings in the tank structure, ruptured areas of steel tank liners combined with nearby underlying concrete shell fractures, and breaks in waste transfer lines. Natural processes then redistributed the excess moisture within the vadose zone, eventually returning the soil to ambient conditions.

The migration process occurred, for the most part in partially saturated soils, because leak/release volumes were not sufficient to fill the soil pore spaces for an appreciable length of time or very far from the point of entry. This condition is referred to as "unsaturated flow." In addition to vertical flow, lateral flow occurred because soil layers with different hydraulic properties tend to be layered more or less horizontally by sediment deposition processes. Consequently, flow in the lateral direction could occur and be enhanced by the unsaturated conditions.

### 2.6.2 Driving Forces

External sources of water or other liquid may have acted to drive contamination downward. Infiltration of fresh water (as well as precipitation and unintentional, manmade releases such as leaking water lines) may move residual waste remaining in the soil downward to the groundwater. The catastrophic break of a 14 in. raw waterline that caused flooding of the S and SY Tank Farms in 1996 is an extreme example in which over 2.2 million L (570,000 gal) of water were released in 2 hours. The portion of this water that reached the S Tank Farm had infiltrated into the ground within a day (DOE/ORP-2008-01).

As waste fluids are migrating within the vadose zone, numerous contaminants are reacting chemically with the vadose zone soil/water system to varying degrees. Water extracts of contaminants from sediments collected from two boreholes near tank SX-108 (PNNL-13757-3, *Characterization of Vadose Zone Sediment: Borehole 41-09-39 in the S-SX Waste Management Area*; PNNL-13757-4, *Characterization of Vadose Zone Sediment: Slant Borehole SX-108 in the S-SX Waste Management Area*) confirmed the variable mobility of the contaminants.

### 2.6.3 Migration

After mobile contaminants reach groundwater beneath WMA S-SX, the contaminants travel in the downgradient direction toward the east. Travel times estimated for contaminants in the southern plume yield a groundwater velocity of approximately 30 m/yr (100 ft/yr) (DOE/RL-2008-01, *Hanford Site Groundwater Monitoring for Fiscal Year 2007*). This is in agreement with the estimated flow velocity of 33 m/yr (108.3 ft/yr) based on water-level measurements and hydrologic testing results (Section 2.4). Similar flow velocities are expected for both the north and south plumes from WMA S-SX.

## 2.7 Data Quality Objectives

The DQO process ensures that data gathered during an investigation are of the appropriate quantity and quality to meet specific objectives. The DQOs for the first determination groundwater quality assessment are presented in WHC-SD-EN-AP-191. The results of the first determination investigation indicated that

multiple sources within WMA S-SX contributed to groundwater contamination and that a continued groundwater quality assessment investigation was warranted (PNNL-11810). The DQOs for the continued groundwater quality assessment are presented in PNNL-12114.

The current groundwater monitoring network for WMA S-SX is a result of these previous investigations and DQOs. Assessment monitoring is ongoing at the WMA in accordance with interim status regulations. The DQO parameters, regulatory interim status requirements, and associated reports supporting the regulatory requirements are outlined in Table 2-2.

**Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA S-SX**

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|
| Scope | **40 CFR 265.93, "Preparation, Evaluation, and Response"; as modified by WAC 173-303-400(3)(b) and WAC 173-303-400(3)(c)(v).**<br>(d)(7) If the owner or operator determines…that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator:<br>(i) Must continue to make the determinations required under paragraph (d)(4) of this section…<br>**40 CFR 265.93, "Preparation, Evaluation, and Response"; as modified by WAC 173-303-400(3)(b) and WAC 173-303-400(3)(c)(v).**<br>(d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine:<br>(i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and<br>(ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water.<br>**40 CFR 265.93, "Preparation, Evaluation, and Response"; as modified by WAC 173-303-400(3)(b) and WAC 173-303-400(3)(c)(v).**<br>(d)(3) The plan to be submitted under 40 CFR 265.90(d)(1) or paragraph (d)(2) of this section must specify:<br>(i) The number, location, and depth of wells;<br>(ii) Sampling and analytical methods for those hazardous wastes or hazardous waste constituents in the facility;<br>(iii) Evaluation procedures, including any use of previously gathered ground-water quality information; and<br>(iv) A schedule of implementation. | WHC-SD-EN-AP-191, *Assessment Groundwater Monitoring Plan for Single Shell Tank Waste Management Area S-SX*<br>PNNL-12114, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area S-SX at the Hanford Site*, as modified by interim change notice<br>This plan, Sections 3.1 and 3.2, Chapter 4, and Appendix A |

**Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA S-SX**

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|
| Number and location of wells<br>Point(s) of compliance | **40 CFR 265.93, "Preparation, Evaluation, and Response"; as modified by WAC 173-303-400(3)(b) and WAC 173-303-400(3)(c)(v).**<br>(d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine:<br>(i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and<br>(ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water. | WHC-SD-EN-AP-191, *Assessment Groundwater Monitoring Plan for Single Shell Tank Waste Management Area S-SX*<br>PNNL-12114, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area S-SX at the Hanford Site*, as modified by interim change notice<br>This plan, Chapters 1 and 3, and Appendix A |
| Well configuration (depth and length of screened interval; well construction) | **40 CFR 265.91, "Ground-Water Monitoring System."**<br>(c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water.<br>**Additional requirements from WAC 173-303-400 (3)(c)(v)(C).**<br>Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground-water contamination. WAC 173-160 may be used as guidance in the installation of wells. | WHC-SD-EN-AP-191, *Assessment Groundwater Monitoring Plan for Single Shell Tank Waste Management Area S-SX*<br>PNNL-12114, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area S-SX at the Hanford Site*, as modified by interim change notice<br>This plan, Section 3.2 and Appendix B |

**Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA S-SX**

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|
| Frequency of sampling<br>Types of analysis or measurement<br>Method detection limits or accuracy and precision<br>Methods used to evaluate the collected data | **40 CFR 265.93, "Preparation, Evaluation, and Response"; as modified by WAC 173-303-400(3)(b) and WAC 173-303-400(3)(c)(v).**<br>(d)(7) If the owner or operator determines…that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator:<br>(i) Must continue to make the determinations required under paragraph (d)(4) of this section on a quarterly basis until final closure of the facility, if the ground-water quality assessment plan was implemented prior to final closure of the facility; or<br>(ii) May cease to make the determinations required under paragraph (d)(4) of this section, if the ground-water quality assessment plan was implemented during the post-closure care period.<br>**40 CFR 265.93, "Preparation, Evaluation, and Response"; as modified by WAC 173-303-400(3)(b) and WAC 173-303-400(3)(c)(v).**<br>(d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine:<br>(i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and<br>(ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water. | PNNL-12114, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area S-SX at the Hanford Site*, as modified by interim change notice<br>This plan, Section 3.1, Chapter 4, and Appendix A |

Notes: The references cited in this table are listed in the reference section (Chapter 5) of this plan.

# 3 Groundwater Monitoring Program

This chapter lists the wells monitored, constituents analyzed, and sampling frequency for WMA S-SX. The quality assurance and quality control requirements are provided in the QAPjP (Appendix A).

## 3.1 Constituent List and Sampling Frequency

The constituent list for groundwater sampling includes the analytes on the RCRA groundwater monitoring list that may be present in SST waste. To identify these analytes, the list of primary nonradiological constituents potentially present in SST waste (RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*) was compared to those constituents listed in Appendix 5 of Ecology Publication 97-407, which references 40 CFR 264, Appendix IX. Those constituents in RPP-23403 that are on the groundwater monitoring list (i.e., listed in Appendix 5 of Ecology Publication 97-407) are included in Table 3-1.

**Table 3-1. Constituents on the RCRA Groundwater Monitoring List Potentially Present in the Single-Shell Tank Farm System**

| Constituent | CAS ID | Constituent | CAS ID |
|---|---|---|---|
| **Volatile Organic Compounds** | | | |
| 1,1,1-Trichloroethane | 71-55-6 | Chloroform | 67-66-3 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | Ethylbenzene | 100-41-4 |
| 1,1,2-Trichloroethane | 79-00-5 | Isobutanol | 78-83-1 |
| 1,1-Dichloroethene | 75-35-4 | Methylene chloride | 75-09-2 |
| 1,2-Dichloroethane | 107-06-2 | Tetrachloroethene | 127-18-4 |
| 2-Butanone (methyl ethyl ketone) | 78-93-3 | Toluene | 108-88-3 |
| 2-Propanone (acetone) | 67-64-1 | Trans-1,3-dichloropropene | 10061-02-6 |
| 4-Methyl-2-pentanone (MIBK) | 108-10-1 | Trichloroethene | 79-01-6 |
| Benzene | 71-43-2 | Trichlorofluoromethane | 75-69-4 |
| Carbon disulfide | 75-15-0 | Vinyl chloride (chloroethene) | 75-01-4 |
| Carbon tetrachloride | 56-23-5 | Xylenes | 1330-20-7 |
| Chlorobenzene | 108-90-7 | | |
| **Semivolatile Organic Compounds** | | | |
| 1,2,4-Trichlorobenzene | 120-82-1 | Aroclor-1260 | 11096-82-5 |
| 2,4,5-Trichlorophenol | 95-95-4 | Butylbenzylphthalate | 85-68-7 |
| 2,4,6-Trichlorophenol | 88-06-2 | Di-n-butylphthalate | 84-74-2 |
| 2,4-Dinitrotoluene | 121-14-2 | Di-n-octylphthalate | 117-84-0 |
| 2-Chlorophenol | 95-57-8 | Fluoranthene | 206-44-0 |

**Table 3-1. Constituents on the RCRA Groundwater Monitoring List Potentially Present in the Single-Shell Tank Farm System**

| Constituent | CAS ID | Constituent | CAS ID |
|---|---|---|---|
| 2-Methylphenol (o-cresol) | 95-48-7 | Hexachlorobutadiene | 87-68-3 |
| 3-Methylphenol (m-cresol) | 108-39-4 | Hexachloroethane | 67-72-1 |
| 4-Chloro-3-methylphenol (p-Chloro-m-cresol) | 59-50-7 | Naphthalene | 91-20-3 |
| 4-Methylphenol (p-cresol) | 106-44-5 | Nitrobenzene | 98-95-3 |
| Acenaphthene | 83-32-9 | N-nitroso-di-n-propylamine | 621-64-7 |
| Aroclor-1016 | 12674-11-2 | n-Nitrosomorpholine | 59-89-2 |
| Aroclor-1221 | 11104-28-2 | 1,2-Dichlorobenzene (o-Dichlorobenzene) | 95-50-1 |
| Aroclor-1232 | 11141-16-5 | 2-Nitrophenol (o-Nitrophenol) | 88-75-5 |
| Aroclor-1242 | 53469-21-9 | Pyrene | 129-00-0 |
| Aroclor-1248 | 12672-29-6 | Pyridine | 110-86-1 |
| Aroclor-1254 | 11097-69-1 | | |
| **Inorganic Constituents (Nonradiological)** | | | |
| Antimony (Sb) | 7440-36-0 | Lead (Pb) | 7439-92-1 |
| Arsenic (As) | 7440-38-2 | Mercury (Hg) | 7439-97-6 |
| Barium (Ba) | 7440-39-3 | Nickel (Ni) | 7440-02-0 |
| Beryllium (Be) | 7440-41-7 | Selenium (Se) | 7782-49-2 |
| Cadmium (Cd) | 7440-43-9 | Silver (Ag) | 7440-22-4 |
| Chromium (Cr) | 7440-47-3 | Sulfide ($S^{2-}$) | 18496-25-8 |
| Cobalt (Co) | 7440-48-4 | Thallium (Tl) | 7440-28-0 |
| Copper (Cu) | 7440-50-8 | Vanadium (V) | 7440-62-2 |
| Cyanide ($CN^-$) | 57-12-5 | Zinc (Zn) | 7440-66-6 |

Notes: This table lists the primary nonradiological constituents provided in RPP-23403, which are also on the RCRA groundwater monitoring list (i.e., also listed in Appendix 5 of Ecology Publication 97-407, which references 40 CFR 264, Appendix IX).

Of the 72 analytes listed in Table 3-1, only chromium has been found in groundwater and has been attributed to releases from the WMA, as described in Section 2.5.1. In addition, nitrate is present in the groundwater and has been attributed to the WMA. Carbon tetrachloride is also found in the groundwater but originates from waste sites associated with the Plutonium Finishing Plant. Thus, chromium and the supporting constituent nitrate (along with the other supporting constituents alkalinity, major cations [metals], and major anions) are routinely sampled for RCRA in the network monitoring wells (Table 3-2).

The supporting constituents provide information on general chemistry and allow for charge-balance computations to assess laboratory performance.

**Table 3-2. Monitoring Network, Constituent List, and Sampling Frequency for WMA S-SX**

| Well | WAC Compliant | RCRA | Supporting Parameters | | | | Field-Measured Parameters | | | | | Table 3-1 Analytes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Chromium[a] | Nitrate | Alkalinity | Anions[b] | Metals[c] | pH | Specific Conductance | Temperature | Turbidity | Water Levels | |
| 299-W22-26 | N[d] | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | Once |
| 299-W22-44 | C | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Once |
| 299-W22-45 | C | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | Once |
| 299-W22-47 | C | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Once |
| 299-W22-48 | C | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | Once |
| 299-W22-49 | C | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | Once |
| 299-W22-50 | C | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Once |
| 299-W22-69 | C | A | A | A | A | A | A | A | A | A | A | N/A |
| 299-W22-72 | C | A | A | A | A | A | A | A | A | A | A | N/A |
| 299-W22-80 | C | A | A | A | A | A | A | A | A | A | A | N/A |
| 299-W22-81 | C | A | A | A | A | A | A | A | A | A | A | N/A |
| 299-W22-82 | C | A | A | A | A | A | A | A | A | A | A | N/A |
| 299-W22-83 | C | A | A | A | A | A | A | A | A | A | A | N/A |
| 299-W22-84 | C | A | A | A | A | A | A | A | A | A | A | N/A |
| 299-W22-85 | C | SA | SA | SA | SA | SA | SA | SA | SA | SA | SA | Once |
| 299-W22-86 | C | A | A | A | A | A | A | A | A | A | A | N/A |
| 299-W22-89 | C | A | A | A | A | A | A | A | A | A | A | N/A |
| 299-W23-15 | C | A | A | A | A | A | A | A | A | A | A | N/A |
| 299-W23-19 | C | Q | Q | Q | Q | Q | Q | Q | Q | Q | N/A | Once |
| ***299-W23-20*** | C | A | A | A | A | A | A | A | A | A | A | Once |
| ***299-W23-21*** | C | A | A | A | A | A | A | A | A | A | A | Once |

**Table 3-2. Monitoring Network, Constituent List, and Sampling Frequency for WMA S-SX**

| Well | WAC Compliant | RCRA | Supporting Parameters | | | | Field-Measured Parameters | | | | | Table 3-1 Analytes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Chromium[a] | Nitrate | Alkalinity | Anions[b] | Metals[c] | pH | Specific Conductance | Temperature | Turbidity | Water Levels | |

Notes:

1. Wells completed at the top of the unconfined aquifer.
2. Bold/italic print indicates upgradient well.
3. Abbreviations in this table include the following:

A = to be sampled annually
C = well is constructed as a resource protection well under WAC 173-160
N = well is not constructed as a resource protection well under WAC 173-160
Q = to be sampled quarterly
SA = to be sampled semiannually

a. Filtered and unfiltered total chromium.

b. Anions include, but are not limited to, chloride, nitrate, and sulfate.

c. Metals (filtered and unfiltered) include, but are not limited to, calcium, magnesium, potassium, and sodium.

d. See Appendix B for construction details. Well is usable as a "Screening well...to assist in defining the extent of contamination..." as stated in EPA and Ecology's "Policy on Remediation of Existing Wells and Acceptance Criteria for RCRA and CERCLA" (Nord and Day, 1990).

Sampling for the remaining constituents identified in Table 3-1 will be performed once during the first available sample event after this plan is in effect to determine if these constituents have impacted groundwater quality. Sampling will be performed in the upgradient and near-field downgradient monitoring wells (Table 3-2). Those constituents not detected in groundwater will be removed from future sampling. If an organic constituent from Table 3-1 is detected in a groundwater sample and it is not attributed to contamination from another facility (e.g., carbon tetrachloride from the Plutonium Finishing Plant), a confirmation sample will be collected at the next scheduled sample event, with split samples sent to different analytical laboratories. If the detection is confirmed by positive results from both laboratories, the constituent will be added to the list of analytes for routine sampling to evaluate the extent of contamination. If the detection is not confirmed, the analyte will be removed from future sampling.

Some of the inorganic constituents included in Table 3-1 occur naturally in groundwater (e.g., barium, selenium, vanadium, and zinc). Detections of an inorganic constituent will be evaluated to determine if the constituent is present naturally by comparison to sample results from the upgradient wells and comparisons to Hanford Site background values (DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*). If it is determined that an inorganic constituent may be present as a contaminant from the WMA, confirmation samples will be collected (as described for the organic constituents). If contamination is confirmed, then the constituent will be added to the routine sample list to evaluate the extent of contamination. If the contamination is not confirmed, the constituent will be removed from future sampling.

Prior to this plan revision, all network monitoring wells were sampled on a quarterly frequency because RCRA regulations require that, for sites in assessment monitoring, the owner/operator "...determine (i) the rate and extent of migration of the dangerous waste or dangerous waste constituents in the groundwater; and (ii) the concentrations of the dangerous waste or dangerous waste constituents in the groundwater..." and the owner/operator "...must continue to make [these] determinations...on a quarterly basis until final closure of the facility..." (40 CFR 265.9, as referenced by WAC 173-303-400). However, if these objectives can be met without performing quarterly sampling for each well in the monitoring network, then the monitoring program would not collect unnecessary information and would be more cost effective.

To evaluate the need for quarterly sampling of each network monitoring well, constituent trends based on the quarterly sampling results were qualitatively compared to the same trends plotted with a reduced sampling frequency. For example, Figure 3-1 depicts the chromium sample results in well 299-W22-83 at both quarterly and annual sampling frequencies. The trend for each frequency is nearly identical, indicating that no loss of resolution in the trend would occur if this well was sampled annually rather than quarterly. However, the situation is different for nitrate in 299-W23-19, which is shown in Figure 3-2 at both quarterly and annual frequencies. For well 299-W23-19, the short-duration nitrate increases are not adequately resolved by annual sampling; in fact, the first nitrate increase in 2003 is missed entirely. Even at a semiannual frequency (not depicted), the peak nitrate concentrations are not very well resolved. Thus, quarterly sampling is needed to adequately document changing constituent concentrations in this well.

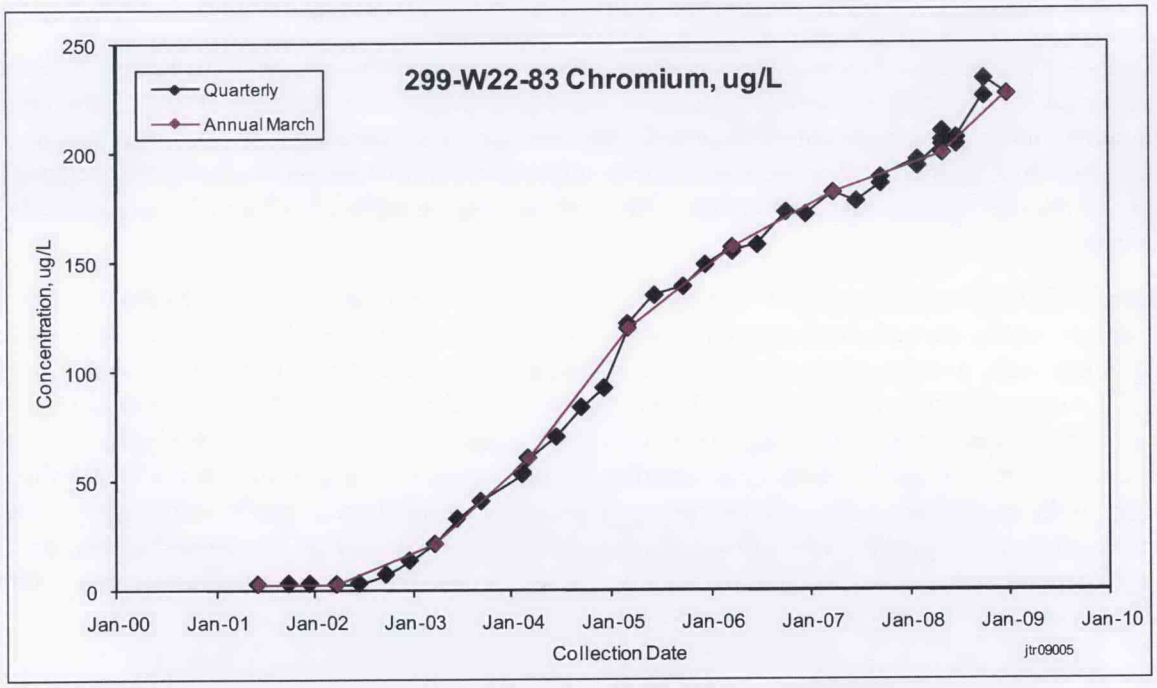


**Figure 3-1. Comparison of Quarterly and Annual Sample Frequency Trends for Chromium in Well 299-W22-83**

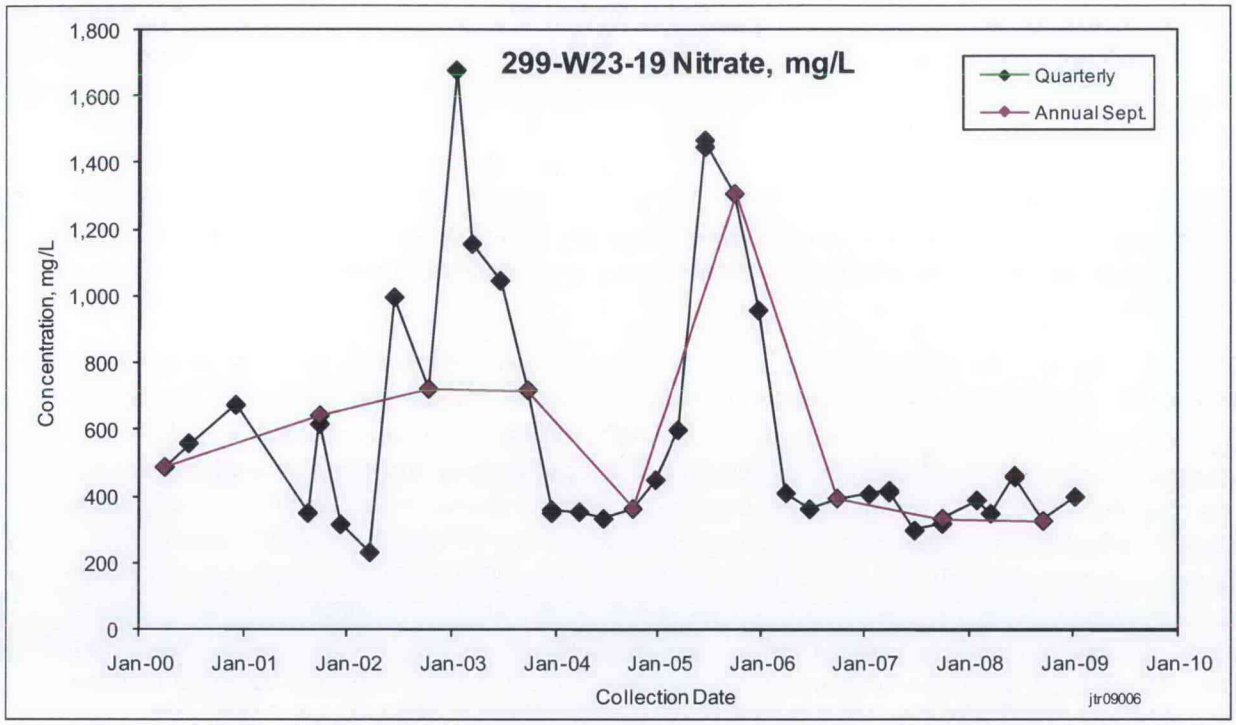


**Figure 3-2. Comparison of Quarterly and Annual Sample Frequency Trends for Nitrate in Well 299-W23-19**

A frequency trend analysis was performed for all wells in the monitoring network. The results indicated that constituent concentrations do not change very rapidly in the majority of the intermediate and far-field downgradient monitoring wells. Because of their distance from the source, short-term concentration variations are no longer present in the trends due to dispersion. For this reason, the sampling frequency for most of the intermediate and far-field downgradient monitoring wells was changed from quarterly to annually.

For the near-field downgradient wells, substantial concentration variations were more likely to occur in wells located within the high-concentration portions of contaminant plumes; therefore, near-field downgradient wells within high-concentration areas remained on a quarterly sampling frequency. Most near-field downgradient wells not within a high-concentration area are sampled on a semiannual basis. Such sampling is performed to spatially bound the existing plumes and to identify new plumes. This is consistent with sites in interim status detection monitoring, which are sampled semiannually. Finally, sampling of the upgradient wells is performed to establish background water quality conditions, and this objective can be accomplished with a lower frequency of sampling; therefore, the sampling frequency for the upgradient wells was also changed to annually. Table 3-3 describes the rationale for the new sampling frequencies for the entire monitoring well network.

**Table 3-3. WMA S-SX Monitoring Well Network Sample Frequencies**

| Well | Sample Frequency | Rationale |
|---|---|---|
| 299-W22-44, 299-W22-47, 299-W22-50, and 299-W23-19 | Quarterly | Near-field downgradient monitoring wells located within higher concentration areas of existing contaminant plumes. These wells have exhibited substantial constituent concentration variability. A quarterly sampling frequency is needed to track concentration variations. |
| 299-W22-45, 299-W22-48, 299-W22-49, and 299-W22-85 | Semiannually | Near-field downgradient monitoring wells located outside of higher concentration areas of contaminant plumes. These wells bound the existing plumes and are also monitored to identify new contaminant plumes. A semiannual sampling frequency is used to meet both of these objectives. This frequency is consistent with the requirements for sites in interim status detection monitoring, which shares the common objective of identifying new contaminant plumes. |
| 299-W22-84 and 299-W22-89 | Annually | Near-field, cross-gradient monitoring wells exhibiting very low constituent concentrations. These wells are too far north or south of existing source areas to be useful for identifying new contaminant plumes; thus, there is no need to sample these wells more frequently than annually. |
| 299-W22-80 and 299-W23-15 | Annually | Near-field downgradient monitoring wells, but samples collected from these wells are apparently not representative of upper aquifer conditions due to vertical flow in the wellbores. These wells are sampled annually in case conditions change (PNNL-15070). |
| 299-W22-69, 299-W22-72, 299-W22-81, 299-W22-82, 299-W22-83, and 299-W22-86 | Annually | Intermediate and far-field downgradient monitoring wells that exhibit constituent concentrations of low variability and/or low concentrations. An annual sampling frequency is adequate to define the concentration trends in these wells. |
| 299-W22-26 | Semiannually | Far-field downgradient monitoring well but it is within a high-concentration area of a contaminant plume and has exhibited increasing concentrations over a period of several years. |
| ***299-W23-20*** and ***299-W23-21*** | Annually | Upgradient wells monitored to establish background water quality conditions. An annual sampling frequency is sufficient to meet this objective. |

Notes: Bold/italic print in the table indicates upgradient wells.

## 3.2 Monitoring Well Network

Table 3-2 includes the list of wells monitored for WMA S-SX, and Figure 2-1 shows the well locations. Many of the wells are co-sampled for the 200-UP-1 Operable Unit (OU) for the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), although CERCLA sampling is at a lower frequency for some wells. Sampling is coordinated to avoid duplication of analyses and additional well trips. Two additional wells, 299-W22-26 and 299-W22-89, were added to the network

as part of this plan update. The sample results from well 299-W22-26 help to delineate the downgradient extent of contamination from the S Tank Farm. Well 299-W22-89 was installed in June 2010 to bound the southern extent of the plume from the SX Tank Farm at a near-field downgradient distance from the source.

Maintenance issues and sampling logistics sometimes delay scheduled sampling events. If a well on a quarterly sample frequency is delayed by 2 months or more, that event will be cancelled, as it is nearly time for the next quarterly sampling event. If sampling of a well scheduled on a semiannual frequency is delayed by 4 months, that event will be cancelled. For wells on an annual sample frequency, attempts will be made to sample the well within the calendar year scheduled.

Table 3-4 summarizes well depth information, including the depth of the water column in each monitoring well. All wells are constructed of stainless-steel casing and screens with full annular seals, with the exception of well 299-W22-26, which has a perforated carbon-steel casing. All wells are equipped with dedicated sampling pumps. With the exception of wells 299-W22-26 and 299-W22-89, as-built diagrams showing details of construction for each well are available in PNNL-12114 or subsequent interim change notices. The as-built diagram for wells 299-W22-26 and 299-W22-89 are shown in Appendix B.

**Table 3-4. WMA S-SX Well Depths and Water Table Elevation**

| Well | Year Drilled | Water Table Elevation, June/July 2010 (m)[a] | Casing Elevation (m)[a] | Open Interval Bottom Elevation (m)[a] | Water Column, June/July 2010 (m) |
|---|---|---|---|---|---|
| 299-W22-26 | 1963 | 134.11 | 208.38 | 133.05 | 1.16 |
| 299-W22-44 | 1991 | 134.48 | 207.76 | 132.97 | 1.51 |
| 299-W22-45 | 1992 | 134.52 | 204.13 | 131.94 | 2.58 |
| 299-W22-47 | 2005 | 134.54 | 206.28 | 125.17 | 9.37 |
| 299-W22-48 | 1999 | 134.36 | 207.90 | 133.60 | 0.76 |
| 299-W22-49 | 1999 | 134.57 | 204.72 | 132.94 | 1.63 |
| 299-W22-50 | 2000 | 134.61 | 205.01 | 133.13 | 1.48 |
| 299-W22-69 | 2006 | 134.00 | 207.95 | 124.04 | 9.96 |
| 299-W22-72 | 2006 | 133.95 | 208.02 | 124.44 | 9.51 |
| 299-W22-80 | 2000 | 134.69 | 200.85 | 126.80 | 7.89 |
| 299-W22-81 | 2001 | 134.36 | 206.64 | 126.13 | 8.23 |
| 299-W22-82 | 2001 | 134.37 | 206.87 | 126.51 | 7.86 |
| 299-W22-83 | 2001 | 134.35 | 207.02 | 126.70 | 7.65 |
| 299-W22-84 | 2001 | 134.47 | 208.51 | 126.41 | 8.06 |
| 299-W22-85 | 2001 | 134.58 | 204.41 | 126.86 | 7.72 |
| 299-W22-86 | 2006 | 134.01 | 206.41 | 124.46 | 9.55 |

**Table 3-4. WMA S-SX Well Depths and Water Table Elevation**

| Well | Year Drilled | Water Table Elevation, June/July 2010 (m)[a] | Casing Elevation (m)[a] | Open Interval Bottom Elevation (m)[a] | Water Column, June/July 2010 (m) |
|---|---|---|---|---|---|
| 299-W22-89 | 2010 | 134.39[b] | 206.137 | 124.42 | 9.97 |
| 299-W23-15 | 1991 | 134.83 | 200.84 | 132.00 | 2.83 |
| 299-W23-19 | 1999 | 134.86[c] | 202.49 | 128.94 | 5.92 |
| ***299-W23-20*** | 2000 | 134.86 | 203.80 | 126.75 | 8.25 |
| ***299-W23-21*** | 2000 | 134.89 | 203.35 | 126.47 | 8.68 |

Notes: Bold/italic print indicates upgradient wells.

a. NAVD88.

b. From September 2010.

c. No water-level measurements available for well 299-W23-19. The water table elevation was estimated by trend surface analysis of the June/July 2010 water-level measurements from the other nearby network monitoring wells.

With the exception of well 299-W23-19, water-level measurements are collected in each well at the time of sampling. In addition, water-level measurements are collected from many of the wells shown in Table 3-2 within a single day during March of each year to support water table mapping. Water-level measurements are not collected from well 299-W23-19, as this well is located within the SX Tank Farm security fence, adjacent to tank SX-115 and it is in a radiological control area. The pump discharge line and electrical wires for the sampling pump in this well pass through an underground pipe into a vault located outside the tank farm boundary. This allows the well to be sampled from the vault without field personnel entering the radiological control area. However, this configuration does not allow for water-level measurements to be collected, as routine access to the wellbore itself is not attained.

The water table elevation beneath WMA S-SX has been declining at an average rate of approximately 0.25 m/yr (0.82 ft/yr) (DOE/RL-2010-11). The decline is the result of reduced effluent discharges to ground at the Hanford Site since the peak discharge occurred in the 1980s. The water table elevation in the 200 West Area is expected to decline a minimum of an additional 4 to 6 m (13.1 to 16.4 ft) before equilibrium conditions are re-established (DOE/RL-2010-11).

As a consequence of the declining water table elevation, some monitoring wells at the WMA may go dry in the near future. When a well is within a few years of going dry, a replacement well is proposed. In addition, new wells may also be installed if needed to better characterize the nature and extent of contamination in the groundwater. All new RCRA wells proposed for installation at the Hanford Site are negotiated annually by Ecology, DOE, and EPA under the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989) Milestone M-24-00. At the time this plan was revised, two new wells were scheduled to be installed during CY 2011 (299-W22-93 and 299-W22-94) to replace existing wells going dry (299-W22-44 and 299-W22-48, respectively) (Figure 2-1).

In the future, the rate of decline of the water table beneath WMA S-SX may change in response to planned remedial action measures. The WMA S-SX is part of the larger 200-UP-1 CERCLA groundwater OU. In accordance with the *Interim Remedial Action Record of Decision for the 200-UP-1 Operable Unit, Hanford Site, Benton County, Washington* (EPA/ROD/R10-97/048), a groundwater pump-and-treat system is being designed targeting the technetium-99 plumes from the S and SX Tank

Farms (DOE/RL-97-36, *200-UP-1 Groundwater Remedial Design/Remedial Action Work Plan*). The system is expected to become operational in December 2011. As currently planned (at the time this document was prepared), extraction wells will be installed near monitoring wells 299-W22-44, 299-W22-50, and 299-W22-86 (Figure 2-1). The pumped water will be transferred to the 200 West Area groundwater treatment facility for treatment and then returned to the aquifer via injection wells in the 200-ZP-1 Groundwater OU (in the northern 200 West Area). Operation of this pump-and-treat system will impact water levels in the RCRA monitoring wells and may also cause local changes in groundwater flow direction. The extraction wells are being designed to accommodate 75 to 110 L/min (20 to 30 gal/min) flow rates. Drawdown in most of the RCRA monitoring wells is estimated to range from approximately 0.2 to 0.5 m (approximately 0.7 to 1.6 ft) and is not expected to exceed approximately 0.75 m (approximately 2.5 ft) in the monitoring wells closest to the extraction wells.

In addition, in the *Record of Decision Hanford 200 Area 200-ZP-1 Operable Unit Superfund Site Benton County, Washington* (EPA et al., 2008), the selected remedy is a combination of pump-and-treat, monitored natural attenuation, flow-path control, and institutional controls. Model simulations predict the groundwater flow direction at WMA S-SX will become northeasterly in the future due to operation of this system. Therefore, evaluation of the adequacy of the monitoring well network at WMA S-SX and the need for replacement wells will be an ongoing process, and the list of new wells under consideration for installation at the WMA will evolve.

## 3.3 Sampling and Analysis Protocol

Groundwater monitoring at WMA S-SX follows the conventions of the project and is discussed in the QAPjP (Appendix A).

# 4 Data Evaluation and Reporting

This chapter discusses data evaluation and reporting for WMA S-SX.

## 4.1 Data Review

Data review, validation, and verification are discussed in the QAPjP (Appendix A).

## 4.2 Interpretation

After sampling and water-level data are validated and verified, acceptable data are used to interpret groundwater conditions at WMA S-SX. Interpretive techniques include the following:

- **Hydrographs:** Graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.
- **Water table maps:** Use water table elevations from multiple wells to construct contour maps and to estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential.
- **Trend plots:** Graph concentrations of constituents versus time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water table maps to determine if concentrations relate to changes in water level or in groundwater flow directions.
- **Plume maps:** Map distributions of chemical constituents in the aquifer to determine extent of contamination. Changes in plume distribution over time assist in determining plume movement and direction of groundwater flow.
- **Contaminant ratios:** Can sometimes be used to distinguish among different sources of contamination.

## 4.3 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements include an annual evaluation of the monitoring well network to determine if it remains adequate to monitor the WMA. The network must include upgradient and downgradient wells to monitor groundwater quality in the uppermost aquifer (see Appendix A). Wells proposed for installation at WMA S-SX are described in Section 3.2.

Water-level measurements will continue to be collected before each sampling event, and more comprehensive measurements will continue to be made in March of each year. The data are presented in the annual Hanford Site groundwater monitoring report (e.g., DOE/RL-2010-11).

## 4.4 Reporting and Notification

The results of assessment monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in the annual Hanford Site groundwater monitoring report.

# 5 References

10 CFR 962, "Byproduct Material," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/10cfr962_10.html.

40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Appendix IX, "Ground-Water Monitoring List," *Code of Federal Regulations*. Available at: http://edocket.access.gpo.gov/cfr_2010/julqtr/40cfr264AppIX.htm.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/40cfr265_10.html.

265.90, "Applicability."

265.91, "Ground-Water Monitoring System."

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

Subpart F, "Ground-Water Monitoring."

51 FR 24504, 1986, "EPA Clarification of Regulatory Authority Over Radioactive Mixed Waste," *Federal Register*, July 3, 1986.

*Atomic Energy Act of 1954*, 42 USC 2011, et seq. Available at: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf.

*Authorized State Hazardous Waste Programs*, 42 USC 6926, et seq. Available at: http://www.law.cornell.edu/uscode/42/6926.html.

*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

DOE/ORP-2008-01, 2008, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0808130005.

DOE/RL-91-60, 1992, *S Plant Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D195065601.

DOE/RL-96-61, 1997, *Hanford Site Background: Part 3, Groundwater Background*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D197226378.

DOE/RL-97-36, 2010, *200-UP-1 Groundwater Remedial Design/Remedial Action Work Plan*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=1003100445.

DOE/RL-2008-01, 2008, *Hanford Site Groundwater Monitoring for Fiscal Year 2007*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=00098824.

DOE/RL-2010-11, 2010, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0084237.

Ecology Publication 97-407, 2009, *Chemical Testing Methods for Designating Dangerous Waste: WAC 173-303-090 & -100*, Appendix 5, "Appendix IX of 40 CFR 264," Washington State Department of Ecology, Olympia, Washington. Available at: http://www.ecy.wa.gov/pubs/97407.pdf.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

EPA, Ecology, and DOE, 2008, *Record of Decision Hanford 200 Area 200-ZP-1 Operable Unit Superfund Site Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/r2008100003103.pdf.

EPA/ROD/R10-97/048, 1997, *Interim Remedial Action Record of Decision for the 200-UP-1 Operable Unit, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/r1097048.pdf.

HNF-4936, 1999, *Subsurface Conditions Description for the S-SX Waste Management Area*, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0911240517.

HNF-EP-0182, 2010, *Waste Tank Summary Report for Month Ending December 31, 2009*, Rev. 261, Washington River Protection Solutions, Richland, Washington. Available at: http://www5.hanford.gov/pdw/fsd/AR/FSD0001/FSD0054/1002011113/%5B1002011113%5D.PDF.

Nord, Timothy L. and Paul T. Day, 1990, "Policy on Remediation of Existing Wells and Acceptance Criteria for RCRA and CERCLA" (letter to Steven H. Wisness, U.S. Department of Energy, Richland Operations Office), Washington State Department of Ecology, and U.S. Environmental Protection Agency, Olympia, Washington, July 16. Available at: http://www.ecy.wa.gov/programs/nwp/Attachment_07_1990-06.pdf.

PNNL-11810, 1998, *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Area S-SX at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D198175192.

PNNL-12114, 1999, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area S-SX at the Hanford Site*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-12114.pdf.

PNNL-12214-ICN-1, 2000, *RCRA Assessment Plan for Single-Shell Task Waste Management Area S-SX at the Hanford Site*, Interim Change Notice 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-12114-ICN1.pdf.

PNNL-12114-ICN-2, 2002, *RCRA Assessment Plan for Single-Shell Task Waste Management Area S-SX at the Hanford Site*, Interim Change Notice 2, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-12114-icn-2.pdf.

PNNL-12114-ICN-3, 2005, *RCRA Assessment Plan for Single-Shell Task Waste Management Area S-SX at the Hanford Site*, Interim Change Notice 3, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-12114-ICN-3.pdf.

PNNL-12114-ICN-4, 2006, *RCRA Assessment Plan for Single-Shell Task Waste Management Area S-SX at the Hanford Site*, Interim Change Notice 4, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-12114-ICN-4.pdf.

PNNL-13441, 2001, *RCRA Groundwater Quality Assessment Report for Waste Management Area S-SX (November 1997 through April 2000)*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13441.pdf.

PNNL-13757-3, 2002, *Characterization of Vadose Zone Sediment: Borehole 41-09-39 in the S-SX Waste Management Area*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/pnnl-13757-3.pdf.

PNNL-13757-4, 2008, *Characterization of Vadose Zone Sediment: Slant Borehole SX-108 in the S-SX Waste Management Area*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13757-4rev1.pdf.

PNNL-13801, 2002, *Groundwater Quality Assessment Report for Waste Management Area S-SX (April 2000 through December 2001)*, Pacific Northwest Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D2756487.

PNNL-13858, 2002, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13858.pdf.

PNNL-15070, 2005, *Hanford Site Groundwater Monitoring for Fiscal Year 2004*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15070.pdf.

RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*, Olympia, Washington. Available at: http://apps.leg.wa.gov/RCW/default.aspx?cite=70.105.

*Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://epw.senate.gov/rcra.pdf.

RPP-7884, 2002, *Field Investigation Report for Waste Management Area S-SX*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at:
http://www5.hanford.gov/arpir/?content=findpage&AKey=D8974033.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D8974041.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D8974046.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D8974049.

RPP-23403, 2006, *Single-Shell Tank Component Closure Data Quality Objectives*, Rev. 3, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-RPT-30976, 2006, *Surface Geophysical Exploration of S Tank Farm at the Hanford Site*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at:
http://www5.hanford.gov/arpir/?content=findpage&AKey=0911240536.

WA7890008967, 2007, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste*, as amended, Washington State Department of Ecology, Richland, Washington. Available at:
http://www.ecy.wa.gov/programs/nwp/piarchive12_07.htm#Hanfords_Site-wide_Permit.

WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Code*, Olympia, Washington. Available at:
http://apps.leg.wa.gov/WAC/default.aspx?cite=173-160.

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

303-400, "Interim Status Facility Standards."

WHC-MR-0517, 1996, *Listed Waste History at Hanford Facility TSD Units*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-AP-012, 1991, *Interim Status Groundwater Monitoring Plan for the Single-Shell Tanks*, Rev. 1, Westinghouse Hanford Company, Richland, Washington. Available at:
http://www5.hanford.gov/arpir/?content=findpage&AKey=D196071250.

WHC-SD-EN-AP-191, 1996, *Assessment Groundwater Monitoring Plan for Single Shell Tank Waste Management Area S-SX*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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# Quality Assurance Project Plan

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# Terms

| | |
|---|---|
| CRDL | contract-required detection limit |
| DOE | U.S. Department of Energy |
| DQO | data quality objective |
| DUP | laboratory matrix duplicate |
| EB | equipment blank |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| FTB | full trip blank |
| FXR | field transfer blank |
| GC | gas chromatography |
| HASQARD | *Hanford Analytical Services Quality Assurance Requirements Documents* |
| HEIS | Hanford Environmental Information System |
| IC | ion chromatography |
| ICP | inductively coupled plasma |
| ICP/MS | inductively coupled plasma/mass spectrometry |
| LCS | laboratory control sample |
| MB | method blank |
| MDA | minimum detectable activity |
| MDL | method detection limit |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| PCB | polychlorinated biphenyl |
| 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 |
| RPD | relative percent difference |
| RSD | relative standard deviation |
| SUR | surrogate |

| | |
|---|---|
| TOC | total organic carbon |
| TOX | total organic halides |
| TPA | *Hanford Federal Facility Agreement and Consent Order* |
| TSD | treatment, storage, and disposal |
| VOC | volatile organic compound |

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

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. Section 6.5 and 7.8 of the *Hanford Federal Facility Agreement and Consent Order* (TPA) (Ecology et al., 1989a), Attachment 2, "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 requirements (DOE/RL-96-68) 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 *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use* (ANSI/ASQ E4-2004). This QAPjP is divided into four sections (as 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, the participants understand the goals and the approaches used, and 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.

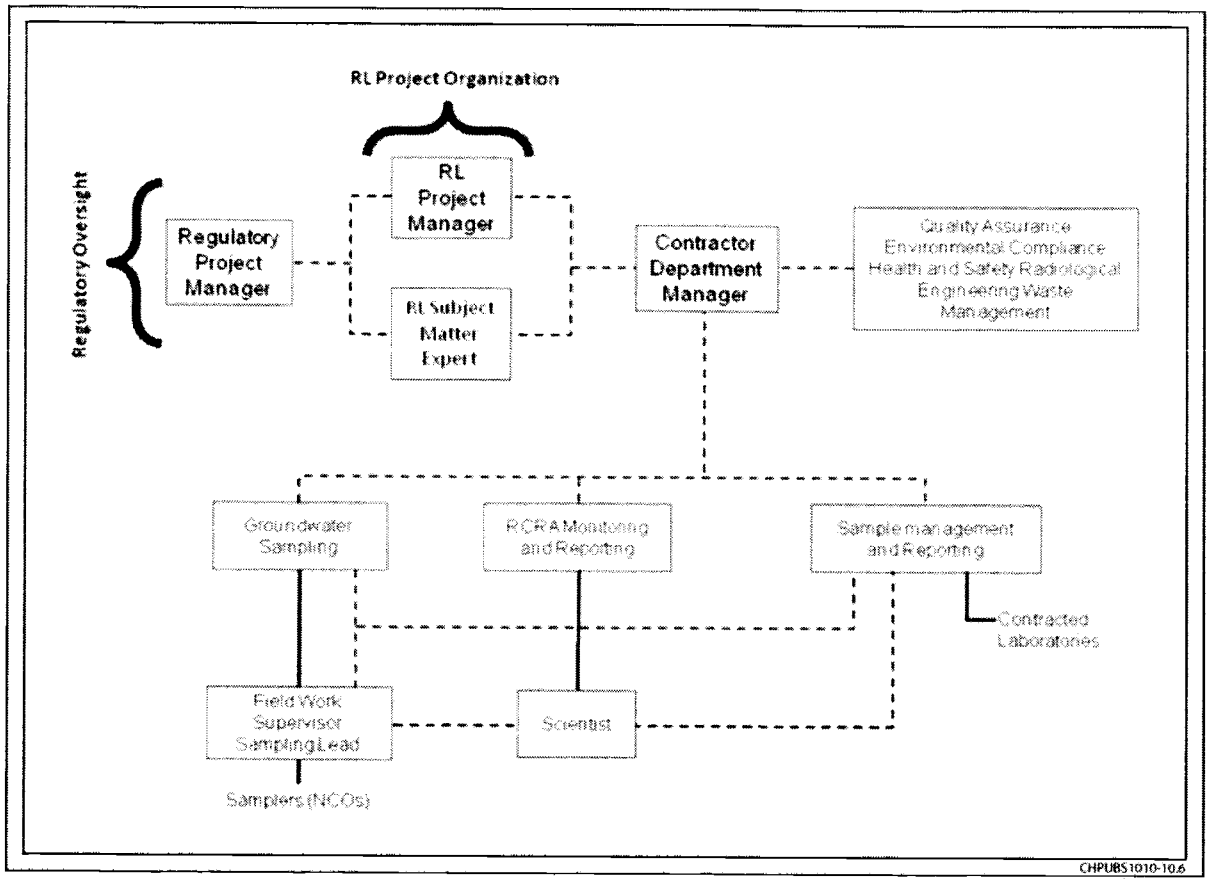



**Figure A-1. Project Organization**

### 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*; the *Resource Conservation and Recovery Act of 1976* (RCRA); the *Atomic Energy Act of 1954*; and the TPA (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 workscope, 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 regulatory agencies, 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 in accordance with corresponding standard procedures and work packages. The samplers also complete field logbooks 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 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 impacts.

### 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, Subpart F ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "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, and reporting.

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 for 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, "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 prior to implementation. Table A-1 defines the types of changes that may be made to the sampling design and 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 TPA (Ecology et al., 1989a) will be managed in accordance with the requirements therein.

**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 impact 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 |

The results of groundwater monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2010-11, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2*).

# 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 unit 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 impact 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] |
|---|---|---|---|
| **Metals Analyzed by ICP Method – Unfiltered/Filtered** | | | |
| Calcium | P, $HNO_3$ to pH <2 | SW-846[d] Method 6010B/C, SW-846 Method 6020[e], or EPA/600 Method 200.8[e] | 1,000 |
| Chromium | | | 10 |
| Sodium | | | 500 |
| Potassium | | | 4,000 |
| Magnesium | | | 750 |
| **Anions by IC** | | | |
| Chloride | P | EPA/600 Method 300.0[f] | 200 |
| Nitrate | | | 250 |
| Sulfate | | | 500 |
| **Other** | | | |
| Temperature | Field measurement | Instrument/meter | -- |
| Conductivity, field | Field measurement | Instrument/meter | 1 µohm |
| pH, field measurement | Field measurement | Instrument/meter | 0.1 |
| Alkalinity | G/P | Standard Method[g] 2320, EPA/600 Method 310.1, EPA/600 Method 310.2 | 5,000 |

a. All samples will be collected in plastic (P) or glass (G) containers and will be cooled to 4°C 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 Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

e. SW-846 Method 6010 is the preferred method; however, Method 6020 or EPA/600 Method 200.8 may be used, as long as the method quantitation limit listed is met.

f. Analytical method adapted from Method 300.0 (EPA-600/4-84-017, *Test Methods for Determination of Inorganic Anions in Water by Ion Chromatography*).

g. *Standard Methods for the Examination of Water and Wastewater* (AWWA et al., 2005).

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Metals Analyzed by ICP Method — Unfiltered/Filtered** | | | |
| Barium | P, $HNO_3$ to pH <2 | SW-845[d] Method 6010B/C, SW-846 Method 6020,[e] or EPA/600 Method 200.8[f] | 20 |
| Beryllium | | | 5 |
| Cadmium | | | 5 |
| Chromium | | | 10 |
| Cobalt | | | 20 |
| Copper | | | 10 |
| Nickel | | | 40 |
| Silver | | | 10 |
| Vanadium | | | 25 |
| Zinc | | | 10 |
| **Trace Metals – Unfiltered/Filtered** | | | |
| Antimony | P, $HNO_3$ to pH <2 | SW-846 Method 6020 or EPA/600 Method 200.8 | 6 |
| Arsenic | | | 10 |
| Lead | | | 5 |
| Selenium | | | 10 |
| Thallium | | | 5 |
| **Trace Metals – Unfiltered/Filtered** | | | |
| Mercury | G, $HNO_3$ to pH <2 | SW-846 Method 7470A, EPA/600 Method 200.8 | 0.5 |
| **Volatiles by GC/MS** | | | |
| 1,1-Dichloroethene | G, no headspace | SW-846 Method 8260B | 10 |
| 1,1,1-Trichloroethane | | | 5 |
| 1,1,2,2-Tetrachloroethane | | | 5 |
| 1,1,2-Trichloroethane | | | 5 |
| 1,2-Dichloroethane | | | 5 |
| 2-Butanone (methyl ethyl ketone) | | | 10 |
| 2-Propanone (acetone) | | | 20 |

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| 4-Methyl-2-petanone (MIBK) | | | 10 |
| Benzene | | | 5 |
| Carbon disulfide | | | 5 |
| Carbon tetrachloride | | | 5 |
| Chlorobenzene | | | 5 |
| Chloroform | | | 5 |
| Ethylbenzene | | | 5 |
| Isobutanol | | | 500 |
| Methylene chloride | | | 5 |
| Tetrachloroethene | | | 5 |
| Toluene | | | 5 |
| trans-1,3-Dichloropropene | | | 5 |
| Trichloroethene | | | 5 |
| Trichlorofluoromethane | | | 10 |
| Vinyl chloride (chloroethene) | | | 10 |
| Xylenes | | | 10 |
| **Semivolatiles by GC/MS** | | | |
| 1,2-Dichlorobenzene (o-Dichlorobenzene) | Amber glass | SW-846 Method 8270D | 10 |
| 1,2,4-Trichlorobenzene | | | 10 |
| 2-Chlorophenol | | | 10 |
| 2-Methylphenol (o-cresol) | | | 10 |
| 2-Nitrophenol (o-Nitrophenol) | | | 20 |
| 2,4-Dinitrotoluene | | | 10 |
| 2,4,5-Trichlorophenol | | | 10 |
| 2,4,6-Trichlorophenol | | | 10 |
| 3-Methylphenol (m-cresol) | | | 20 |
| 4-Chloro-3-methylphenol (p-Chloro-m-cresol) | | | 10 |

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| 4-Methylphenol (p-cresol) | | | 10 |
| Acenaphthene | | | 10 |
| Butylbenzylphthalate | | | 10 |
| Di-n-butylphthalate | | | 10 |
| Di-n-octylphthalate | | | 10 |
| Fluoranthene | | | 10 |
| Hexachlorobutadiene | | | 10 |
| Hexachloroethane | | | 10 |
| n-Nitroso-di-n-propylamine | | | 10 |
| n-Nitrosomorpholine | | | 10 |
| Naphthalene | | | 10 |
| Nitrobenzene | | | 10 |
| Pyrene | | | 10 |
| Pyridine | | | 20 |
| **PCBs** | | | |
| Aroclor-1016 | | | 0.5 |
| Aroclor-1221 | | | 0.5 |
| Aroclor-1232 | | | 0.5 |
| Aroclor-1242 | G | SW-846 Method 8082 | 0.5 |
| Aroclor-1248 | | | 0.5 |
| Aroclor-1254 | | | 0.5 |
| Aroclor-1260 | | | 0.5 |
| **Other** | | | |
| Cyanide | P, NaOH to pH >12 | SW-846 Method 9012, Standard Method[f] 4500, EPA/600 Method 335.2 | 5 |
| Sulfide | G/P, 2 mL 2N zinc acetate and NaOH pH >9, cool 4°C | Sulfides – 9030 | 500 |

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

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

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

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

c. Detection limit units.

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

e. SW-846 Method 6010 is the preferred method; however, Method 6020 or EPA/600 Method 200.8 may be used, as long as the method quantitation limit listed is met.

f. *Standard Methods for the Examination of Water and Wastewater* (AWWA et al., 2005).

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 impacts 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 (EBs). 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 (FTB) | Contamination from containers or transportation | One per 20 well trips |
| Field transfer blank (FXR) | Contamination from sampling site | One each day; VOCs sampled |
| Equipment blank (EB) | Contamination from non-dedicated equipment | As needed[a] |
| Replicate/duplicate sample | Reproducibility | One per 20 well trips |

**Table A-4. Quality Control Samples**

| Sample Type | Primary Characteristics Evaluated | Frequency |
|---|---|---|
| **Laboratory QC** | | |
| Method blank (MB) | Laboratory contamination | One per batch |
| Laboratory duplicate | Laboratory reproducibility | See footnote b |
| Matrix spike (MS) | Matrix effect and laboratory accuracy | See footnote b |
| Matrix spike duplicate (MSD) | Laboratory reproducibility/accuracy | See footnote b |
| Surrogate (SUR) | Recovery/yield | See footnote b |
| Laboratory control sample (LCS) | Method accuracy | One per batch |

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

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

### 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 prior to 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 (VOCs) only. The FXRs are used to evaluate potential contamination caused by conditions in the field.

The 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 (MDL) 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 MDL.

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 (RPD). Only field duplicates with at least one result greater than five times the MDL or minimum detectable activity (MDA) 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 [MBs], laboratory control samples [LCSs]/blank spikes, and MSs) are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, 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 concentration limit determined for Hanford Site groundwater. 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<br>Conductivity<br>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** | | | |
| Anions by IC<br>Cyanide<br>Sulfide | 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<br>Cadmium<br>Chromium<br>Lead<br>Mercury<br>Selenium<br>Thallium<br>ICP metals<br>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" |
| **VOCs** | | | |
| Volatiles by GC/MS | 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" |
| **Semi-VOCs** | | | |
| PCBs by GC<br>Phenols by GC<br>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 TOC and TOX only.

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

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

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|

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.

Data flags:

B, C = possible laboratory contamination (analyte was detected in the associated MB)

N = result may be biased (associated MS 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 (%) | Precision (% RSD)* |
|---|---|---|---|
| Nitrate | Quarterly | ±25% | ≤25% |
| Chromium | Annually | ±20% | ≤25% |

* 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.

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 *Methods of Chemical Analysis of Water and Wastes* (EPA/600/4-79/020). 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 the 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 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 prior to 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 *Hanford Federal Facility Agreement and Consent Order 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 (provided in Section A2.5) 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.

# A5 References

10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*. Available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&rgn=div6&view=text&node=10:4.0.2.5.26.1&idno=10.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/40cfr265_10.html.

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

Subpart F, "Ground-Water Monitoring."

ANSI/ASQ E4-2004, 2004, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use*, American National Standards Institute/American Society for Quality, Milwaukee, Wisconsin.

*Atomic Energy Act of 1954*, 42 USC 2011, et seq. Available at: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf.

AWWA, APHA, and WEF, 2005, *Standard Methods for the Examination of Water and Wastewater*, 21st ed., American Water Well Association, Denver, Colorado; American Public Health Association, Washington, D.C.; and Water Environment Federation, Alexandria, Virginia.

*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

DOE O 414.1C, 2005, *Quality Assurance*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/current-directives/414.1-BOrder-c/view.

DOE/RL-96-68, 2007, *Hanford Analytical Services Quality Assurance Requirements Documents*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/orp/?page=141&parent=14.

DOE/RL-2010-11, 2010, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0084237.

Ecology, EPA, and DOE, 1989a, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

Ecology, EPA, and DOE, 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=82.

EPA/240/B-01/003, 2001, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/QUALITY/qs-docs/r5-final.pdf.

EPA-600/4-79/020, *Methods of Chemical Analysis of Water and Wastes*, U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196018581.

EPA-600/4-84-017, 1984, *Test Methods for Determination of Inorganic Anions in Water by Ion Chromatography*, Method 300.0, U.S. Environmental Protection Agency, Washington, D.C.

*Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://epw.senate.gov/rcra.pdf.

SW-846, 2007, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, as amended, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm.

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

303-330, "Personal Training."

303-400, "Interim Status Facility Standards."

# Appendix B

# Construction Information for Wells 299-W22-26 and 299-W22-89

## WELL CONSTRUCTION AND COMPLETION SUMMARY

| | |
|---|---|
| Drilling Method: Cable tool | Sample Method: Hand tool (nom) |
| Drilling Fluid Used: Water | Additives Used: Not documented |
| Driller's Name: Rodda | WA State Lic Nr: Not documented |
| Drilling Company: Bach Drilling Co | Company Location: Yakima, WA |
| Date Started: 13Nov63 | Date Complete: 20Dec63 |

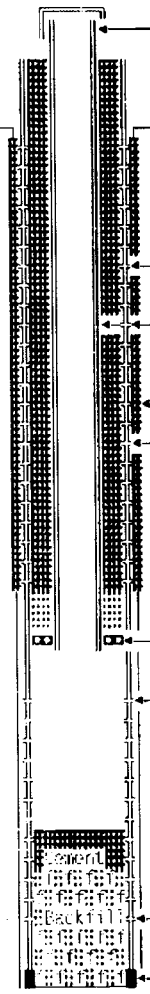
WELL NUMBER: 299-W22-26 TEMPORARY WELL NO:
Hanford Coordinates: N/S N 36,100 E/W W 74,450
State Coordinates: N 441,211 E 2,220,783
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 676.8 Estimated

Depth to water: 213-ft Dec63
(Ground surface) 217.2-ft 08Dec92

GENERALIZED STRATIGRAPHY Driller's Log

0-5: Fine SAND, SILT
5-10: Coarse SAND and GRAVEL
10-15: Coarse SAND
15-20: Coarse SAND and fine GRAVEL
20-25: Coarse SAND
25-40: Coarse SAND and GRAVEL
40-55: SAND and GRAVEL
55-60: GRAVEL and SAND
60-64: SILT to SAND
64-80: SILT and SAND
80-140: SAND and SILT
140-150: CLAY
150-165: CLAY and SAND
165-172: SAND and GRAVEL
172-175: SAND and SILT
175-179: SAND, SILT and GRAVEL
179-185: SAND and GRAVEL
185-187: GRAVEL, very little SAND
187-195: SAND and GRAVEL
195-197: GRAVEL, very little SAND
197-216: GRAVEL and SAND
216-225: SAND and GRAVEL
225-230: GRAVELL, some SAND
230-246: SAND and GRAVEL
246-255: Pea GRAVEL and SAND
255-275: SAND and GRAVEL
275-280: Gum SAND and GRAVEL
280-300: SAND and GRAVEL (Heaving)

REMEDIATION:
Mar79 by Evans.
Placed sand and cement plug in bottom at about 252-ft.
Perforated 70-190 and 0-70-ft, 2 cuts/rd/ft.
Set 4-in liner and packer to 195-ft.
Placed sand and cement plug on packer. Then grouted annulus.




- Elevation of reference point: [680.30-ft] (top of casing)
- Height of reference point above ground surface [3.5-ft]
- Depth of surface seal [0-190-ft]
  Type of surface seal: Cement grout through perforations
- I.D. of surface casing (if present) [ND]
- Perforated 0-190-ft 2 cuts/rd/ft
- I.D. of riser pipe: [4 & 8-in]
  Type of riser pipe: Carbon steel
- Diameter of borehole: [9-in nom]
- Type of filler: Not documented
- 4-in liner set to 195-ft on packer. 5-gal sand placed above packer.
- Depth top of perforations: [200-ft]
  Description of perforations:
  200-240-ft, 6 cuts/rd/ft
  240-260-ft, 4 cuts/rd/ft
  260-297-ft, 1 cut/rd/ft spiraling
- Depth bottom of perforations: [297-ft]
- Depth bottom of casing: [300-ft]
- Depth bottom of borehole: [300-ft]

Drawing By: RS/2022-26 ASB Date: 23Apr93
Reference: HANFORD WELLS

## SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
## RESOURCE PROTECTION WELL - 299-W22-26

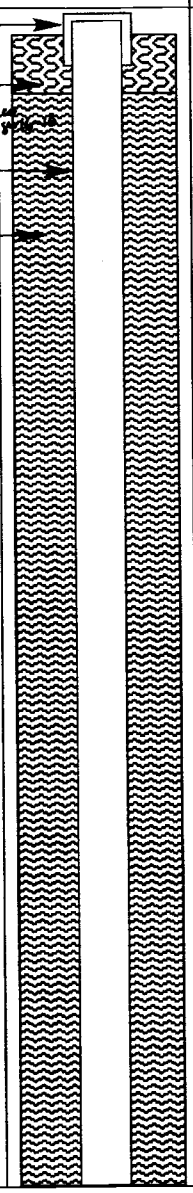
| | |
|---|---|
| WELL DESIGNATION : | 299-W22-26 |
| CERCLA UNIT : | 200 Aggregate Area Management Study |
| RCRA FACILITY : | Not applicable |
| HAN-GRID COORDINATES : | N 36,100 W 74,450 |
| LAMBERT COORDINATES : | N 441,211 E 2,220,783 [HANCONV] |
| DATE DRILLED : | Dec63 |
| DEPTH DRILLED (GS) : | 300-ft |
| MEASURED DEPTH (CS) : | Not documented |
| DEPTH TO WATER (CS) : | 213-ft, Dec63;<br>217.2-ft, 08Dec92 |
| CASING DIAMETER : | 8-in carbon steel, +3.0-300-ft;<br>4-in carbon steel, +3.5-195-ft |
| ELEV TOP CASING : | 680.30-ft, |
| ELEV GROUND SURFACE : | 676.8-ft, Estimated |
| PERFORATED INTERVAL : | 0-190, 200-297-ft |
| SCREENED INTERVAL : | Not applicable |
| COMMENTS : | FIELD INSPECTION, 19Apr91,<br>4 and 8-in carbon steel casing.<br>No pad, no posts, capped and locked.<br>No permanent identification.<br>Not in radiation zone.<br>OTHER: Cement plug in bottom, depth not documented. |
| AVAILABLE LOGS : | Driller |
| TV SCAN COMMENTS : | Not applicable |
| DATE EVALUATED : | Not applicable |
| EVAL RECOMMENDATION : | Not applicable |
| LISTED USE : | Separations area Semiannual water level measurement, 24Aug88-08Dec92;<br>PNL Annual and Semiannual; WHC Semiannual water sample schedule |
| PUMP TYPE : | Electric submersible. |
| MAINTENANCE : | |

| WELL SUMMARY SHEET | Start Date: 6/10/10<br>Finish Date: 6/21/10 | Page 1 of 2 |
|---|---|---|

| | | | |
|---|---|---|---|
| Well ID: C7664 | | Well Name: 299-W22-89 | |
| Location: 45 meters south of 299-W22-47 | | Project: 5 M-24 RCRA Monitoring Wells | |
| Prepared By: Ryan W. Brauchla | Date: 6/23/10 | Reviewed By: L. D. Walker | Date: 8-9-10 |
| Signature: Ryan W. Brauchla | | Signature: L D Walker | |

**CONSTRUCTION DATA**

| Description | Diagram |
|---|---|
| Stainless Steel Protective Casing: + 3.00 ft above ground surface | |
| Portland Cement Type I/II: 0 - 9.0 ft bgs, sch. 10 | |
| 4-in I.D. Stainless Steel Type 304L, Permanent Blank Casing: + 2.00 - 230.84 ft bgs | |
| #8 Granular Bentonite Crumbles: 9.0 - 222.0 ft bgs | |



All temporary drill casing was removed from the ground.

All depths are in feet below ground surface.

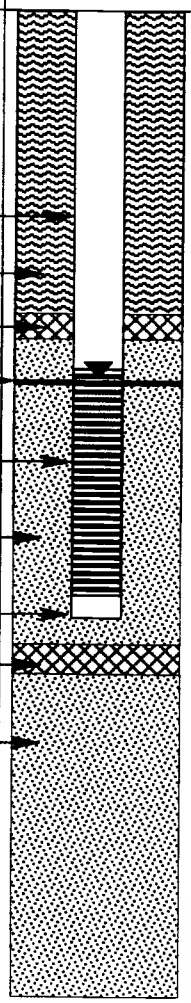
Borehole drilled with 9-inch O.D. casing: 0.0 - 332.6 ft bgs.

**GEOLOGIC/HYDROLOGIC DATA**

| Depth in Feet | Graphic Log | Lithologic Description/Groundwater Sample Depths (ft bgs) |
|---|---|---|
| 0 | | 0-1 Gravel (G) |
| | | 1-8 Sand (S) |
| | | 8-12 Silty Sand (mS) |
| | | 12-19 Sand (S) |
| 20 | | 19-25 Slightly Gravelly Sand (gmS) |
| | | 25-27 Silty Sand (mS) |
| | | 27-39 Sand (S) |
| 40 | | 39-52 Silty Sand (mS) |
| | | 52-78 Sand (S) |
| 60 | | |
| 80 | | 78-82 Gravelly Sand (gS) |
| | | 82-86 Gravel (G) |
| | | 86-90 Sand (S) |
| | | 90-100 Silty Sand (mS) |
| 100 | | 100-112 Sand (S) |
| | | 112-137 Silty Sand (mS) |
| 120 | | |
| 140 | | 137-142 Silt (M) |
| | | 142-159 Sandy Silt (sM) |
| 160 | | 159-163 Silty Sand (mS) |
| | | 163-167 Silty Sandy Gravel (msG) |
| | | 167-174 Sand (S) |
| | | 174-183 Gravelly Sand (gS) |

| WELL SUMMARY SHEET | Start Date: 6/10/10<br>Finish Date: 6/21/10 | Page 2 of 2 |
|---|---|---|
| Well ID: C7664 | Well Name: 299-W22-89 | |
| Location: 45 meters south of 299-W22-47 | Project: 5 M-24 RCRA Monitoring Wells | |
| Prepared By: Ryan W. Brauchla | Date: 6/23/10 | Reviewed By: L.D. Walker | Date: 8-9-10 |
| Signature: | Signature: | |

**CONSTRUCTION DATA**

| Description | Diagram |
|---|---|
| LW 8-16-10<br>Sch. 10<br>4-in I.D. Stainless Steel Type 304L, Permanent Blank Casing: + 2.00 - 230.84 ft bgs<br>#8 Granular Bentonite Crumbles: 9.0 - 222.0 ft bgs<br>Uncoated Bentonite Pellets: 222.0 - 226.3 ft bgs<br>Static Water Level: 232.31 ft bgs (6/8/10)<br>4-in I.D. Stainless Steel Type 316, 20 Slot (0.020-in) Screen: 230.84 - 265.87 ft bgs<br>Primary Sand Pack<br>10-20 Mesh Colorado Silica Sand: 226.3 - 272.2 ft bgs<br>4-in, I.D. Stainless Steel Type 304, Sump/End Cap: 265.87 - 269.19 ft bgs<br>Coated Bentonite Pellets: 272.2 - 277.1 ft bgs<br>Backfill Sand Pack<br>10-20 Mesh Colorado Silica Sand: 277.1 - 332.6 ft bgs<br><br>All temporary drill casing was removed from the ground.<br><br>All depths are in feet below ground surface.<br><br>Borehole drilled with 9-inch O.D. casing: 0.0 - 332.6 ft bgs. |  |

**GEOLOGIC/HYDROLOGIC DATA**

| Depth in Feet | Graphic Log | Lithologic Description/Groundwater Sample Depths (ft bgs) |
|---|---|---|
| 180 | | 174-183 Gravelly Sand (gS) |
| | | 183-188 Silty Sandy Gravel (msG) |
| | | 188-249 Sandy Gravel (sG) |
| 200 | | |
| 220 | | |
| 240 | | |
| | | 249-273 Gravel (G) |
| 260 | | |
| | | 273-279 Silty Sandy Gravel (msG) |
| 280 | | 279-310 Sandy Gravel (G) |
| 300 | | |
| | | 310-323 Gravel (G) |
| 320 | | |
| | | 323-326 Sandy Gravel (sG) |
| | | 326-332.6 Gravel (G) |
| | | Total Depth Drilled: 332.6 ft bgs (6/14/10) |
| 340 | | |

# Distribution

| | MS | Quantity |
|---|---|---|
| U.S. Department of Energy, Richland Operations Office | | |
| N.M. Bland | A5-11 | 1 |
| R.D. Hildebrand | A6-38 | 1 |
| DOE Public Reading Room | H2-53 | 1 |
| | | |
| U.S. Department of Energy, Office of River Protection | | |
| L. Huffman | H6-60 | 1 |
| C.J. Kemp | H6-60 | 1 |
| R.W. Lober | H6-60 | 1 |
| | | |
| CH2M HILL Plateau Remediation Company – Electronic Distribution | | |
| G.A. Aljure | H8-45 | |
| W.R. Faught | H8-15 | |
| R.L. Fleshman | R3-50 | |
| D.A. Gamon | R3-50 | |
| J.W. Lindberg | R3-50 | |
| S.P. Luttrell | R3-50 | |
| C.J. Martin | R3-50 | |
| J.P. McDonald | R3-50 | |
| C.W. Miller | H8-15 | |
| R.W. Oldham | R3-60 | |
| L.C. Swanson | R3-50 | |
| W.R. Thackaberry | R3-60 | |
| G.S. Thomas | R3-50 | |
| J.A. Winterhalder | R3-60 | |
| C.D. Wittreich | H8-15 | |
| M.I. Wood | H8-51 | |

DOE/RL-2009-74
Revision 0

# Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area U

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

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

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Date Published
January 2011

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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LE Bratton 2/2/2011
Release Approval Date

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Further Dissemination Unlimited

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# Executive Summary

Waste Management Area (WMA) U, which incorporates the U Tank Farm, is regulated under Washington State's "Hazardous Waste Management Act" (RCW 70.105) and its implementing requirements in WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards." The Washington State Department of Ecology (Ecology) has been authorized by the U.S. Environmental Protection Agency, in accordance with *Authorized State Hazardous Waste Programs*, to conduct its hazardous waste regulatory program in lieu of the *Resource Conservation and Recovery Act of 1976* (RCRA), including the requirements in 40 CFR 265, Subpart F ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring"). The WMA U is also subject to the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989), with Ecology identified as the lead regulatory agency for the unit.

The WMA U was placed in assessment monitoring in 2000 because of elevated specific conductance, and a groundwater quality assessment plan was implemented (PNNL-13185, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U at the Hanford Site*). An assessment report of the initial findings was issued in July 2000 (PNNL-13282, *Groundwater Quality Assessment for Waste Management Area U: First Determination*), and it was concluded that the tank farm had impacted groundwater quality. The assessment plan was updated in 2001 (PNNL-13612, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U*), and two subsequent interim change notices were issued for continued RCRA groundwater quality assessment (PNNL-13612-ICN-1 and PNNL-13612-ICN-2), as required by 40 CFR 265.93(d)(7), "Preparation, Evaluation, and Response."

This document supersedes PNNL-13612 and updates the groundwater monitoring project management organization.

This plan describes the WMA U facility and operating history, waste characteristics, hydrogeology, previous monitoring at the WMA, groundwater and vadose zone contamination associated with the WMA, and the conceptual model for the WMA. The plan addresses the following:

- Adequacy of the wells monitoring groundwater at WMA U
- Sampling requirements and schedule
- Analytes, groundwater parameters, and analytical methods necessary to determine extent of contamination from WMA U
- Procedures for evaluating groundwater quality data
- Reporting requirements

This assessment plan is the principal controlling document for conducting groundwater monitoring at WMA U.

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# Terms

| | |
|---|---|
| CAS | Chemical Abstracts Service |
| CERCLA | *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* |
| CY | calendar year |
| DOE | U.S. Department of Energy |
| DQO | data quality objective |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| ID | identification |
| NAVD88 | North American Vertical Datum of 1988 |
| OU | operable unit |
| QAPjP | quality assurance project plan |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| SST | single-shell tank |
| WMA | waste management area |

# 1 Introduction

Since 1944, the Hanford Site's single-shell tanks (SSTs) have stored radioactive waste and dangerous chemical waste generated from plutonium-production and separation activities. The 149 SSTs are recognized as dangerous waste management units and are regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA), RCW 70.105 ("Hazardous Waste Management"), and its implementing requirements (WAC 173-303, "Dangerous Waste Regulations"). Only dangerous chemical waste is regulated by RCRA; radioactive waste is regulated under the *Atomic Energy Act of 1954*.

The U Tank Farm in the 200 West Area comprises Waste Management Area (WMA) U (Figure 1-1). A RCRA interim status detection groundwater monitoring program for the SSTs was implemented in 1989 (WHC-SD-EN-AP-012, *Interim Status Groundwater Monitoring Plan for the Single-Shell Tanks*), and detection monitoring began at WMA U in 1991. The WMA was placed into assessment status monitoring in 2000 due to elevated specific conductance in downgradient monitoring wells (PNNL-13185, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U at the Hanford Site*).

This document presents a revised groundwater assessment plan for WMA U that supersedes the previous groundwater assessment plan (PNNL-13612, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U*) and two subsequent interim change notices (PNNL-13612-ICN-1 and PNNL-13612-ICN-2). Background information is summarized in this document, and references are provided to other documents for additional detail.

The specific objective of this revised groundwater assessment plan is to fulfill the requirements specified in WAC 173-303-400(3) ("Interim Status Facility Standards"), incorporating by reference 40 CFR 265.93 ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Preparation, Evaluation, and Response"). These requirements specify that the concentration, rate, and extent of migration of dangerous waste constituents in the groundwater must be determined. To meet this objective, this plan defines a network of groundwater monitoring wells; specifies the sampling frequency; and lists the dangerous constituents, indicators, and supporting constituents to be monitored in groundwater. This monitoring plan is prepared to be consistent, to the extent possible, with the final status monitoring plan that will be incorporated into the *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste* (WA7890008967, as amended) in the future.

Chapter 2 of this plan summarizes background information, including a description of WMA U and the types of waste present, a brief history of the groundwater monitoring program, and a description of the geology and hydrogeology of the area. This information is incorporated into the site conceptual model to assist in development of the groundwater monitoring program. Chapter 3 describes the RCRA groundwater monitoring program, the wells monitored, sampling frequency and protocols, and the constituents analyzed. Chapter 4 describes data evaluation, interpretation, and reporting. A list of the references cited in this document is provided in Chapter 5. Appendix A provides the quality assurance project plan (QAPjP), and Appendix B includes construction information for well 299-W19-47.

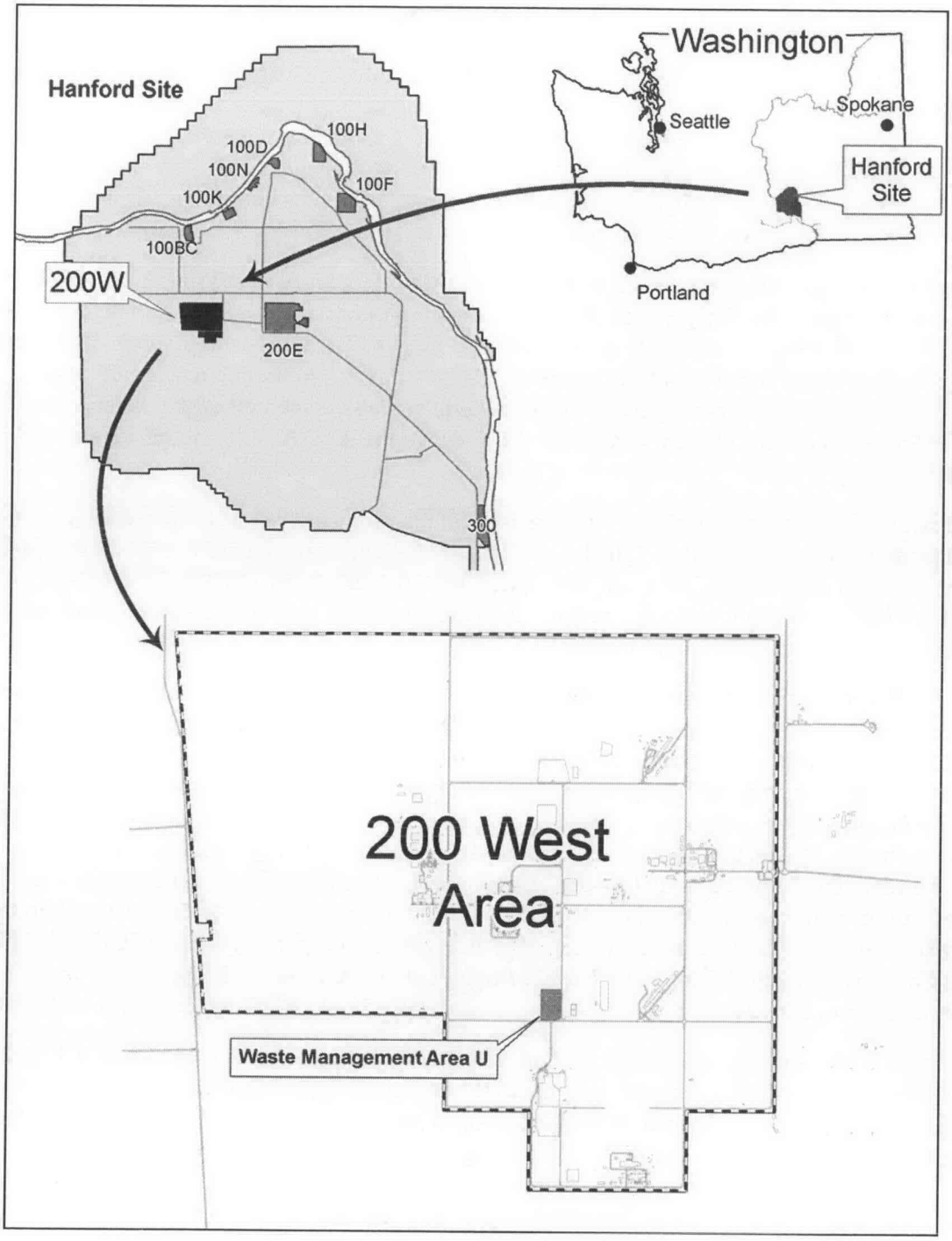


**Figure 1-1. Location of WMA U**

# 2 Background

This chapter describes WMA U, the regulatory requirements for groundwater monitoring, and waste characteristics. It also summarizes the hydrogeology beneath the WMA, outlines a conceptual model for contaminant migration, describes groundwater contamination in the uppermost aquifer, and addresses the data quality objectives (DQOs).

## 2.1 Facility Description and Operational History

The WMA U occupies an area of approximately 29,000 $m^2$ (310,000 $ft^2$) and contains 16 underground SSTs (Figure 2-1). The SSTs were constructed between 1943 and 1944. Twelve of the SSTs are 100-series tanks, which are 23 m (75 ft) in diameter and have capacities of 2,020,000 L (535,000 gal) (RPP-35485, *Field Investigation Report of Waste Management Area U)*. Four of the SSTs are 200-series tanks, which are 6 m (20 ft) in diameter and have capacities of 210,000 L (55,000 gal). The bases of both the 100-series and the 200-series tanks are approximately 11.3 m (37 ft) below ground surface. The WMA also contains a variety of ancillary equipment used to manage tank waste during operations, including six diversion boxes, the 271-UR control house, the 244-UR process vault, the 244-U double-contained receiver tank, waste transfer lines, pits, and junction boxes.

The tank farm received waste from the bismuth-phosphate process between 1946 and 1948 and from the reduction-oxidation process between 1954 and 1957 (WHC-MR-0132, *History of 200 Area Tank Farms*). In 1952, some waste was retrieved and pumped to the 242-T evaporator, and between 1952 and 1957, the metal wastes (stored in nine of the 100-series tanks) were transferred to U Plant to facilitate uranium recovery. A more detailed history of operations is presented in *Groundwater Quality Assessment for Waste Management Area U: First Determination* (PNNL-13282) and is also addressed in *Historical Vadose Zone Contamination from U Farm Operations* (RPP-7580) and RPP-35485.

The tank status and inventory are documented in monthly updates of the waste tank summary report (e.g., HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2009*, Rev. 261). Four tanks are known or assumed to have experienced a leak/release: U-101, U-104, U-110, and U-112. To minimize future leaks/releases, all Hanford Site SSTs have been interim stabilized, which means that the drainable liquid in each tank has been removed and transferred to double-shell tanks[1] (DOE/ORP-2008-01, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*). While this reduces the possibility of a future leak/release, releases may still be possible because some residual liquid generally remains in an interim-stabilized tank.

## 2.2 Regulatory Basis

In May 1987, the U.S. Department of Energy (DOE) issued a final rule (10 CFR 962, "Byproduct Material") stating that the hazardous waste components of mixed waste are subject to RCRA regulations. In November 1987, the U.S. Environmental Protection Agency (EPA) authorized the Washington State Department of Ecology (Ecology) to regulate these hazardous waste components within the state of Washington (51 FR 24504, "EPA Clarification of Regulatory Authority Over Radioactive Mixed Waste"). In 1996, the Washington State Attorney General determined that the effective date for regulation of mixed waste in Washington State was August 19, 1987.

---

[1] A more precise definition of an interim stabilized tank is one that contains less than 189,000 L (50,000 gal) of drainable interstitial liquid and less than 18,900 L (5,000 gal) of supernatant (HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2009*, Rev. 261).

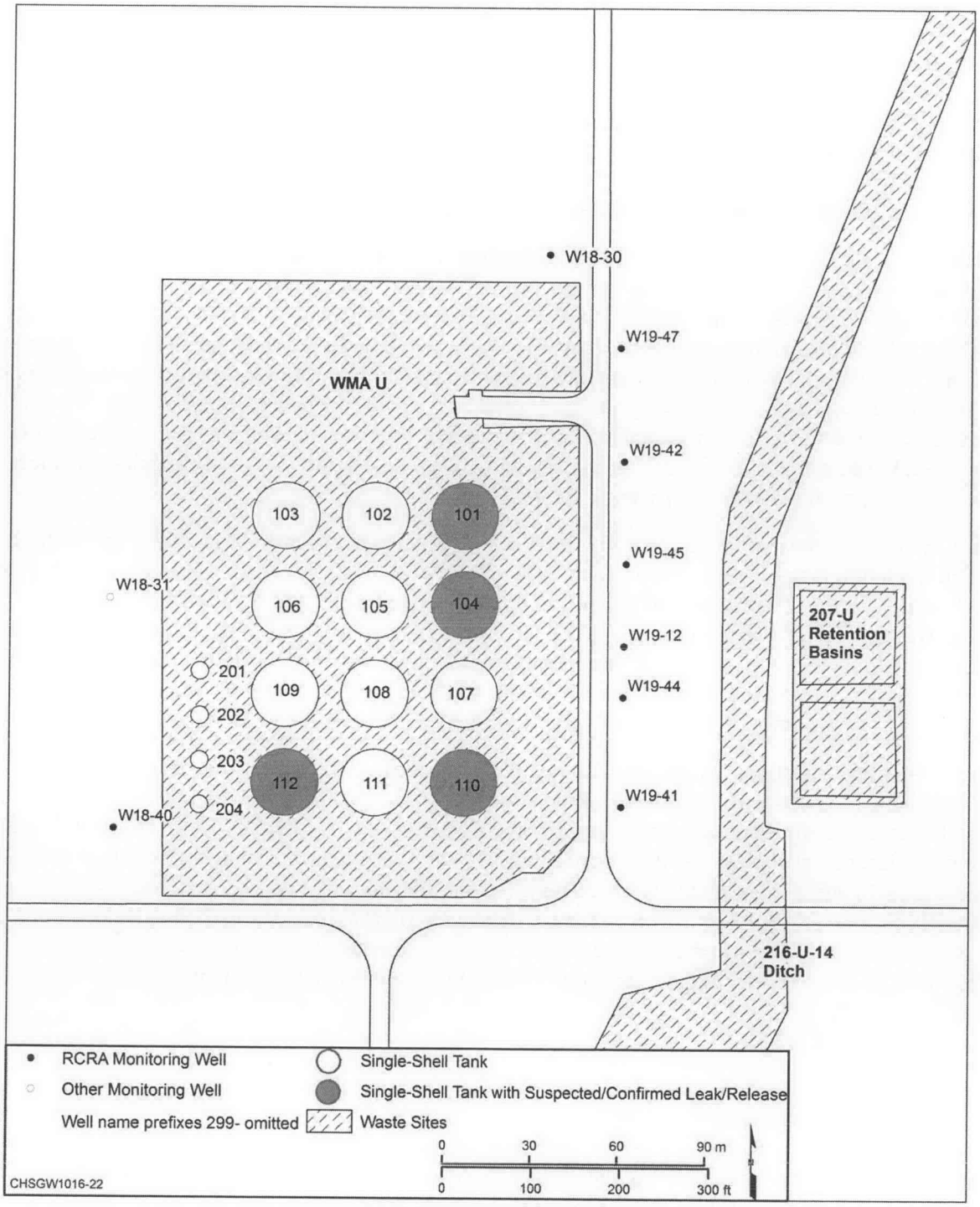


**Figure 2-1. WMA U and Vicinity**

Groundwater monitoring is conducted at WMA U in accordance with WAC 173-303-400(3) and, by reference, 40 CFR 265, Subpart F ("Ground-Water Monitoring"), which requires monitoring to determine whether dangerous waste or dangerous waste constituents from the waste site have entered the groundwater. The WMA U was placed in assessment monitoring (40 CFR 265.93[d][4]) after elevated specific conductance in a downgradient monitoring well was observed and confirmed (PNNL-13185).

An assessment report of the initial findings was issued in July 2000 (PNNL-13282), which concluded that the tank farm had impacted groundwater quality and that tank waste constituents present in the groundwater resulted from surface water infiltration in the southern portion of the WMA. As required by 40 CFR 265.93(d)(7)(i), assessment monitoring has continued under several updates to the monitoring plan.

## 2.3 Waste Characteristics

Table 2-1 lists the dangerous constituents found in the Dangerous Waste Permit Part A form (WA7890008967). Mobile tank waste constituents originally identified in the groundwater included nitrate and chromium, but chromium concentrations have since declined to near the chromium analytical detection limit (DOE/RL-2010-11, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2*).

**Table 2-1. Dangerous Wastes in the Single-Shell Tank System (Dangerous Waste Permit Application Part A Form)**

| Dangerous Waste Code | Contaminant Description | Dangerous Waste Code | Contaminant Description |
|---|---|---|---|
| D001 | Ignitable waste | D034 | Hexachloroethane |
| D002 | Corrosive waste | D035 | Methyl ethyl ketone |
| D003 | Reactive waste | D036 | Nitrobenzene |
| D004 | Arsenic | D038 | Pyridine |
| D005 | Barium | D039 | Tetrachloroethylene |
| D006 | Cadmium | D040 | Trichloroethene |
| D007 | Chromium | D041 | 2,4,5-Trichlorophenol |
| D008 | Lead | D043 | Vinyl chloride |
| D009 | Mercury | F001 | 1,1,1-Trichloroethane |
| D010 | Selenium | F002 | Methylene chloride |
| D011 | Silver | F003 | Acetone, methyl isobutyl ketone |
| D018 | Benzene | F004 | Cresol-m, -o, -p |
| D019 | Carbon tetrachloride | F005 | Methyl ethyl ketone |
| D022 | Chloroform | WT01 | Extremely hazardous waste/ toxic dangerous waste |
| D028 | 1,2-Dichloroethane | WT02 | Dangerous waste/ toxic dangerous waste |
| D029 | 1,1-Dichloroethylene | WP01 | Extremely hazardous waste/ persistent dangerous waste |

**Table 2-1. Dangerous Wastes in the Single-Shell Tank System (Dangerous Waste Permit Application Part A Form)**

| Dangerous Waste Code | Contaminant Description | Dangerous Waste Code | Contaminant Description |
|---|---|---|---|
| D030 | 2,4-Dinitrotoluene | WP02 | Dangerous waste/persistent dangerous waste |
| D033 | Hexachlorobutadiene | | |

Notes:

1. This table is based on the Dangerous Waste Permit Application Part A form (WA789000896).
2. Analytes associated with the "F001" through "F005" waste codes are from WHC-MR-0517, *Listed Waste History at Hanford Facility TSD Units*.

## 2.4 Geology and Hydrology

The generalized stratigraphy of the Hanford Site is shown in Figure 2-2. The local stratigraphy beneath WMA U consists of unconsolidated to semiconsolidated sediments overlying basalt bedrock of the Columbia River Basalt Group. The sedimentary units present (in descending sequence) are as follows:

- Sand and gravel backfill
- Sand and gravel of the Hanford formation
- Fine-grained Cold Creek unit
- Sand and gravel of the Ringold Formation Unit E
- Fine-grained Ringold Formation lower mud unit
- Sand and gravel of Ringold Formation Unit A (which overlies the basalt)

Note that the Ringold Formation upper fines (member of Savage Island and member of Taylor Flat) are not present beneath the WMA. The water table occurs within Ringold Formation Unit E, and the vadose zone beneath the WMA is approximately 67 m (220 ft) thick. The base of the aquifer is the fine-grained Ringold Formation lower mud unit. The unconfined aquifer is approximately 70 m (230 ft) thick. A more detailed description of the geology of WMA U is provided in *Subsurface Conditions Description of the U Waste Management Area* (RPP-15808) and PNNL-13612. The *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington* (PNNL-13858) describes the hydrogeology of the entire 200 West Area and vicinity.

Figure 2-3 shows the March 2009 water table map for the WMA U and vicinity. Groundwater flow conditions at WMA U have varied greatly over the past several decades because of changing wastewater disposal in areas surrounding the WMA. Between 1950 and 1970, the groundwater flow direction beneath the WMA varied between southeast, east, and northeast, depending on effluent disposal volumes to the former 216-T-4 Pond to the north of the WMA and the former 216-U-10 Pond to the southwest (PNNL-16069, *Development of Historical Water Table Maps of the 200 West Area of the Hanford Site [1950-1970]*).

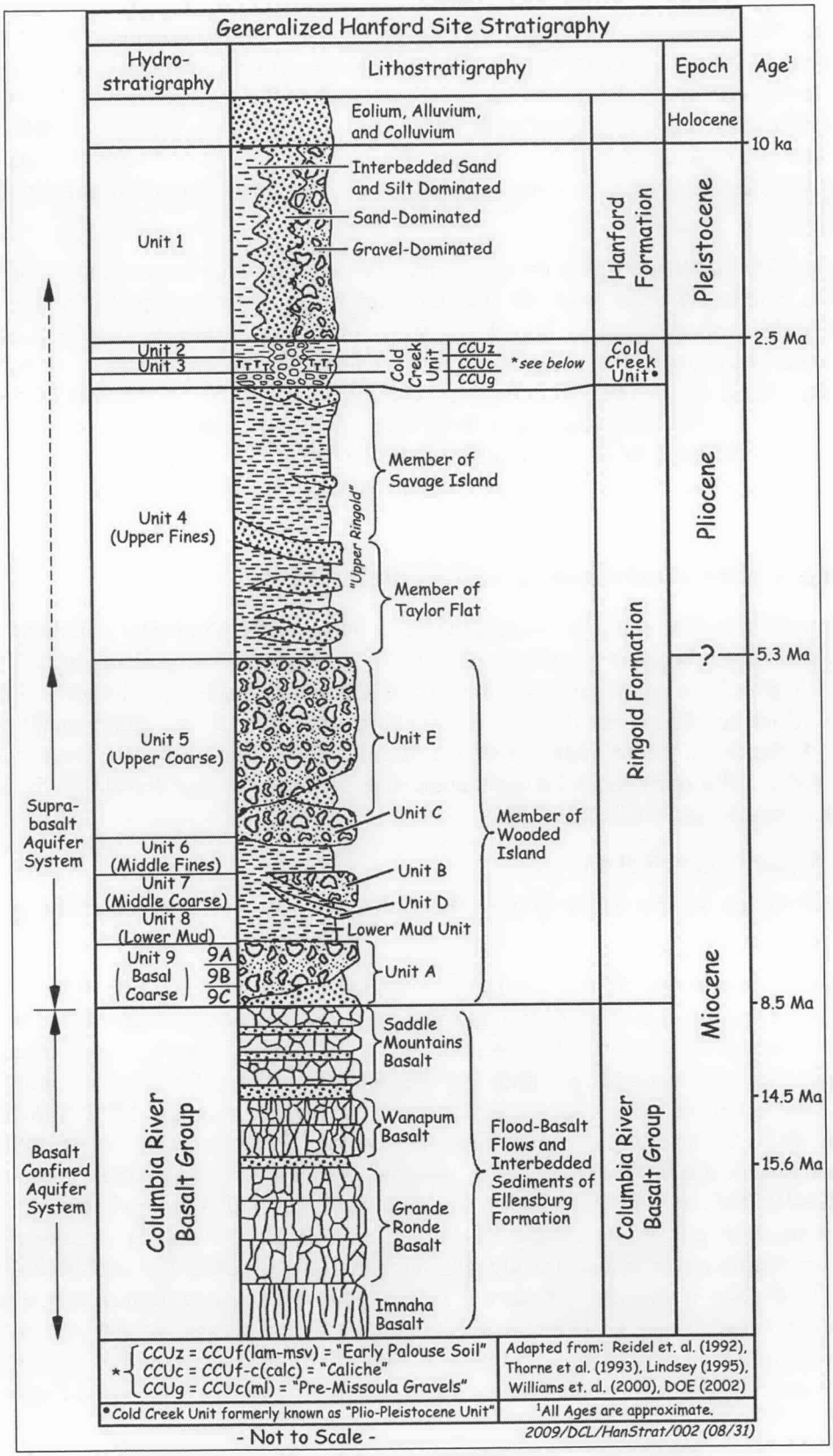


**Figure 2-2. Generalized Stratigraphy of the Hanford Site**

During the 1980s, the flow direction changed from northeast to east in response to decommissioning of the 216-U-10 Pond in 1985. In the late 1980s and early 1990s, nearby effluent discharges occurred at the 216-Z-20 Crib to the west of the WMA and the 216-U-14 Ditch to the east (see Figure 2-1 for waste site locations). The effluent volume discharged to the 216-Z-20 Crib declined in 1992, and the flow direction beneath the WMA reversed to westerly flow because discharges to the 216-U-14 Ditch became dominant. Discharges to both sites had ceased by 1996, and the flow direction has been toward the east-northeast since that time.

Between January 2005 and March 2009, the water table elevation declined at an average rate of 0.29 m/yr (0.95 ft/yr) in the monitoring wells. Analysis of water-level data collected during March 2009 indicates that the hydraulic gradient magnitude is $2.2 \times 10^{-3}$ m/m, and the groundwater flow rate (i.e., average linear velocity) ranges between 7 and 77 m/yr (23 and 250 ft/yr), depending on the hydraulic conductivity and effective porosity. Using values believed to be most representative, 6.12 m/d (20.1 ft/d) for the hydraulic conductivity and 0.17 for the effective porosity (both values are from a constant-rate pumping test conducted in well 299-W19-42, as provided in PNNL-13378, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 1999*), the groundwater flow rate most representative for this site is 29 m/yr (95 ft/yr).

## 2.5 Summary of Previous Groundwater Monitoring

In 1999, the groundwater monitoring program for WMA U changed from indicator parameter evaluation to groundwater assessment because specific conductance in downgradient monitoring well 299-W19-41 exceeded the critical mean value. An assessment report of the initial findings was issued in July 2000 (PNNL-13282), which concluded that the tank farm had impacted groundwater quality and that tank waste constituents present in the groundwater resulted from surface water infiltration in the southern portion of the WMA. Subsequent annual assessment results have been included in Hanford Site annual groundwater reports (e.g., DOE/RL-2010-11).

### 2.5.1 Groundwater Contamination

The following discussion is summarized from DOE/RL-2010-11 and represents conditions in calendar year (CY) 2009.

Groundwater contamination from WMA U is limited to the downgradient (east) side of the site (PNNL-13282). Constituents found in the groundwater originally included the dangerous waste chromium and the supporting constituent nitrate, but chromium concentrations have decreased in the recent past to near the analytical detection limit. Nitrate concentrations are the highest along the southern half of the site. Nitrate concentrations are increasing in all but two monitoring wells (299-W19-41 and 299-W19-44) at WMA U, including the upgradient well. During CY 2009, nitrate concentrations were above the drinking water standard (45 mg/L) in at least one sample from downgradient wells 299-W19-12, 299-W19-42, 299-W19-44, 299-W19-45, and 299-W19-47. The maximum nitrate concentration measured in a quarterly sample was 86 mg/L in well 299-W19-44 during January 2009. Concentrations are higher in the downgradient wells compared to upgradient well 299-W18-40, confirming that WMA U is a source of nitrate to the aquifer; however, nitrate from an upgradient source is also affecting groundwater quality. During CY 2009, the maximum nitrate concentration measured in upgradient well 299-W18-40 was 43 mg/L in October 2009, nearly exceeding the drinking water standard. Nitrate concentrations for some of the network monitoring wells are shown in Figure 2-4.

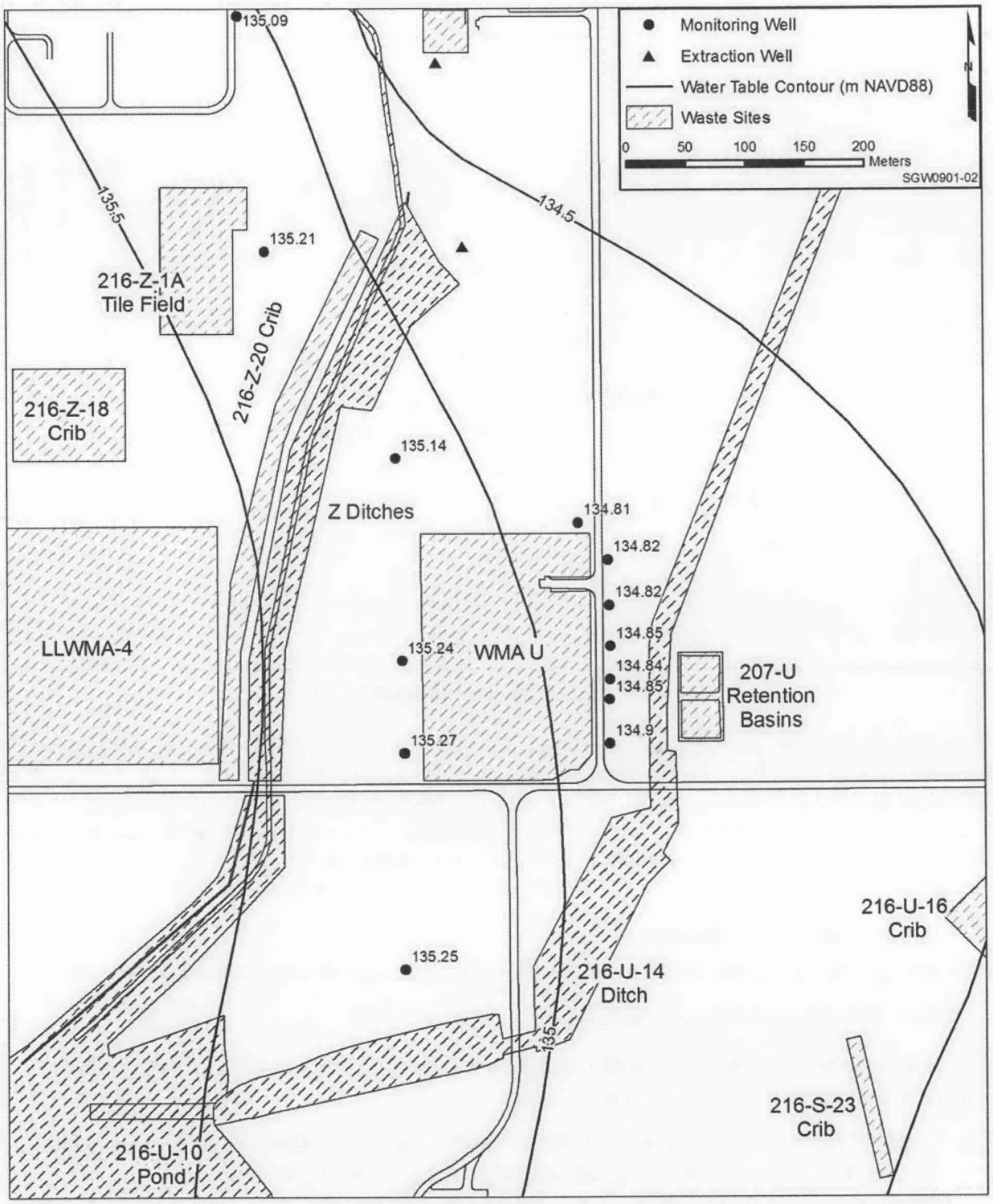


**Figure 2-3. Water Table Elevations, March 2009**

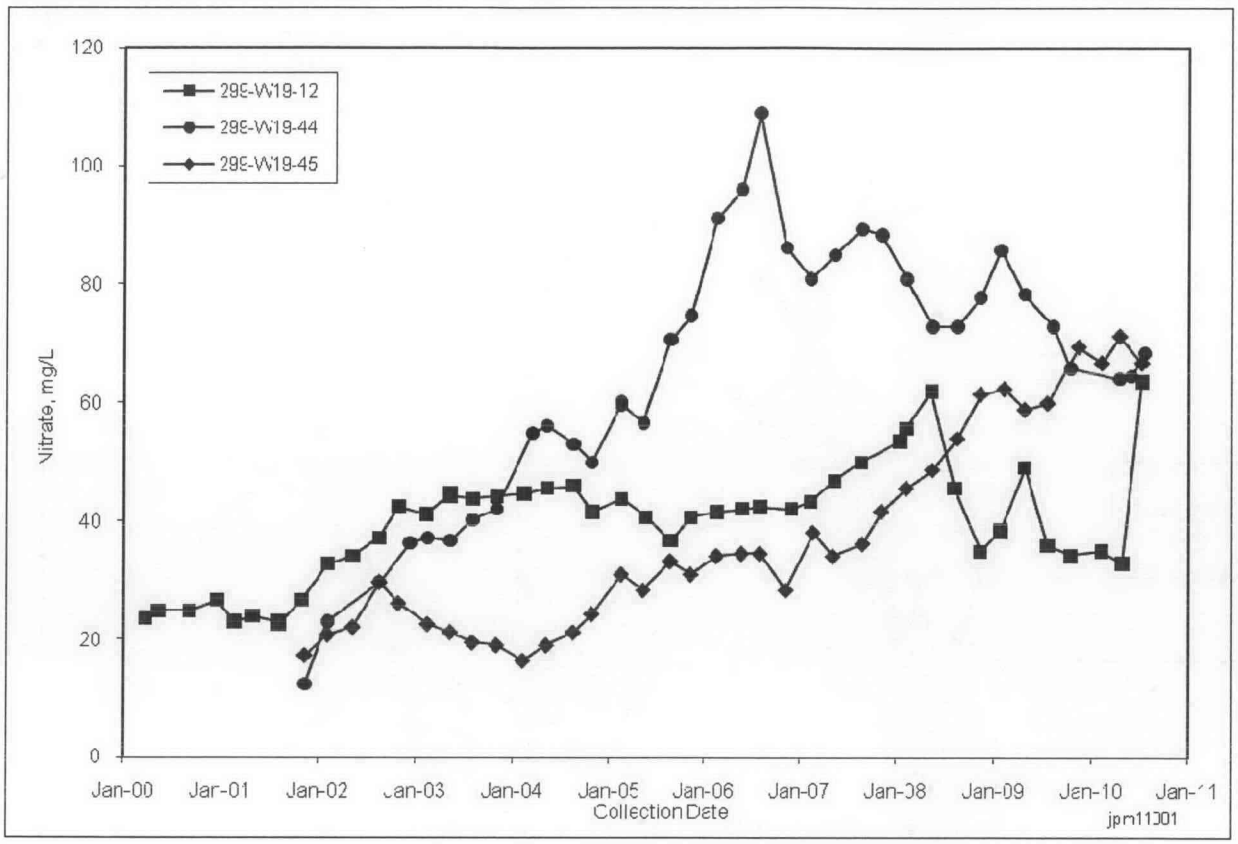


**Figure 2-4. Nitrate Concentrations at WMA U**

Carbon tetrachloride is found in groundwater beneath WMA U at concentrations above the drinking water standard of 5 µg/L. Well 299-W18-30 is the only well in which samples are analyzed for carbon tetrachloride, and the well had results of 130 and 200 µg/L for duplicate samples collected during July 2009. The regional distribution of carbon tetrachloride indicates that this constituent originates from liquid waste disposal sites at the Plutonium Finishing Plant, located northwest of WMA U. Carbon tetrachloride is monitored as part of the 200-UP-1 and 200-ZP-1 Operable Units (OUs).

### 2.5.2 Vadose Zone Contamination

The threat to groundwater posed by the tanks themselves has been significantly reduced for two reasons:

- All SSTs at the Hanford Site have been interim stabilized.
- Interim measures have been implemented to reduce the forces driving contamination downward to the groundwater, such as the following:
  - Constructing berms around the tank farms to divert surface water runoff away from the facility
  - Testing all nearby water lines and removing the leaking water lines from service
  - Capping all vadose zone monitoring boreholes in the tank farms.

However, past tank leaks/releases have left portions of the vadose zone contaminated. This contamination has the potential to move downward into the groundwater, especially if a driving force is present.

To identify areas of vadose zone contamination, a surface geophysical survey was conducted in 2006 (RPP-RPT-31557, *Surface Geophysical Exploration of U Tank Farm at the Hanford Site*). This survey

found a low-resistivity plume (indicating either high soil moisture or high inorganic ions) near tanks U-104 and U-105. This plume is consistent with releases from tank U-104 that have apparently migrated to the west in the vadose zone to beneath tank U-105. Low-resistivity plumes were not found near tanks U-101, U-110, and U-112.

During 2007, 20 direct-push probe holes were installed at WMA U to investigate vadose zone contamination (PNNL-17163, *Characterization of Direct Push Vadose Zone Sediments from the 241-U Single-Shell Tank Farm*). Vadose zone contamination was found near tank U-104, confirming the results of the geophysical survey. In addition, contamination was found near tank U-110. The contamination found at tank U-104 was largely limited to radionuclides; elevated dangerous waste or dangerous waste constituents were not found in the vadose zone near this tank. Water-extractable nitrate and chromium were found elevated in the vadose zone near tank U-110, and elevated pH and specific conductance were also found in the water extracts. The contamination extends to at least a depth of 28 m (92 ft) near tank U-104 and a depth of 30 m (98 ft) near tank U-110, which are the depths at which the probe holes were installed. Contamination was not found in the two probe holes installed near tank U-101 and the single probe hole installed near tank U-112. Additional characterization efforts are needed to understand the full lateral and vertical extent of vadose zone contamination at WMA U.

## 2.6 Conceptual Model

DOE/ORP-2008-01 summarizes a conceptual model of tank leak/release pathways to the groundwater, and Appendix A of that document presents the conceptual model in detail. The following summary is from DOE/ORP-2008-01, as well as PNNL-13282 and PNNL-13612. Conceptual models for the tank leaks/releases at WMA U are also discussed in RPP-35485.

### 2.6.1 Contaminant Source

Tank leak/release events began with rapid discharge of some waste fluid volume into the subsurface from a point of entry likely having a small spatial extent (on the order of inches to rarely feet). This discharge temporarily increased the moisture content of the unsaturated soil, particularly at the point of entry. Points of entry included poorly sealed openings in the tank structure, ruptured areas of steel tank liners combined with nearby underlying concrete shell fractures, and breaks in waste transfer lines. Natural processes then redistributed the excess moisture within the vadose zone, eventually returning the soil to ambient conditions.

The migration process occurred, for the most part, in partially saturated soils because leak/release volumes were not sufficient to fill the soil pore spaces for an appreciable length of time or very far from the point of entry. This condition is referred to as "unsaturated flow." In addition to vertical flow, lateral flow occurred because soil layers with different hydraulic properties tend to be layered more or less horizontally by sediment deposition processes. Consequently, flow in the lateral direction could occur and be enhanced by the unsaturated conditions.

In addition to tank leaks/releases, four unplanned releases have been documented at WMA U (DOE/RL-91-52, *U Plant Source Aggregate Area Management Study Report*; RPP-23405, *Tank Farm Vadose Zone Contamination Volume Estimates*; and the Waste Information Data System database). The releases were at the ground surface or near the surface, and the waste volumes associated with these unplanned releases are unknown. The releases may have resulted in significant spread of contamination. One release occurred in 1950 at the surface near the 241-U-151 and 241-U-152 diversion boxes, to the east of the southern portion of the WMA (UPR-200-W-6). The second release occurred in 1953 and consisted of a violent chemical reaction in a blending tank in the 244-UR vault, located at the northern end of the WMA, which spread first-cycle metal waste contamination over an unspecified area

(UPR-200-W-24). This release continued to spread to the north, beyond the fence, where the area is roped off. The third release was an overflow event at the 241-UR-151 diversion box in 1956 (UPR-200-W-132), and the fourth release involved a ruptured buried waste line at tank U-103 in 1971 (UPR-200-W-128). In the *Vadose Zone Characterization Project at the Hanford Tank Farms U Tank Farm Report* (GJO-97-1-TAR/GJO-HAN-8), significant surface contamination was reported within the tank farm, as well as several undocumented spills or leaks/releases.

### 2.6.2 Driving Force

External sources of water or other liquid may have acted to drive contamination downward. Infiltration of fresh water (as well as precipitation and unintentional, manmade releases such as leaking water lines) may move residual waste remaining in the soil downward to the groundwater. Another potential source of water was discharges to nearby wastewater disposal sites: the 216-Z-20 Crib and Z Ditches to the west, and the 216-U-14 Ditch to the east (RPP-23405). Perched water beneath these disposal sites may have migrated laterally beneath WMA U, although this has not been confirmed.

As waste fluids are migrating within the vadose zone, numerous contaminants are reacting chemically with the vadose zone soil/water system to varying degrees. Water extracts of contaminants from sediments collected from the direct-push probe holes installed at WMA U during 2007 confirmed variable mobility of the contaminants (PNNL-17163).

### 2.6.3 Migration

Upon reaching the groundwater, the plumes migrate toward the east with the groundwater flow. The groundwater flow velocity has been estimated at 29 m/yr (95 ft/yr) (see Section 2.4). RPP-35485 discusses conceptual models of tank leak/release pathways to the groundwater at WMA U in more detail.

## 2.7 Data Quality Objectives

The DQO process ensures that data gathered during an investigation are of the appropriate quantity and quality to meet specific objectives. The DQO parameters, regulatory interim status requirements, and associated reports supporting the regulatory requirements are outlined in Table 2-2.

**Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA U**

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|
| Scope | **40 CFR 265.93, "Preparation, Evaluation, and Response"; as modified by WAC 173-303-400(3)(b) and -400(3)(c)(v).**<br>(d)(7) If the owner or operator determines…that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator:<br>(i) Must continue to make the determinations required under paragraph (d)(4) of this section…<br>**40 CFR 265.93, "Preparation, Evaluation, and Response"; as modified by WAC 173-303-400(3)(b) and -400(3)(c)(v).**<br>(d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine:<br>(i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and<br>(ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water.<br>**40 CFR 265.93, "Preparation, Evaluation, and Response"; as modified by WAC 173-303-400(3)(b) and -400(3)(c)(v).**<br>(d)(3) The plan to be submitted under 40 CFR 265.90(d)(1) or paragraph (d)(2) of this section must specify:<br>(i) The number, location, and depth of wells;<br>(ii) Sampling and analytical methods for those hazardous wastes or hazardous waste constituents in the facility;<br>(iii) Evaluation procedures, including any use of previously gathered ground-water quality information; and<br>(iv) A schedule of implementation. | PNNL-13185, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U at the Hanford Site*<br>PNNL-13612, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U*, as modified by interim change notice<br>This plan, Sections 3.1 and 3.2, Chapter 4, and Appendix A |

**Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA U**

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|
| Number and location of wells<br>Point(s) of compliance | **40 CFR 265.93, "Preparation, Evaluation, and Response"; as modified by WAC 173-303-400(3)(b) and -400(3)(c)(v).**<br>(d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine:<br>(i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and<br>(ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water. | PNNL-13185, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U at the Hanford Site*<br>PNNL-13612, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U*, as modified by interim change notice<br>This plan, Chapters 1 and 3, and Appendix A |
| Well configuration (depth and length of screened interval; well construction) | **40 CFR 265.91, "Ground-Water Monitoring System."**<br>(c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water.<br>**Additional requirements from WAC 173-303-400 (3)(c)(v)(C).**<br>Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground-water contamination. WAC 173-160 may be used as guidance in the installation of wells. | PNNL-13185, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U at the Hanford Site*<br>PNNL-13612, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U*, as modified by interim change notice<br>This plan, Section 3.2 |
| Frequency of sampling<br>Types of analysis or measurement<br>Method detection limits or accuracy and precision<br>Methods used to evaluate the collected data | **40 CFR 265.93, "Preparation, Evaluation, and Response"; as modified by WAC 173-303-400(3)(b) and -400(3)(c)(v).**<br>(d)(7) If the owner or operator determines…that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator:<br>(i) Must continue to make the determinations required under paragraph (d)(4) of this section <u>on a quarterly basis</u> until final closure of the facility, if the ground-water quality assessment plan was implemented prior to final closure of the facility; or<br>(ii) May cease to make the determinations required under paragraph (d)(4) of this section, if the ground-water quality assessment plan was implemented during the post-closure care period. | PNNL-13612, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U*, as modified by interim change notice<br>This plan, Section 3.1, Chapter 4, and Appendix A |

**Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA U**

| DQO Parameter | Related Requirements | Plan Criteria and Associated Historical Documentation |
|---|---|---|
| | **40 CFR 265.93, "Preparation, Evaluation, and Response"; as modified by WAC 173-303-400(3)(b) and -400(3)(c)(v).**<br>(d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine:<br>(i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and<br>(ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water. | |

Notes: The references cited in this table are listed in the reference section (Chapter 5) of this plan.

# 3 Groundwater Monitoring Program

This chapter lists the wells monitored, constituents analyzed, and sampling frequency for WMA U. Quality assurance and quality control requirements are provided in the QAPjP (Appendix A).

## 3.1 Constituent List and Sampling Frequency

The constituent list for groundwater sampling includes those analytes on the RCRA groundwater monitoring list that may be present in SST waste. To identify these analytes, the list of primary nonradiological constituents potentially present in SST waste (RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*) was compared to those constituents listed in Appendix 5 of Ecology Publication 97-407, *Chemical Testing Methods for Designating Dangerous Waste: WAC 173-303-090 & -100* (which references 40 CFR 264, Appendix IX). Those constituents in RPP-23403 that are on the groundwater monitoring list (i.e., listed in Appendix 5 of Ecology Publication 97-407) are included in Table 3-1.

**Table 3-1. Constituents on the RCRA Groundwater Monitoring List Potentially Present in the Single-Shell Tank Farm System**

| Constituent | CAS ID | Constituent | CAS ID |
|---|---|---|---|
| **Volatile Organic Compounds** | | | |
| 1,1,1-Trichloroethane | 71-55-6 | Chloroform | 67-66-3 |
| 1,1,2,2-Tetrachloroethane | 79-34-5 | Ethylbenzene | 100-41-4 |
| 1,1,2-Trichloroethane | 79-00-5 | Isobutanol | 78-83-1 |
| 1,1-Dichloroethene | 75-35-4 | Methylene chloride | 75-09-2 |
| 1,2-Dichloroethane | 107-06-2 | Tetrachloroethene | 127-18-4 |
| 2-Butanone (methyl ethyl ketone) | 78-93-3 | Toluene | 108-88-3 |
| 2-Propanone (acetone) | 67-64-1 | Trans-1,3-dichloropropene | 10061-02-6 |
| 4-Methyl-2-pentanone (MIBK) | 108-10-1 | Trichloroethylene | 79-01-6 |
| Benzene | 71-43-2 | Trichlorofluoromethane | 75-69-4 |
| Carbon disulfide | 75-15-0 | Vinyl chloride (chloroethene) | 75-01-4 |
| Carbon tetrachloride | 56-23-5 | Xylenes | 1330-20-7 |
| Chlorobenzene | 108-90-7 | | |
| **Semivolatile Organic Compounds** | | | |
| 1,2,4-Trichlorobenzene | 120-82-1 | Aroclor-1260 | 11096-82-5 |
| 2,4,5-Trichlorophenol | 95-95-4 | Butylbenzylphthalate | 85-68-7 |
| 2,4,6-Trichlorophenol | 88-06-2 | Di-n-butylphthalate | 84-74-2 |
| 2,4-Dinitrotoluene | 121-14-2 | Di-n-octylphthalate | 117-84-0 |

**Table 3-1. Constituents on the RCRA Groundwater Monitoring List Potentially Present in the Single-Shell Tank Farm System**

| Constituent | CAS ID | Constituent | CAS ID |
|---|---|---|---|
| 2-Chlorophenol | 95-57-8 | Fluoranthene | 206-44-0 |
| 2-Methylphenol (o-cresol) | 95-48-7 | Hexachlorobutadiene | 87-68-3 |
| 3-Methylphenol (m-Cresol) | 108-39-4 | Hexachloroethane | 67-72-1 |
| 4-Chloro-3-methylphenol (p-Chloro-m-cresol) | 59-50-7 | Naphthalene | 91-20-3 |
| 4-Methylphenol (p-cresol) | 106-44-5 | Nitrobenzene | 98-95-3 |
| Acenaphthene | 83-32-9 | n-Nitroso-di-n-propylamine | 621-64-7 |
| Aroclor-1016 | 12674-11-2 | n-Nitrosomorpholine | 59-89-2 |
| Aroclor-1221 | 11104-28-2 | 1,2-Dichlorobenzene (o-Dichlorobenzene) | 95-50-1 |
| Aroclor-1232 | 11141-16-5 | 2-Nitrophenol (o-Nitrophenol) | 88-75-5 |
| Aroclor-1242 | 53469-21-9 | Pyrene | 129-00-0 |
| Aroclor-1248 | 12672-29-6 | Pyridine | 110-86-1 |
| Aroclor-1254 | 11097-69-1 | | |
| **Inorganic Constituents (Nonradiological)** | | | |
| Antimony (Sb) | 7440-36-0 | Lead (Pb) | 7439-92-1 |
| Arsenic (As) | 7440-38-2 | Mercury (Hg) | 7439-97-6 |
| Barium (Ba) | 7440-39-3 | Nickel (Ni) | 7440-02-0 |
| Beryllium (Be) | 7440-41-7 | Selenium (Se) | 7782-49-2 |
| Cadmium (Cd) | 7440-43-9 | Silver (Ag) | 7440-22-4 |
| Chromium (Cr) | 7440-47-3 | Sulfide ($S^{2-}$) | 18496-25-8 |
| Cobalt (Co) | 7440-48-4 | Thallium (Tl) | 7440-28-0 |
| Copper (Cu) | 7440-50-8 | Vanadium (V) | 7440-62-2 |
| Cyanide ($CN^-$) | 57-12-5 | Zinc (Zn) | 7440-66-6 |

Notes: This table lists the primary nonradiological constituents provided in RPP-23403, which are also on the RCRA groundwater monitoring list (i.e., also listed in Appendix 5 of Ecology Publication 97-407, which references 40 CFR 264, Appendix IX).

As described in Section 2.5.1, of the 72 analytes listed in Table 3-1, only chromium has historically been found in groundwater and has been attributed to releases from the WMA, although concentrations have decreased in recent years to near the analytical detection limit. In addition, nitrate is present in the groundwater and has been attributed to the WMA. Carbon tetrachloride is also found in the groundwater

but originates from waste sites associated with the Plutonium Finishing Plant. Thus, chromium and the supporting constituent nitrate (along with the other supporting constituents alkalinity, major cations [metals], and major anions) are routinely sampled under RCRA in the network monitoring wells (Table 3-2). The supporting constituents provide information on general chemistry and allow for charge-balance computations to assess laboratory performance.

**Table 3-2. Monitoring Network, Constituent List, and Sampling Frequency for WMA U**

| Well | WAC Compliant | RCRA | Supporting Parameters | | | | Field-Measured Parameters | | | | | Table 3-1 Analytes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Chromium[a] | Nitrate | Alkalinity | Anions[b] | Metals[c] | pH | Specific Conductance | Temperature | Turbidity | Water Levels | |
| 299-W18-30 | C | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Once |
| ***299-W18-40*** | C | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Once |
| 299-W19-12 | N[d] | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Once |
| 299-W19-41 | C | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Once |
| 299-W19-42 | C | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Once |
| 299-W19-44 | C | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Once |
| 299-W19-45 | C | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Once |
| 299-W19-47 | C | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Once |

Notes:

1. Wells completed at the top of the unconfined aquifer.
2. Bold/italic print indicates upgradient well.
3. Abbreviations in this table include the following:
   C = well is constructed as a resource protection well under WAC 173-160
   N = well is not constructed as a resource protection well under WAC 173-160
   Q = to be sampled quarterly

a. Filtered and unfiltered total chromium.

b. Anions include, but are not limited to, chloride, nitrate, and sulfate.

c. Metals (filtered and unfiltered) include, but are not limited to, calcium, magnesium, potassium, and sodium.

d. Well is usable as a "Screening well...to assist in defining the extent of contamination..." as stated in EPA and Ecology's "Policy on Remediation of Existing Wells and Acceptance Criteria for RCRA and CERCLA" (Nord and Day, 1990).

Sampling for the remaining constituents identified in Table 3-1 will be performed once in all wells during the first available sample event after this plan is in effect to determine if these constituents have impacted groundwater quality. Those constituents not detected in groundwater will be removed from future sampling. If an organic constituent from Table 3-1 is detected in a groundwater sample and it is not attributed to contamination from another facility (e.g., carbon tetrachloride from the Plutonium Finishing Plant), a confirmation sample will be collected at the next scheduled sample event, with split samples

sent to different analytical laboratories. If the detection is confirmed by positive results from both laboratories, the constituent will be added to the list of analytes for routine sampling to evaluate the extent of contamination. If the detection is not confirmed, the analyte will be removed from future sampling.

Some of the inorganic constituents included in Table 3-1 occur naturally in groundwater at concentrations above the laboratory method detection limit (e.g., barium, selenium, vanadium, and zinc). Detections of an inorganic constituent will be evaluated to determine if the constituent is present naturally by comparison to sample results from the upgradient well and comparisons to the Hanford Site background values (DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*). If it is determined that an inorganic constituent may be present as a contaminant from the WMA, confirmation samples will be collected (as described for the organic constituents). If contamination is confirmed, then the constituent will be added to the routine sample list to evaluate the extent of contamination. If the contamination is not confirmed, the constituent will be removed from future sampling.

## 3.2 Well Network

Table 3-2 includes the list of wells monitored for WMA U, and Figure 2-1 shows the well locations. One well, 299-W18-30, is co-sampled for the 200-UP-1 OU (under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* [CERCLA]), although CERCLA sampling is at a lower frequency (annually). Sampling is coordinated to avoid duplication of analyses and additional well trips.

Maintenance issues and sampling logistics sometimes delay scheduled sampling events. If sampling of a well is delayed by 2 months or more, that event will be cancelled, as it is nearly time for the next quarterly sampling event.

Table 3-3 summarizes well depth information, including the depth of the water column in each monitoring well. All wells are constructed of stainless-steel casing and screens with full annular seals, with the exception of well 299-W19-12, which has a perforated carbon-steel casing. All wells are equipped with dedicated sampling pumps. With the exception of well 299-W19-47, as-built diagrams showing details of construction for each well are provided in PNNL-13612 (or subsequent interim change notices). Construction information for well 299-W19-47 is provided in Appendix B.

**Table 3-3. Well Depths and Water Table Elevation at WMA U**

| Well | Year Drilled | Water Table Elevation (m)[a] (July 2010) | Casing Elevation (m)[a] | Open Interval Bottom Elevation (m)[a] | Water Column (m) (July 2010) |
|---|---|---|---|---|---|
| 299-W18-30 | 1991 | 134.59 | 206.117 | 133.85 | 0.74 |
| ***299-W18-31***[b] | 1991 | 134.91[c] | 203.474 | 134.76 | 0.15 |
| ***299-W18-40*** | 2001 | 134.97 | 203.413 | 125.91 | 9.06 |
| 299-W19-12 | 1983 | 134.58 | 206.232 | 129.49 | 5.09 |
| 299-W19-41 | 1998 | 134.64 | 206.531 | 128.01 | 6.63 |
| 299-W19-42 | 1998 | 134.57 | 206.242 | 127.67 | 6.90 |
| 299-W19-44 | 2001 | 134.59 | 207.277 | 125.78 | 8.81 |

**Table 3-3. Well Depths and Water Table Elevation at WMA U**

| Well | Year Drilled | Water Table Elevation (m)[a] (July 2010) | Casing Elevation (m)[a] | Open Interval Bottom Elevation (m)[a] | Water Column (m) (July 2010) |
|---|---|---|---|---|---|
| 299-W19-45 | 2001 | 134.59 | 206.413 | 126.71 | 7.88 |
| 299-W19-47 | 2004 | 134.57 | 206.276 | 125.68 | 8.89 |

Notes: Bold/italic print indicates upgradient well.

a. NAVD88.

b. Used for water-level measurements only; not enough water in well to sample.

Water-level measurements are collected in each well at the time of sampling. In addition, water-level measurements are collected from each of the wells shown in Table 3-3 within a single day during March of each year to support water table mapping. The water table elevation beneath WMA U has been declining at an average rate of approximately 0.28 m/yr (0.92 ft/yr) (DOE/RL-2010-11), although fluctuations can occur due to operation of the nearby 200-ZP-1 OU pump-and-treat system. The long-term decline is the result of reduced effluent discharges to ground at the Hanford Site since the peak discharge occurred in the 1980s. The water table elevation in the 200 West Area is expected to decline a minimum of an additional 4 to 6 m (13.1 to 19.7 ft) before equilibrium conditions are re-established (DOE/RL-2010-11).

As a consequence of the declining water table elevation, monitoring well 299-W18-30 is expected to go dry in the near future. When a well is within a few years of going dry, a replacement well is proposed. In addition, new wells may also be installed to better characterize the nature and extent of contamination in the groundwater. All new RCRA wells proposed for installation at the Hanford Site are negotiated annually by Ecology, DOE, and EPA under the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989) Milestone M-24-00. At the time this plan was revised, two new replacement wells have been proposed under Milestone M-24-00 to be installed at WMA U: one well to replace 299-W18-30, which is going dry; and one well to replace 299-W19-12 because it does not comply with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells."

In the future, the rate of decline of the water table beneath WMA U may change in response to remedial action measures. In accordance with the *Record of Decision Hanford 200 Area 200-ZP-1 Operable Unit Superfund Site Benton County, Washington* (EPA et al., 2008) (the 200-ZP-1 OU is located in the northern portion of the 200 West Area), the selected remedy is a combination of pump-and-treat, monitored natural attenuation, flow-path control, and institutional controls. The pump-and-treat system is expected to begin operating in December 2011, and the system is designed to include extraction and injection wells in and near the northern 200 West Area (DOE/RL-2008-78, *200 West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan*). The water will be transferred to the 200 West Area groundwater treatment facility, which is being designed for a capacity of 3,785 L/min (1,000 gal/min). Operation of this pump-and-treat system is expected to affect water levels and the groundwater flow direction at WMA U. Analysis of the future flow field indicates that the groundwater flow direction at WMA U may become more northeasterly during operation of the pump-and-treat system. Therefore, evaluation of the adequacy of the monitoring well network at WMA U and the need for replacement wells will be an ongoing process; thus, the list of new wells under consideration for installation at the WMA will evolve.

## 3.3 Sampling and Analysis Protocol

Groundwater monitoring at WMA U follows the conventions of the project and is discussed in the QAPjP (Appendix A).

# 4 Data Evaluation and Reporting

This chapter discusses data evaluation and reporting for WMA U.

## 4.1 Data Review

Data review, validation, and verification are discussed in the QAPjP (Appendix A).

## 4.2 Interpretation

After sampling and water-level data are validated and verified, the acceptable data are used to interpret groundwater conditions at WMA U. Interpretive techniques include the following:

- **Hydrographs:** Graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.
- **Water table maps:** Use water table elevations from multiple wells to construct contour maps and to estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential.
- **Trend plots:** Graph concentrations of constituents versus time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water table maps to determine if concentrations relate to changes in water level or in groundwater flow directions.
- **Plume maps:** Map distributions of chemical constituents in the aquifer to determine extent of contamination. Changes in plume distribution over time assist in determining plume movement and direction of groundwater flow.
- **Contaminant ratios:** Can sometimes be used to distinguish among different sources of contamination.

## 4.3 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements include an annual evaluation of the monitoring well network to determine if it remains adequate to monitor the WMA. The network must include upgradient and downgradient wells to monitor groundwater quality in the uppermost aquifer (see Appendix A). Wells proposed for installation at WMA U are described in Section 3.2.

Water-level measurements will continue to be collected before each sampling event, and more comprehensive measurements will continue to be made in March of each year. The data are presented in the annual Hanford Site groundwater monitoring report (e.g., DOE/RL-2010-11).

## 4.4 Reporting and Notification

The results of assessment monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring report.

# 5 References

10 CFR 962, "Byproduct Material," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/10cfr962_10.html.

40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Appendix IX, "Ground-Water Monitoring List," *Code of Federal Regulations*. Available at: http://edocket.access.gpo.gov/cfr_2010/julqtr/40cfr264AppIX.htm.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/40cfr265_10.html.

265.90, "Applicability."

265.91, "Ground-Water Monitoring System."

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

Subpart F, "Ground-Water Monitoring."

51 FR 24504, 1986, "EPA Clarification of Regulatory Authority Over Radioactive Mixed Waste," *Federal Register*, July 3, 1986.

*Atomic Energy Act of 1954*, 42 USC 2011, et seq. Available at: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf.

*Authorized State Hazardous Waste Programs*, 42 USC 6926, et seq. Available at: http://www.law.cornell.edu/uscode/42/6926.html.

*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

DOE/ORP-2008-01, 2008, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0808130005.

DOE/RL-91-52, 1992, *U Plant Source Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196110688.

DOE/RL-96-61, 1997, *Hanford Site Background: Part 3, Groundwater Background*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D197226378.

DOE/RL-2008-78, 2009, *200 West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan*, Rev. 0, REISSUE, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0096137.

DOE/RL-2010-11, 2010, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volume 1 & 2*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0084237.

Ecology Publication 97-407, 2009, *Chemical Testing Methods for Designating Dangerous Waste: WAC 173-303-090 & -100*, Appendix 5, "Appendix IX of 40 CFR 264," Washington State Department of Ecology, Olympia, Washington. Available at: http://www.ecy.wa.gov/pubs/97407.pdf.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

EPA, Ecology, and DOE, 2008, *Record of Decision Hanford 200 Area 200-ZP-1 Operable Unit Superfund Site Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.epa.gov/superfund/sites/rods/fulltext/r2008100003103.pdf.

GJO-97-1-TAR, GJO-HAN-8, 1997, *Vadose Zone Characterization Project at the Hanford Tank Farms U Tank Farm Report*, U.S. Department of Energy, Grand Junction Office, Grand Junction, Colorado. Available at: http://www.osti.gov/bridge/servlets/purl/572701-TQmzHp/webviewable/572701.pdf.

HNF-EP-0182, 2010, *Waste Tank Summary Report for Month Ending December 31, 2009*, Rev. 261, Washington River Protection Solutions, Richland, Washington. Available at: http://www5.hanford.gov/pdw/fsd/AR/FSD0001/FSD0054/1002011113/%5B1002011113%5D.PDF.

Nord, Timothy L. and Paul T. Day, 1990, "Policy on Remediation of Existing Wells and Acceptance Criteria for RCRA and CERCLA" (letter to Steven H. Wisness, U.S. Department of Energy, Richland Operations Office), Washington State Department of Ecology, and U.S. Environmental Protection Agency, Olympia, Washington, July 16. Available at: http://www.ecy.wa.gov/programs/nwp/Attachment_07_1990-06.pdf.

PNNL-13185, 2000, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13185.pdf.

PNNL-13282, 2000, *Groundwater Quality Assessment for Waste Management Area U: First Determination*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13282.pdf.

PNNL-13378, 2001, *Results of Detailed Hydrologic Characterization Tests—Fiscal Year 1999*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13378.PDF.

PNNL-13612, 2001, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/pnnl-13612.pdf.

PNNL-13612-ICN-1, 2003, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U, Interim Change Notice 1*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13612-ICN-1.pdf.

PNNL-13612-ICN-2, 2006, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U, Interim Change Notice 2*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13612-ICN-2.pdf.

PNNL-13858, 2002, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13858.pdf.

PNNL-16069, 2006, *Development of Historical Water Table Maps of the 200 West Area of the Hanford Site (1950-1970)*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-16069.pdf.

PNNL-17163, 2007, *Characterization of Direct Push Vadose Zone Sediments from the 241-U Single-Shell Tank Farm*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0911240534.

RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*, Olympia, Washington. Available at: http://apps.leg.wa.gov/RCW/default.aspx?cite=70.105.

*Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://epw.senate.gov/rcra.pdf.

RPP-7580, 2001, *Historical Vadose Zone Contamination from U Farm Operations*, Rev. 0, Fluor Federal Services, Richland, Washington.

RPP-15808, 2003, *Subsurface Conditions Description of the U Waste Management Area*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0911240299.

RPP-23403, 2006, *Single-Shell Tank Component Closure Data Quality Objectives*, Rev. 3, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-23405, 2006, *Tank Farm Vadose Zone Contamination Volume Estimates*, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0911240667.

RPP-35485, 2007, *Field Investigation Report of Waste Management Area U*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-RPT-31557, 2006, *Surface Geophysical Exploration of U Tank Farm at the Hanford Site*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0911240537.

WA7890008967, 2007, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste*, as amended, Washington State Department of Ecology, Richland, Washington. Available at: http://www.ecy.wa.gov/programs/nwp/piarchive12_07.htm#Hanfords_Site-wide_Permit.

WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-160.

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

303-400, "Interim Status Facility Standards."

WHC-MR-0132, 1990, *History of 200 Area Tank Farms*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at:
http://www5.hanford.gov/arpir/?content=findpage&AKey=D196015712.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D196015715.

WHC-MR-0517, 1996, *Listed Waste History at Hanford Facility TSD Units*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-AP-012, 1991, *Interim Status Groundwater Monitoring Plan for the Single-Shell Tanks*, Rev. 1, Westinghouse Hanford Company, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196071250.

# Appendix A

# Quality Assurance Project Plan

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# Terms

| | |
|---|---|
| CRDL | contract-required detection limit |
| DOE | U.S. Department of Energy |
| DQO | data quality objective |
| DUP | laboratory matrix duplicate |
| EB | equipment blank |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| FTB | full trip blank |
| FXR | field transfer blank |
| GC | gas chromatography |
| HASQARD | *Hanford Analytical Services Quality Assurance Requirements Documents* |
| HEIS | Hanford Environmental Information System |
| IC | ion chromatography |
| ICP | inductively coupled plasma |
| ICP/MS | inductively coupled plasma/mass spectrometry |
| LCS | laboratory control sample |
| MB | method blank |
| MDA | minimum detectable activity |
| MDL | method detection limit |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| PCB | polychlorinated biphenyl |
| 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 |
| RPD | relative percent difference |
| RSD | relative standard deviation |
| SUR | surrogate |

| | |
|---|---|
| TOC | total organic carbon |
| TOX | total organic halides |
| TPA | *Hanford Federal Facility Agreement and Consent Order* |
| TSD | treatment, storage, and disposal |
| VOC | volatile organic compound |

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

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. Section 6.5 and 7.8 of the *Hanford Federal Facility Agreement and Consent Order* (TPA) (Ecology et al., 1989a), Attachment 2, "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 requirements (DOE/RL-96-68) 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 *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use* (ANSI/ASQ E4-2004). This QAPjP is divided into four sections (as 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, the participants understand the goals and the approaches used, and 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.

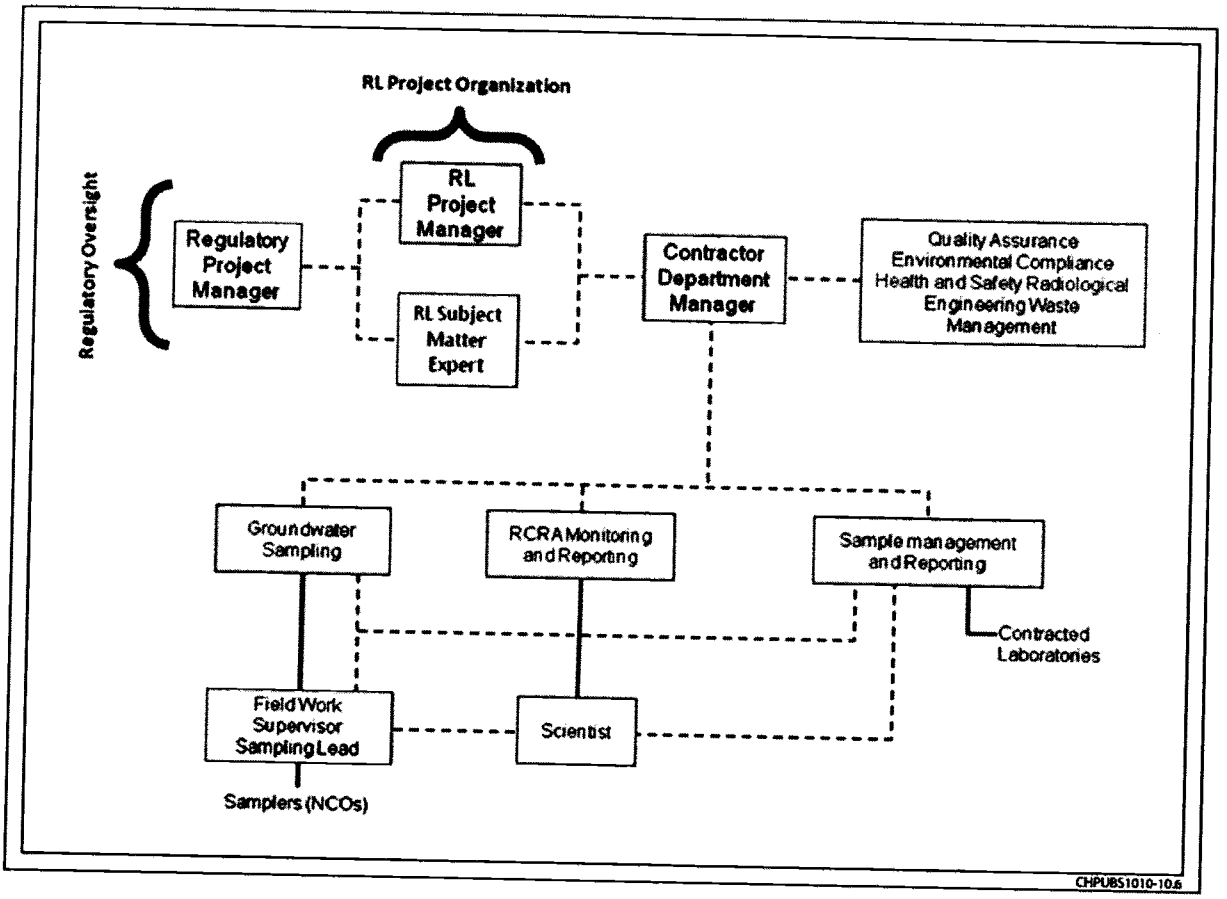



**Figure A-1. Project Organization**

### 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*; the *Resource Conservation and Recovery Act of 1976* (RCRA); the *Atomic Energy Act of 1954*; and the TPA (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 workscope, 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 regulatory agencies, 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 in accordance with corresponding standard procedures and work packages. The samplers also complete field logbooks 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 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 impacts.

### 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, Subpart F ("Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "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, and reporting.

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 for 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, "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 prior to implementation. Table A-1 defines the types of changes that may be made to the sampling design and 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 TPA (Ecology et al., 1989a) will be managed in accordance with the requirements therein.

The results of groundwater monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2010-11, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2*).

**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 impact 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 |

# 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 unit 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 impact 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] |
|---|---|---|---|
| **Metals Analyzed by ICP Method – Unfiltered/Filtered** | | | |
| Calcium | P, $HNO_3$ to pH <2 | SW-846[d] Method 6010B/C, SW-846 Method 6020[e], or EPA/600 Method 200.8[e] | 1,000 |
| Chromium | | | 10 |
| Magnesium | | | 750 |
| Potassium | | | 4,000 |
| Sodium | | | 500 |
| **Anions by IC** | | | |
| Chloride | P | EPA/600 Method 300.0[f] | 200 |
| Nitrate | | | 250 |
| Sulfate | | | 500 |
| **Other** | | | |
| Alkalinity | G/P | Standard Method[g] 2320, EPA/600 Method 310.1, EPA/600 Method 310.2 | 5,000 |
| Conductivity, field | Field measurement | Instrument/meter | 1 µohm |
| pH, field measurement | Field measurement | Instrument/meter | 0.1 |
| Temperature | Field measurement | Instrument/meter | -- |
| Turbidity, field measurement | Field measurement | Instrument/meter | 0.1 NTU |

a. All samples will be collected in plastic (P) or glass (G) containers and will be cooled to 4°C 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 Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

e. SW-846 Method 6010 is the preferred method; however, Method 6020 or EPA/600 Method 200.8 may be used, as long as the method quantitation limit listed is met.

f. Analytical method adapted from Method 300.0 (EPA-600/4-84-017, *Test Methods for Determination of Inorganic Anions in Water by Ion Chromatography*).

g. *Standard Methods for the Examination of Water and Wastewater* (AWWA et al., 2005).

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| **Metals Analyzed by ICP Method – Unfiltered/Filtered** | | | |
| Barium | P, $HNO_3$ to pH <2 | SW-846[d] Method 6010B/C, SW-846 Method 6020[e], or EPA/600 Method 200.8[e] | 20 |
| Beryllium | | | 5 |
| Cadmium | | | 5 |
| Cobalt | | | 20 |
| Copper | | | 10 |
| Nickel | | | 40 |
| Silver | | | 10 |
| Vanadium | | | 25 |
| Zinc | | | 10 |
| **Trace Metals – Unfiltered/Filtered** | | | |
| Antimony | P, $HNO_3$ to pH <2 | SW-846 Method 6020 or EPA/600 Method 200.8 | 6 |
| Arsenic | | | 10 |
| Lead | | | 5 |
| Mercury | G, $HNO_3$ to pH <2 | SW-846 Method 7470A, EPA/600 Method 200.8 | 0.5 |
| Selenium | P, $HNO_3$ to pH <2 | SW-846 Method 6020 or EPA/600 Method 200.8 | 10 |
| Thallium | | | 5 |
| **Volatile Organic Analyses** | | | |
| 1,1-Dichloroethene | G, no headspace | SW-846 Method 8260B | 10 |
| 1, 2-Dichloroethane | | | 5 |
| 1,1,1-Trichloroethane | | | 5 |
| 1,1,2-Trichloroethane | | | 5 |
| 1,1,2,2-Tetrachloroethane | | | 5 |
| Acetone (2-propanone) | | | 20 |
| Benzene | | | 5 |
| Carbon disulfide | | | 5 |
| Carbon tetrachloride | | | 5 |

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| Chlorobenzene | | | 5 |
| Chloroform | | | 5 |
| Ethylbenzene | | | 5 |
| Isobutanol | | | 500 |
| Methylene chloride | | | 5 |
| Methyl ethyl ketone (2-butanone) | | | 10 |
| Methyl isobutyl ketone (4-methyl-2-pentanone) (MIBK) | | | 10 |
| Tetrachloroethene | | | 5 |
| Toluene | | | 5 |
| trans-1,3-Dichloropropene | | | 5 |
| Trichloroethene | | | 5 |
| Trichlorofluoromethane | | | 10 |
| Vinyl chloride (chloroethene) | | | 10 |
| Xylenes | | | 10 |
| **Semivolatile Organic Analyses** | | | |
| 1,2-Dichlorobenzene (o-Dichlorobenzene) | | | 10 |
| 1,2,4-Trichlorobenzene | | | 10 |
| 2-Chlorophenol | | | 10 |
| 2-Methylphenol (o-cresol) | | | 10 |
| 2-Nitrophenol (o-Nitrophenol) | | | 20 |
| 2,4-Dinitrotoluene | | | 10 |
| 2,4,5-Trichlorophenol | Amber glass | SW-846 Method 8270D | 10 |
| 2,4,6-Trichlorophenol | | | 10 |
| 3-Methylphenol (m-cresol) | | | 20 |
| 4-Chloro-3-methylphenol (p-Chloro-m-cresol) | | | 10 |
| 4-Methylphenol (p-cresol) | | | 10 |
| Acenaphthene | | | 10 |

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

| Constituent | Collection and Preservation[a] | Analysis Methods[b] | Method Quantitation Limit (µg/L)[c] |
|---|---|---|---|
| Butylbenzylphthalate | | | 10 |
| Di-n-butylphthalate | | | 10 |
| Di-n-octylphthalate | | | 10 |
| Fluoranthene | | | 10 |
| Hexachlorobutadiene | | | 10 |
| Hexachloroethane | | | 10 |
| n-Nitroso-di-n-propylamine | | | 10 |
| n-Nitrosomorpholine | | | 10 |
| Naphthalene | | | 10 |
| Nitrobenzene | | | 10 |
| Pyrene | | | 10 |
| Pyridine | | | 20 |
| **PCBs** | | | |
| Aroclor-1016 | G | SW-846 Method 8082 | 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 |
| **Other** | | | |
| Cyanide | P, NaOH to pH >12 | SW-846 Method 9012, Standard Method[f] 4500, EPA/600 Method 335.2 | 5 |
| Sulfide | G/P, 2 mL 2N zinc acetate and NaOH pH >9, cool 4°C | Sulfides – 9030 | 500 |

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

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

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

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

c. Detection limit units.

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

e. SW-846 Method 6010 is the preferred method; however, Method 6020 or EPA/600 Method 200.8 may be used, as long as the method quantitation limit listed is met.

f. *Standard Methods for the Examination of Water and Wastewater* (AWWA et al., 2005).

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 impacts 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 (EBs). 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 (FTB) | Contamination from containers or transportation | One per 20 well trips |
| Field transfer blank (FXR) | Contamination from sampling site | One each day; VOCs sampled |
| Equipment blank (EB) | Contamination from non-dedicated equipment | As needed[a] |
| Replicate/duplicate sample | Reproducibility | One per 20 well trips |

**Table A-4. Quality Control Samples**

| Sample Type | Primary Characteristics Evaluated | Frequency |
|---|---|---|
| **Laboratory QC** | | |
| Method blank (MB) | Laboratory contamination | One per batch |
| Laboratory duplicate | Laboratory reproducibility | See footnote b |
| Matrix spike (MS) | Matrix effect and laboratory accuracy | See footnote b |
| Matrix spike duplicate (MSD) | Laboratory reproducibility/accuracy | See footnote b |
| Surrogate (SUR) | Recovery/yield | See footnote b |
| Laboratory control sample (LCS) | Method accuracy | One per batch |

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

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

### 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 prior to 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 (VOCs) only. The FXRs are used to evaluate potential contamination caused by conditions in the field.

The 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 (MDL) 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 MDL.

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 (RPD). Only field duplicates with at least one result greater than five times the MDL or minimum detectable activity (MDA) 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 [MBs], laboratory control samples [LCSs]/blank spikes, and MSs) are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, 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 concentration limit determined for Hanford Site groundwater. 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<br>Conductivity<br>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" |
| **Anions** | | | |
| Anions by IC<br>Cyanide<br>Sulfide | 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<br>Cadmium<br>Chromium<br>Lead<br>Mercury<br>Selenium<br>Thallium<br>ICP metals<br>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" |
| **VOCs** | | | |
| Volatiles by GC/MS | 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" |
| **Semi-VOCs** | | | |
| PCBs by GC<br>Phenols by GC<br>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 TOC and TOX 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.

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

| Method[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|

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.

Data flags:

B, C = possible laboratory contamination (analyte was detected in the associated MB)

N = result may be biased (associated MS 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 (%) | Precision (% RSD)* |
|---|---|---|---|
| Nitrate | Quarterly | ±25% | ≤25% |
| Chromium | Annually | ±20% | ≤25% |

* 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.

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 *Methods of Chemical Analysis of Water and Wastes* (EPA/600/4-79/020). 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 the 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 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 prior to 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 *Hanford Federal Facility Agreement and Consent Order 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 (provided in Section A2.5) 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.

# A5 References

10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*. Available at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&rgn=div6&view=text&node=10:4.0.2.5.26.1&idno=10.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/40cfr265_10.html.

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

Subpart F, "Ground-Water Monitoring."

ANSI/ASQ E4-2004, 2004, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use*, American National Standards Institute/American Society for Quality, Milwaukee, Wisconsin.

*Atomic Energy Act of 1954*, 42 USC 2011, et seq. Available at: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf.

AWWA, APHA, and WEF, 2005, *Standard Methods for the Examination of Water and Wastewater*, 21st ed., American Water Well Association, Denver, Colorado; American Public Health Association, Washington, D.C.; and Water Environment Federation, Alexandria, Virginia.

*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

DOE O 414.1C, 2005, *Quality Assurance*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/current-directives/414.1-BOrder-c/view.

DOE/RL-96-68, 2007, *Hanford Analytical Services Quality Assurance Requirements Documents*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/orp/?page=141&parent=14.

DOE/RL-2010-11, 2010, *Hanford Site Groundwater Monitoring and Performance Report for 2009: Volumes 1 & 2*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0084237.

Ecology, EPA, and DOE, 1989a, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

Ecology, EPA, and DOE, 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=82.

EPA/240/B-01/003, 2001, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/QUALITY/qs-docs/r5-final.pdf.

EPA-600/4-79/020, *Methods of Chemical Analysis of Water and Wastes*, U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D196018581.

EPA-600/4-84-017, 1984, *Test Methods for Determination of Inorganic Anions in Water by Ion Chromatography*, Method 300.0, U.S. Environmental Protection Agency, Washington, D.C.

*Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://epw.senate.gov/rcra.pdf.

SW-846, 2007, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, as amended, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm.

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

303-330, "Personal Training."

303-400, "Interim Status Facility Standards."

# Appendix B

# Construction Information for Well 299-W19-47

# WELL CONSTRUCTION SUMMARY REPORT

Start Date 04/23/04
Finish Date 08/25/04
Page 1 of 1

Well ID 699268 | Well Name 299-W19-47 | Approximate Location East side of 18th A-U/200 West
Project 200A\ 200CU Drilling, FY 2004 | Other Companies FH, CHG
Drilling Company Blue Star Enterprises | Geologist(s) C. Martinez, J. Whalen, D. Weekes
Driller David Curry | License # 2617

| TEMPORARY CASING AND DRILL DEPTH | | | DRILLING METHOD | HOLE DIAMETER (in.) / INTERVAL (ft) |
|---|---|---|---|---|
| *Size/Grade/Lbs Per Ft | Interval | Shoe O D / I D | Auger | Diameter ____ From ____ to ____ |
| 11 3/4 / 10 3/4 CSPT | 0' - 248' | 20" / 10 3/4" | Cable Tool (drive barrel) | Diameter 8 5/8" From 0' to 95' |
| | ____ - ____ | | Air Rotary | Diameter ____ From ____ to ____ |
| | ____ - ____ | | A R w/Sonic | Diameter ____ From ____ to ____ |
| | ____ - ____ | | Cable tool (hard tool) | Diameter 10" From 95' to 140' |
| | ____ - ____ | | Cable tool (drive barrel) | Diameter 8 5/8" From 140' to 241' |
| *Indicate Welded (W) - Flush Joint (FJ) Coupled (C) & Thread Design | | | Cable tool (DB) | Diameter 9 1/2" From 241' to 245' |
| | | | Cable tool (DB) | Diameter 8 5/8" From 245' to 249' |

Drilling Fluid N/A

Total Drilled Depth 249' | Hole Dia @ TD 8 5/8" | Total Amt Of Water Added During Drilling
Well Straightness Test Results Passed on 06/08/04 using 20' long 8 5/8" OD Tool. | Static Water Level 204.84' | Date 08/09/04

## GEOPHYSICAL LOGGING

| Sondes (type) | Interval | Date | Sondes (type) | Interval | Date |
|---|---|---|---|---|---|
| Spectral Gamma | 0' - 248' | 06/02, 06/03 & 06/07/04 | | ____ - ____ | |
| | ____ - ____ | | | ____ - ____ | |
| | ____ - ____ | | | ____ - ____ | |

## COMPLETED WELL

| Size/Wt /Material | Depth | Thread | Slot Size | Type | Interval Annular Seal/Filter Pack | Volume | Mesh Size |
|---|---|---|---|---|---|---|---|
| 4" ID SS 304 Sch 5 riser | 4 - 227.05' | F480 | N/A | Portland cement (94#) | 0' - 107' | 7 | N/A |
| 4" ID SS 304 Sch 5 wellscreen | 227.05' - 246.04' | F480 | 0.020" | Granular bentonite (50#) | 107' - 215.8' | 196 | N/A |
| 4" ID SS 304 Sch 5 sump | 246.04' - 246.02' | F480 | N/A | Bentonite Pellets (50#) | 215.8' - 220.7' | 7 | 3/8" |
| | ____ - ____ | | | Colorado Silica Sand (50#) | 220.7' - 249' | 42 | 10-20 |
| | ____ - ____ | | | | ____ - ____ | | |

## OTHER ACTIVITIES

| Aquifer Test well development | Date 08/23/04 to 08/25/04 | Well Decommission | Yes | No | Date |
|---|---|---|---|---|---|
| Description S 264.6 \ M 251.6 \ F 240.1 \ Final turb (NTU) 459 (S) \ 334 (M) | | Description | | | |
| 154 NTU. 6 gpm: S 24, 22, 31, 10 \ M 21, 20 \ F 10 | | | | | |

## WELL SURVEY DATA (if applicable)

Washington State Plane Coordinates | Protective Casing Elevation | Brass Survey Marker Elevation

## COMMENTS / REMARKS

Vol. calcs: F.C. ⇒ 7 bags @ 1.285 ft³/bag = 9.00 ft³. Granules ⇒ 196 bags @ 0.71 ft³/bags 139.16 ft³. Pellets ⇒ 7 buckets @ 0.62 ft³/bucket = 4.34 ft³; 10-20 sand ⇒ 42 bags @ 0.585 ft³/bag = 33.17 ft³

| Reported By | Title | Signature | Date |
|---|---|---|---|
| Charlene Martinez | Geologist | Charlene Martinez | 09/14/04 |

A-6003-658 (04/03)

# WELL SUMMARY SHEET

Start Date 04/23/04
Finish Date. 08/08/04
Page 1 of 2

| | |
|---|---|
| Well ID: C4258 | Well Name 299-W19-47 |
| Location East side of WMA-4 \ 200 West | Project. RCRA \ CERCLA drilling. FY 2004 |
| Prepared By Charlene Martinez Date: 08/11/04 | Reviewed By L.D. Walker Date. 8-24-04 |
| Signature Charlene Martinez | Signature. LD Walker |

## CONSTRUCTION DATA

**Description**

11 7/8" \ 10 7/8" temporary casing used.

6" ID SS304 protective casing set + 1.0' above permanent

4" ID SS304, sch.5 riser:
+ 2.0' → 227.05'

Portland Cement:
0' → 10.7'

Granular Bentonite:
10.7' → 215.8'

*Formation Slough 62.3' → 66.3'

3/8" Bentonite Pellets:
215.8' → 220.7'

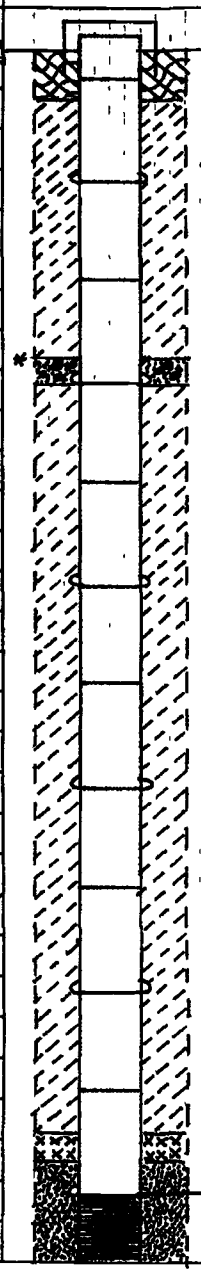
10-20 mesh Colorado Silica Sand:
220.7' → 269'

4" ID SS304, sch.5, 0.020-inch cont. wire-wrap wellscreen:
227.05' → 262.04'

All depths in feet below ground surface

All temporary casing removed from ground.

**Diagram**



## GEOLOGIC/HYDROLOGIC DATA

| Depth in Feet | Graphic Log | Lithologic Description |
|---|---|---|
| 0 | | 0'-1' Backfill material |
| | | 1'-8' SAND(S) Hanford Fmtn |
| | | 8'-15' sandy GRAVEL(SG) |
| | | 15'-16.5' SAND(S) |
| | | 16.5'-17.5' sandy GRAVEL(SG) |
| 40 | | 17.5'-23' SAND(S) |
| | | 23'-27' sandy GRAVEL(SG) |
| | | 27'-36' silty sandy GRAVEL(MSG) |
| | | 36'-47' sandy GRAVEL(SG) |
| | | 47'-53' gravelly SAND (gS) |
| 80 | | 53'-90' SAND(S) |
| | | 90'-124' silty SAND(mS) |
| 120 | | 124'-138' SILT(M) (Cold Creek unit) |
| | | 138'-145' CALICHE. Silty Sandy Gravel (MSG) |
| | | 145'-162' Silty Sandy GRAVEL (MSG) |
| 160 | | 162'-165' Sandy GRAVEL(SG) |
| | | 165'-185.5' Silty Sandy GRAVEL (MSG) |
| | | 185.5'-192' Sand (S) |
| 200 | | 192'-198.5' silty sandy gravel (MSG) |
| | | 198.5'-201' sand (S) |
| | | 201'-204' sandy gravel (SG) |
| | | 204'-227' silty sandy gravel (MSG) |
| | | 227'-229' sandy GRAVEL(SG) |

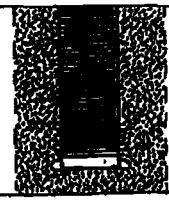
A-6003-643 (03/03)

# WELL SUMMARY SHEET

Start Date 04/23/04
Finish Date 08/09/04
Page 2 of 2

Well ID: C4258
Well Name 299-W19-47
Location East side of WMA-U/200 West
Project: RCRA/CERCLA drilling FY 2004
Prepared By: Charlene Martinez
Date 08/11/04
Reviewed By: L.D. Walker
Date 8-24-04
Signature: Charlene Martinez
Signature: D Walker

## CONSTRUCTION DATA

| Description | Diagram |
|---|---|
| 4" ID SS304, sch. 5 sump: 262.04' → 265.02' |  |
| | TD => 269' bgs |
| NCR-04-GRP-015 issued on the formation slough condition at 62.3' → 66.3' | |
| All depths in feet below ground surface: | |
| All temporary casing removed from ground. | |

## GEOLOGIC/HYDROLOGIC DATA

| Depth in Feet | Graphic Log | Lithologic Description |
|---|---|---|
| 240 | | 229'-238' silty sandy GRAVEL (msG) |
| | | 238'-244' sandy GRAVEL (sG) |
| | | 244'-260' silty sandy GRAVEL (msG) |
| | | 260'-266' sandy GRAVEL (sG) |
| | | 266'-269' silty sandy GRAVEL (msG) |
| 280 | | |
| | | TD @ 269' bgs |
| | | Static water => 226.84' bgs (08/09/04) |

A-6003-643 (03/03)

# Distribution

| | MS | Quantity |
|---|---|---|
| U.S. Department of Energy, Richland Operations Office | | |
| N.M. Bland | A5-11 | 1 |
| R.D. Hildebrand | A6-38 | 1 |
| DOE Public Reading Room | H2-53 | 1 |
| | | |
| U.S. Department of Energy, Office of River Protection | | |
| L. Huffman | H6-60 | 1 |
| C.J. Kemp | H6-60 | 1 |
| R.W. Lober | H6-60 | 1 |
| | | |
| CH2M HILL Plateau Remediation Company – Electronic Distribution | | |
| G.A. Aljure | H8-45 | |
| W.R. Faught | H8-15 | |
| R.L. Fleshman | R3-50 | |
| D.A. Gamon | R3-50 | |
| J.W. Lindberg | R3-50 | |
| S.P. Luttrell | R3-50 | |
| C.J. Martin | R3-50 | |
| J.P. McDonald | R3-50 | |
| C.W. Miller | H8-15 | |
| R.W. Oldham | R3-60 | |
| L.C. Swanson | R3-50 | |
| W.R. Thackaberry | R3-60 | |
| G.S. Thomas | R3-50 | |
| J.A. Winterhalder | R3-60 | |
| C.D. Wittreich | H8-15 | |
| M.I. Wood | H8-51 | |

| | MS | Quantity |
|---|---|---|
| Washington River Protection Solutions | | |
| S.J. Eberlein | E6-31 | 1 |
| J.G. Field | E6-31 | 1 |
| J.J. Luke | R1-51 | 1 |
| D.A Myers | E6-31 | 1 |
| C.L. Tabor | E6-31 | 1 |
| Administrative Record | H6-08 | 1 |
| Document Clearance | H6-08 | 1 |