RCRA-CN-02_DOE/RL-2010-93_R2

# Interim Status Change Number 2: Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib

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**

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Prepared for the U.S. Department of Energy
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# RCRA INTERIM STATUS GROUNDWATER MONITORING PLAN INTERIM CHANGE FORM

| Change Number: *(Obtain Change Number From Interim Change Custodian)* | | Date: |
|---|---|---|
| RCRA-CN-02_DOE/RL-2010-93_R2 | | 9/17/2020 |
| Document Number: DOE/RL-2010-93 | Title: Interim Status Change Number 2: Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib | Rev: 2 |
| Originator: Tessa Clark | | Phone: 3605203189 |

**Description of Change:** This form is used only for RCRA interim status groundwater monitoring plans *(i.e., shall not be used for final status groundwater monitoring plans)*. Describe the interim changes made to the RCRA interim status groundwater monitoring plan; consider any previous interim changes made to the plan. Changes cannot be made to the plan that conflict with the requirements of 40 CFR 265, Subpart F.

-On p. 3-1, changed the sampling frequency description for the site-specific constituents for water chemistry analysis and stainless steel corrosion constituents (alkalinity, anions, and metals) from an annual to semiannual frequency.
-In Tables 3-1 and 3-5, changed the sampling frequency for stainless steel corrosion constituents (chromium, iron, manganese, molybdenum, and nickel) and water chemistry analysis (alkalinity, anions [fluoride, nitrate, and nitrite], calcium, magnesium, and potassium) from annual to semiannual.

**NOTE:** For form use see CHPRC-03210, *Review of RCRA Groundwater Data and Management Plans.* Identify page(s), section(s), and table(s) that changed. Attach redline/strikeout of entire groundwater monitoring plan. Post interim change form(s) and redline/strikeout of entire groundwater monitoring plan on the S&GRP webpage as the current plan and place in Facility Operating Record.

**Justification and Impacts of Change**: State the reason and justification for the change(s) to the issued groundwater monitoring plans. Identify any impacts or actions that may result from this change.

-The sampling frequency for stainless steel corrosion constituents and water chemistry analysis was changed to semiannual to align with the frequency for collection of contamination indicator parameters.

## RCRA INTERIM STATUS GROUNDWATER MONITORING PLAN
## INTERIM CHANGE FORM (Continued)

**Approvals:** Include "Other" approvals as appropriate *(e.g., Obtain SMR approvals on changes to "Field and Laboratory Quality Control Elements and Acceptance Criteria" table).*

| | | |
|---|---|---|
| Other: | | |
| K. M. Whitley | email approval attached | 10/01/2020 |
| *Print First and Last Name* | *Signature* | *Date* |
| S&GRP Environmental Compliance Officer: | | |
| J. A. Johanson | email approval attached | 09/30/2020 |
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| *Print First and Last Name* | *Signature* | *Date* |
| DOE Subject Matter Expert: | | |
| R. D. Hildebrand | email approval attached | 10/01/2020 |
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Comment: RCRA interim status change to the 216-A-36B groundwater monitoring plan, for your review and approval

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| Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Crib | DOE/RL-2010-93 | 2 | RCRA-CN-01_DOE/RL-2010-93_R2 | 4/30/2020 |
| Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Crib | DOE/RL-2010-93 | 2 | RCRA-CN-02_DOE/RL-2010-93_R2 | 9/17/2020 |

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# Executive Summary

This document presents a revision to the 2011 groundwater monitoring plan[1] (Rev. 1) for the 216-A-36B Plutonium-Uranium Extraction (PUREX) Plant Crib. This revised monitoring plan is based on the requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976*[2] (RCRA) and the implementing requirements in WAC 173-303-400[3] which, in turn, specifies groundwater monitoring regulations under 40 CFR 265.[4] The U.S. Department of Energy, Richland Operations Office, is revising this groundwater monitoring plan due to the age of the plan and to ensure that the plan contains the most current Hanford groundwater monitoring information for the treatment, storage, and disposal (TSD) unit (updated groundwater flow direction and revised monitoring network). This indicator evaluation program groundwater monitoring plan is the principal controlling document for conducting groundwater monitoring at the 216-A-36B Crib.

The 216-A-36B Crib is an inactive interim status TSD unit in the 200-EA-1 Soil Operable Unit (OU), which is located above the underlying 200-PO-1 Groundwater OU. The 216-A-36B Crib is located approximately 360 m (1,200 ft) south of the PUREX Plant in the southeast corner of the 200 East Area. The 216-A-36B Crib was a liquid effluent disposal facility comprising the southern 152 m (500 ft) portion of the original 216-A-36 Crib. The original 216-A-36 Crib received PUREX Plant ammonia scrubber waste streams beginning in September 1965. In March 1966, the 216-A-36 Crib was divided into two sections. The northern section was removed from service due to the rapid buildup of fission products within the first 30 m (100 ft) of the crib. A vertical grout barrier was placed 30 m (100 ft) from the north end of the crib to isolate the heavily contaminated northern portion, thus subdividing the crib into the 216-A-36A (northern) portion and the 216-A-36B (southern) portion. Piping was also extended to the 216-A-36B portion of the crib to resume discharge of the PUREX ammonia scrubber

[1] DOE/RL-2010-93, 2011, *Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1108241345.

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

[3] 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.

[4] 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.ecfr.gov/cgi-bin/text-idx?SID=24aad4966ac52acbeba416c2c1114889&mc=true&node=pt40.26.265&rgn=div5.

distillate (ASD) effluent which continued until October 1972 when the 216-A-36B Crib was temporarily removed from service due to shut down of the PUREX process. The 216-A-36B Crib was placed back in service in November 1982, with the restart of the PUREX process, and operated again until it received the final volume of PUREX ASD effluent waste on September 6, 1987.

The 216-A-36B Crib received ASD wastewater contaminated with dangerous waste or dangerous waste constituents (designated as a state-only toxic waste [waste code WT02]) under the Washington State Department of Ecology waste mixture rule. The waste was determined to be WT02 because the concentrations of ammonium hydroxide were in excess of 1 percent by weight. The Part A Form identified liquid ammonium hydroxide as the only dangerous waste compound potentially managed at 216-A-36B.

A groundwater monitoring program[5] in accordance with 40 CFR 265 was implemented in 1988. In the plan revision in 1994, the 216-A-36B Crib shared a groundwater monitoring plan[6] with the 216-A-10 Crib. In both 1995 and 1996, monitoring for indicator parameters at well 299-E17-9 showed specific conductance at concentrations statistically greater than background levels. A groundwater quality assessment plan which combined the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs was prepared and initiated in 1997.[7] By 2010, a separate site-specific groundwater monitoring plan[8] was developed for the 216-A-36B Crib. The 216-A-36B Crib was returned to an indicator parameters evaluation program because it was determined that nitrate, which is not a dangerous waste constituent, was the cause of elevated specific conductance in well 299-E17-9. However, nitrate may indicate the presence of dangerous constituents in groundwater. Since 2010, concentrations of specific conductance in RCRA compliant

[5] Izatt, R.D., 1988, "Compliance Order DE 87-295" (letter to Jon Neel, State of Washington, Department of Ecology, from R.D. Izatt, U.S. Department of Energy, Richland Operations Office, and R.E. Lerch, Westinghouse Hanford Company), July 12. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=E0003475.

[6] WHC-SD-EN-AP-170, 1994, *Interim Status Groundwater Monitoring Plan for the 216-A-10 and 216-A-36B Cribs*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196214236.

[7] PNNL-11523, 1997, *Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D1662256.

[8] DOE/RL-2010-93, 2010, *Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1106170792.

wells have remained below the statistical comparison value (as defined in 40 CFR 265.93(b)) for the site.

This revised groundwater monitoring plan presents a revised indicator evaluation program for detection monitoring of the uppermost aquifer beneath the 216-A-36B Crib. This plan addresses the following:

- Number, locations, and depths of wells in the 216-A-36B groundwater monitoring network
- Sampling and analytical methods of parameters required for groundwater contamination detection monitoring
- Methods for evaluating groundwater quality information
- Schedule for groundwater monitoring at the 216-A-36B Crib

This revised plan updates the existing groundwater monitoring well network as identified in the previous groundwater monitoring plan (DOE/RL-2010-93, Rev. 1). Groundwater flow direction determinations indicate that a southeast groundwater flow direction exists beneath the 216-A-36B Crib (DOE/RL-2015-07[9]). Groundwater in the 216-A-36B monitoring wells will be sampled and analyzed semiannually for the parameters used as indicators of groundwater contamination (pH, specific conductance, total organic carbon, and total organic halogen) and annually for parameters establishing groundwater quality (chloride, iron, manganese, phenols, sodium, and sulfate) in accordance with 40 CFR 265.92(b)(2)&(3) and (d). Additional site-specific constituents, anions, and cations will also be collected for general groundwater chemistry to support the evaluation of upgradient and downgradient water chemistry variations. Water-level measurements will be taken each time that a sample is collected to satisfy the requirements of 40 CFR 265.92(e) and chlorinated hydrocarbon volatile organic compounds (VOCs) will be collected triennially. Two existing wells, one upgradient (299-E17-1) and one downgradient (299-E17-15) of the site, are being added to the monitoring network and will be sampled quarterly for indicator parameters (pH, specific conductance, total organic carbon, and total organic halogen) and groundwater quality parameters (chloride,

[9] DOE/RL-2015-07, 2015, *Hanford Site Annual Groundwater Monitoring Report for 2014*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0080600H.

iron, manganese, phenols, sodium, and sulfate) for 1 year. Because these wells are newly added to the 216-A-36B network, they will be sampled quarterly for 1 year for drinking water suitability parameters included in Appendix III to 40 CFR 265.

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# Terms

Commented [CTJ1]: RCRA-CN-01-DOE/RL-2010-93_R2

| | |
|---|---|
| AEA | *Atomic Energy Act of 1954* |
| ASD | ammonia scrubber distillate |
| bgs | below ground surface |
| CSM | conceptual site model |
| DOE | U.S. Department of Energy |
| DOE-RL | DOE Richland Operations Office |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| FWS | Field Work Supervisor |
| HSU | hydrostatigraphic unit |
| H1 | Hanford 1 |
| H2 | Hanford 2 |
| H3 | Hanford 3 |
| NAD | *North American Datum of 1983* |
| NAVD88 | *North American Vertical Datum of 1988* |
| OU | operable unit |
| PUREX | Plutonium-Uranium Extraction |
| QAPjP | quality assurance project plan |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| TOC | total organic carbon |
| TOX | total organic halogen |
| Tri-Party Agreement | *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989a) |
| TSD | treatment, storage, and disposal |
| VOC | volatile organic compound |

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# 1 Introduction

This document presents the revised groundwater monitoring plan for the 216-A-36B Plutonium-Uranium Extraction (PUREX) Crib and supersedes the previous plan (DOE/RL-2010-93, Rev. 1, *Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib*). The U.S. Department of Energy (DOE), Richland Operations Office (DOE-RL), is revising this groundwater monitoring plan due to the age of the plan and to ensure that the plan contains the most current Hanford Site groundwater monitoring information for the treatment, storage, and disposal (TSD) unit (updated groundwater flow direction and revised monitoring network). This groundwater monitoring plan is based on the requirements for interim status facilities, as defined by the *Resource Conservation and Recovery Act of 1976* (RCRA), with regulations promulgated by the Washington State Department of Ecology (Ecology) in the *Washington Administrative Code*, and the *Code of Federal Regulations* by reference (WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards;" 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring"). This plan monitors indicator parameters in groundwater samples that are used to determine whether dangerous waste or dangerous waste constituents have entered the groundwater. This plan also monitors parameters used in establishing groundwater quality.

The 216-A-36B Crib is an inactive interim status TSD unit, as defined in WAC 173-303-040, "Definitions." In accordance with Section I.A of WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste* (hereafter referred to as the Hanford Facility RCRA Permit), 216-A-36B will continue to be considered an interim status unit until it is incorporated into Part III, V, and/or VI of the Hanford Facility RCRA Permit, or until interim status is terminated. Therefore, groundwater monitoring for the 216-A-36B Crib continues under interim status requirements. For regulatory purposes, the TSD unit boundary of the 216-A-36B Crib is identified on the current Hanford Facility RCRA Permit Part A Form.

The 216-A-36B Crib is located in the 200-EA-1 Soil Operable Unit (OU), approximately 360 m (1,200 ft) south of the PUREX Plant in the southeast corner of the 200 East Area (Figure 1-1). The crib received ammonia scrubber distillate (ASD) effluent from PUREX Plant operations. Operating records indicate that the original 316-A-36 Crib began receiving PUREX Plant effluent wastewater in September 1965. In March 1966, the original crib was divided into two sections: northern 216-A-36A section and southern 216-A-36B section. The 216-A-36B Crib was temporarily removed from service in October 1972, then placed back into service in November 1982 to receive ASD effluent wastewater due to the restart of the PUREX Plant. Discharges ceased on September 6, 1987.

The purpose of this groundwater monitoring plan is to present an updated groundwater monitoring program for the parameters used as indicators of groundwater contamination and groundwater quality from the 216-A-36B Crib, commonly referred to as an indicator evaluation program under interim status. This plan is required by 40 CFR 265.90, "Applicability," (a) and (b) and is intended specifically to satisfy monitoring requirements for interim status TSD units, as required by WAC 173-303-400(3) and 40 CFR 265.92, "Sampling and Analysis." This monitoring plan is the principal controlling document for conducting groundwater monitoring at the 216-A-36B Crib. The indicator evaluation program detailed in this plan requires semiannual sampling for parameters used as indicators of groundwater contamination, and annual sampling for parameters establishing groundwater quality. Volatile organic compounds (VOCs) have historically been intermittently detected at low concentrations in wells both upgradient and downgradient of the 216-A-36B Crib. Analysis for VOCs as site specific constituents will continue on a triennial frequency to monitor the consistency of detections and trending of analytical results. One existing upgradient well and one existing downgradient well are added to the network and will be

monitored quarterly for 1 year for parameters used as indicators of groundwater contamination and parameters establishing groundwater quality; then, it will revert to the same sampling frequency as the other wells. Wells that are newly added to the 216-A-36B network will be sampled quarterly for 1 year for drinking water suitability parameters included in Appendix III to 40 CFR 265. Water-level measurements are also required each time that a sample is collected in accordance with 40 CFR 265.92(e).

This groundwater monitoring plan addresses the operational history, current hydrogeology, and conceptual site model (CSM) for the 216-A-36B Crib and incorporates knowledge about the potential for contamination originating from the 216-A-36B Crib and includes the following chapters and appendices:

- Chapter 2 summarizes background information and references other documents that contain more detailed or additional information. It also describes the 216-A-36B Crib and the regulatory basis, types of waste present, and pertinent geology and hydrogeology beneath the 216-A-36B Crib, and it presents a brief history of groundwater monitoring. This information is summarized as a CSM to support development of the groundwater monitoring program.
- Chapter 3 describes the groundwater monitoring program, including the wells in the monitoring network, constituents analyzed, sampling frequency, and sampling protocols.
- Chapter 4 describes data evaluation and reporting.
- Chapter 5 provides an updated outline for a groundwater quality assessment plan.
- Chapter 6 contains the references cited in this plan.
- Appendix A provides the quality assurance project plan (QAPjP).
- Appendix B contains sampling protocols.
- Appendix C provides information for wells within the groundwater monitoring network.

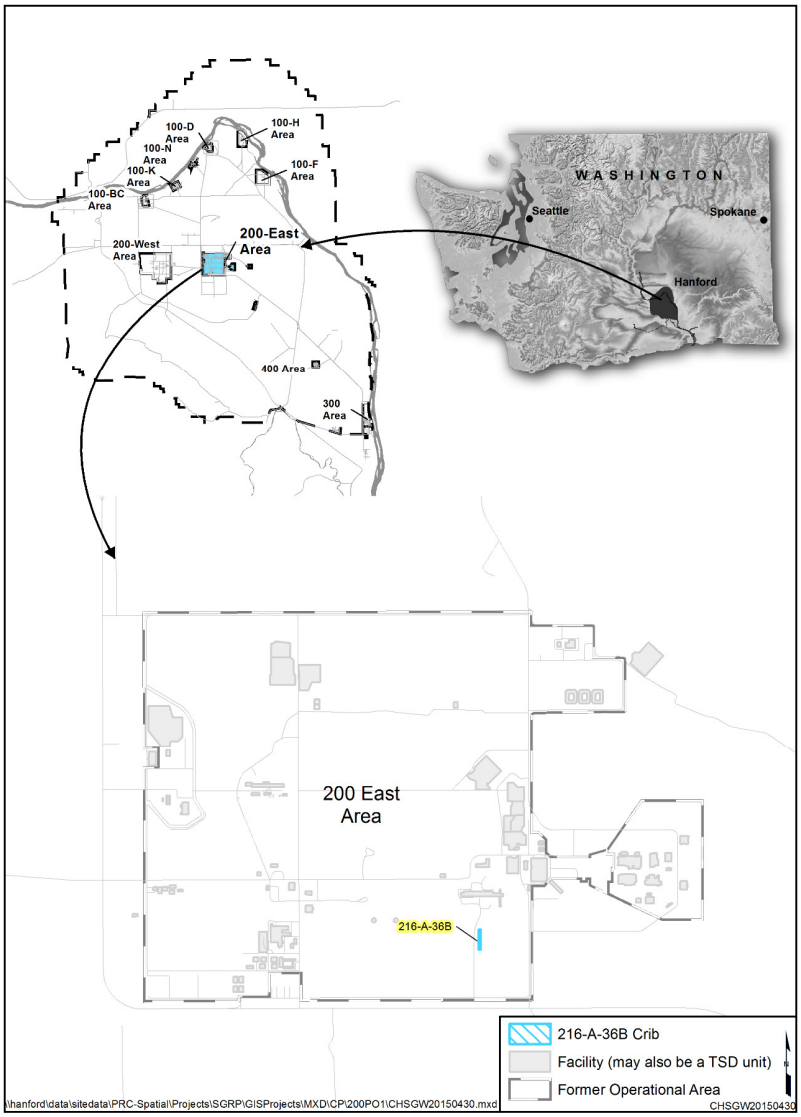


**Figure 1-1. Location Map for the 216-A-36B Crib**

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# 2 Background

This chapter describes the 216-A-36B Crib and its operating history, regulatory basis, wastes and waste characteristics associated with the 216-A-36B Crib, local subsurface geology and hydrogeology, a summary of previous groundwater monitoring, and the CSM for the 216-A-36B Crib.

The information contained in this chapter was obtained from several sources, including previous groundwater monitoring plans listed in Section 2.5 and DOE, 1988, *Closure Plan 216-A-36B Crib.*

## 2.1 Facility Description and Operational History

The original 216-A-36 Crib received ammonia scrubber waste effluent from PUREX Plant operations beginning in September 1965. In March 1966, the northern segment of the 216-A-36 Crib was removed from service because of the rapid buildup of fission products within the first 30 m (100 ft) of the crib from the routine effluent discharge. A vertical grout barrier was placed into the gravel layer of the crib 30 m (100 ft) from the north end of the crib to isolate the contaminated north end from the south end. The grout barrier subdivided the original crib into the northern segment (216-A-36A) and southern segment (216-A-36B) (Figure 2-1). The effluent sent to 216-A-36B was a mixed waste, primarily consisting of ASD wastewater which contained ammonium hydroxide and small quantities of low-level radionuclides delivered via pipeline to the soil column in the crib. Additional details on disposal to the unit may be found in BHI-00178, *PUREX Plant Aggregate Area Management Study Technical Baseline Report* (Section 4.10) and DOE/RL-92-19, *200-E Groundwater Aggregate Area Management Study Report* (Sections 2.3.1 and 2.8.2.6; Table 2-1). An estimated inventory of contaminants released to the soil during Hanford Site operations is available in RPP-26744, *Hanford Soil Inventory Model, Rev. 1* (Tables 6-29, 6-30, and A5-21).

The 216-A-36B Crib is approximately 152 m (500 ft) long and 3.4 m (11 ft) wide at the bottom. The bottom of the crib is approximately 7.3 m (24 ft) below grade. A 15 cm (6 in.) diameter perforated stainless steel distributor pipe was placed horizontally approximately 7 m (23 ft) below grade (Figure 2-2). When the northern segment (216-A-36A) was isolated, a pipe was inserted into the original 15 cm (6 in.) diameter outer pipe. The inserted pipe was a 12.7 cm (5 in.) diameter non-perforated stainless steel pipe, that after the first 30 m (100 ft) of the 216-A-36A Crib reduced to a 10 cm (4 in.) diameter stainless steel pipe. The section of the pipe passing through the 216-A-36A portion of the crib was not perforated and was further isolated from 216-A-36B by an annulus seal installed between the original 15 cm (6 in.) pipe and the inner 12.7 cm (5 in.) pipe. The inner 12.7 cm (5 in.) pipe reduced in size to a 10 cm (4 in.) diameter perforated pipe in the 216-A-36B Crib. This piping configuration allowed for distribution of liquids to only the 216-A-36B portion of the crib. The crib was equipped with two gauge wells. The gauge wells allowed for monitoring of the liquid in the crib. The crib construction includes approximately 7 m (23 ft) of clean backfilled soil that naturally revegetated with native grasses over time. An herbicide treatment program has controlled deep rooting plants. After the grout barrier was placed, the 216-A-36B Crib was put back into service and continued to receive the PUREX Plant effluent until October 1972 when it was temporarily removed from service. In November 1982, the 216-A-36B Crib was placed back into service for the restart of the PUREX Plant, and the crib continued to operate until final receipt of the ASD effluent wastewater on September 6, 1987.

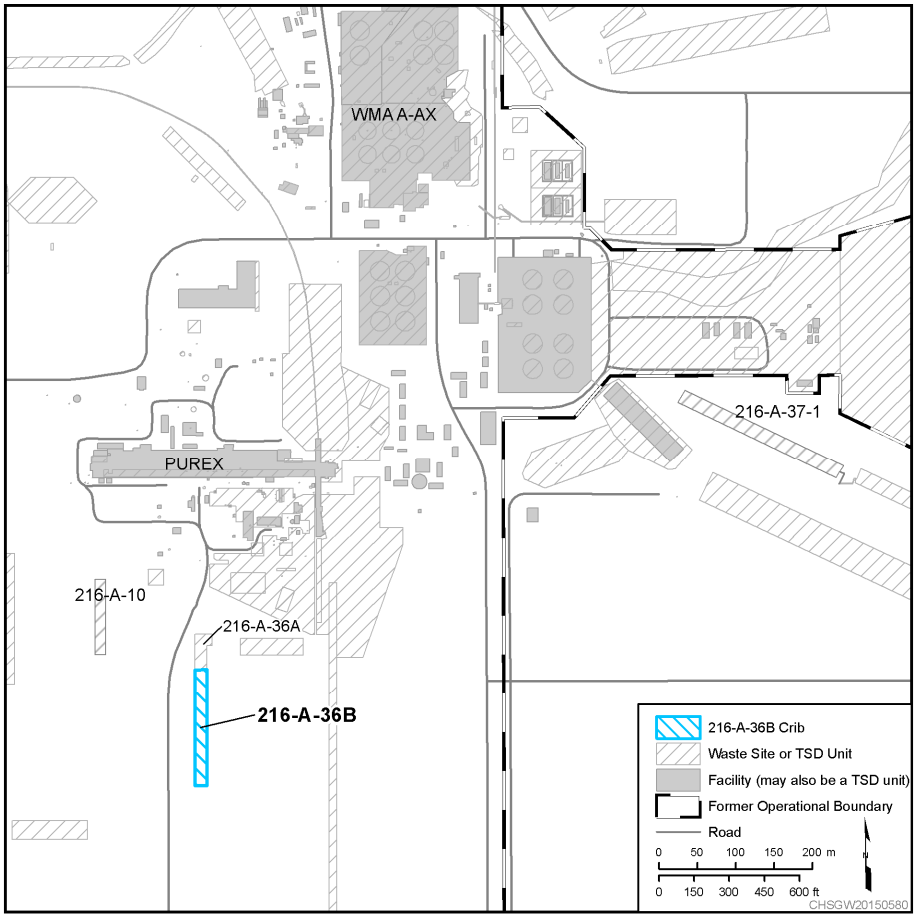



**Figure 2-1. Site Map for the 216-A-36B Crib and Surrounding Facilities**

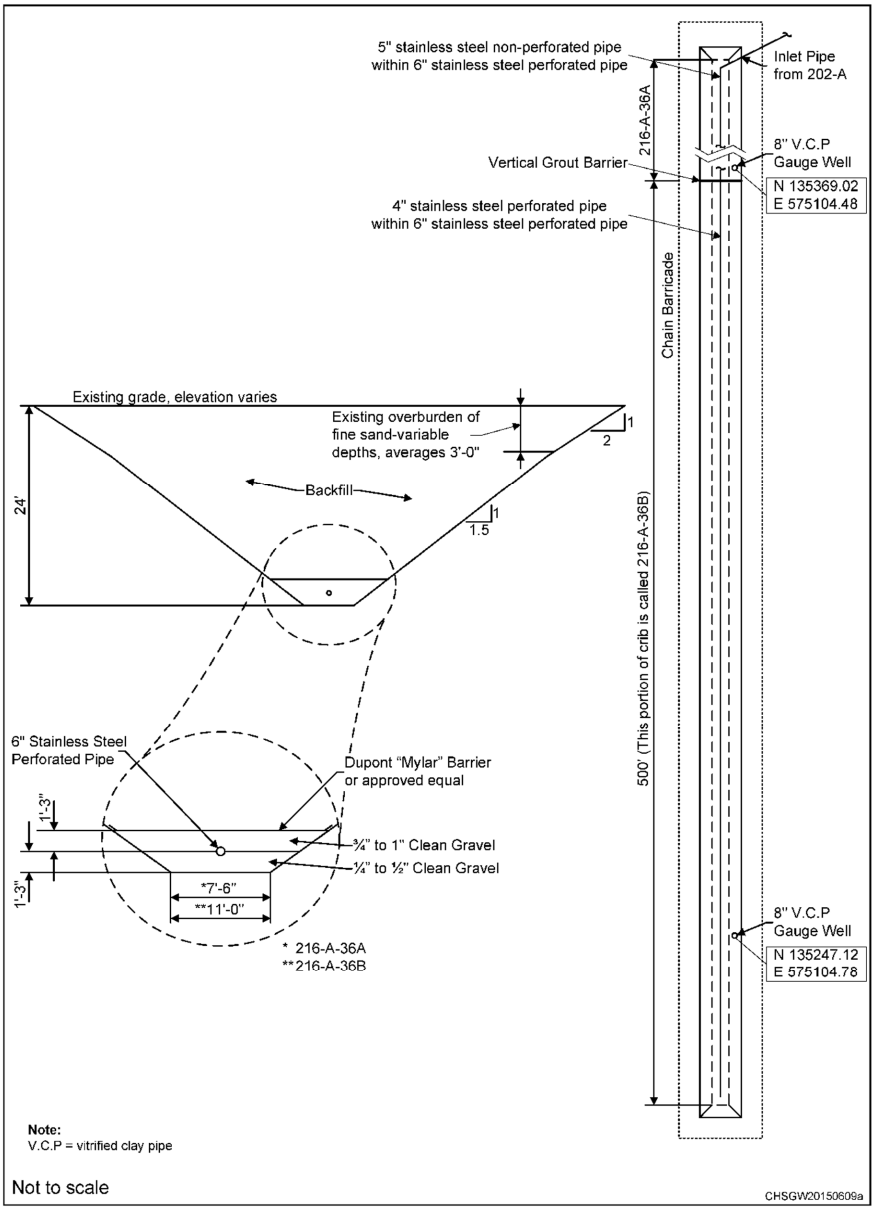



**Figure 2-2. Construction Diagram for the 216-A-36B Crib**

## 2.2 Regulatory Basis

In May 1987, DOE issued a final rule (10 CFR 962, "Byproduct Material"), stating that the hazardous waste components of mixed waste are subject to RCRA regulations. The hazardous waste components of mixed waste were determined to be subject to Ecology authority to regulate these waste since August 19, 1987.

In May 1989, DOE, the U.S. Environmental Protection Agency (EPA), and Ecology signed the Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement). This agreement established the roles and responsibilities of the agencies involved in regulating and controlling remedial restoration of the Hanford Site, which includes the 216-A-36B Crib. Groundwater monitoring is conducted at the 216-A-36B Crib in accordance with WAC173-303-400(3) (and by reference, 40 CFR 265, Subpart F), which requires monitoring to determine whether the dangerous waste constituents from the TSD unit have entered the groundwater in the uppermost aquifer underlying the TSD unit.

Dangerous waste is regulated under RCW 70.105, "Hazardous Waste Management," and its Washington State implementing regulations (WAC 173-303). Radionuclides in mixed waste may include source, special nuclear, and byproduct materials as defined in the *Atomic Energy Act of 1954* (AEA). AEA states that these radionuclide materials are regulated at DOE facilities, exclusively by DOE, acting pursuant to its AEA authority. Radionuclide materials are not hazardous/dangerous wastes and, therefore, are not subject to regulation by the State of Washington under RCRA or RCW 70.105.

In 1988, a groundwater monitoring program for the 216-A-36B Crib, compliant with WAC 173-303-400(3) and 40 CFR 265, Subpart F, was required by a regulatory order (Ecology, 1987, *Order No. DE 87-295*) based on the interim status indicator evaluation program requirements of 40 CFR 265, Subpart F, and WAC 173-303-400.

In order to satisfy well installation requirements of the regulatory order, a letter was provided to Ecology (Izatt, R.D., 1988, "Compliance Order DE 87-295"), which described the status of drilling and sampling wells at the 216-A-36B Crib and contained an informal groundwater monitoring plan. A complete indicator evaluation groundwater monitoring plan for the 216-A-36B Crib was published in 1994 (WHC-SD-EN-AP-170, *Interim-Status Groundwater Monitoring Plan for the 216-A-10 and 216-A-36B Cribs*) and addressed both the 216-A-10 Crib and 216-A-36B Crib in a joint plan. Later, a combination groundwater quality assessment monitoring plan for the 216-A-36B, 216-A-10, and 216-A-37-1 PUREX Cribs (Figure 2-1) was published in 1997 (PNNL-11523, *Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Crib,* Rev. 0). This combined approach was based on the proximity, similarities in construction, waste history, and hydrogeologic regime of the three cribs. The 1997 plan was designed as a groundwater quality assessment program due to elevated specific conductance in well 299-E17-9 (Figure 2-3) at the 216-A-36B Crib and the recognition that the three cribs had contributed to radiological and non-radiological groundwater contamination from PUREX Plant operations. The combined groundwater monitoring plan was revised in 2005 (PNNL-11523, *Interim-Status RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs*, Rev. 1) to remove radioactive constituents and far-field wells from the well monitoring network.

In 2010, the combined groundwater monitoring plan (PNNL-11523, Rev. 1) required replacement as the Permit Application Part A Form for the 216-A-10 Crib was removed from the Hanford Facility RCRA Permit, thereby eliminating the RCRA groundwater monitoring requirement from the 216-A-10 Crib. Therefore, a site-specific groundwater monitoring plan was developed for the 216-A-36B Crib

(DOE/RL-2010-93, *Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib*, Rev. 0), in which the site entered back into an indicator evaluation program.

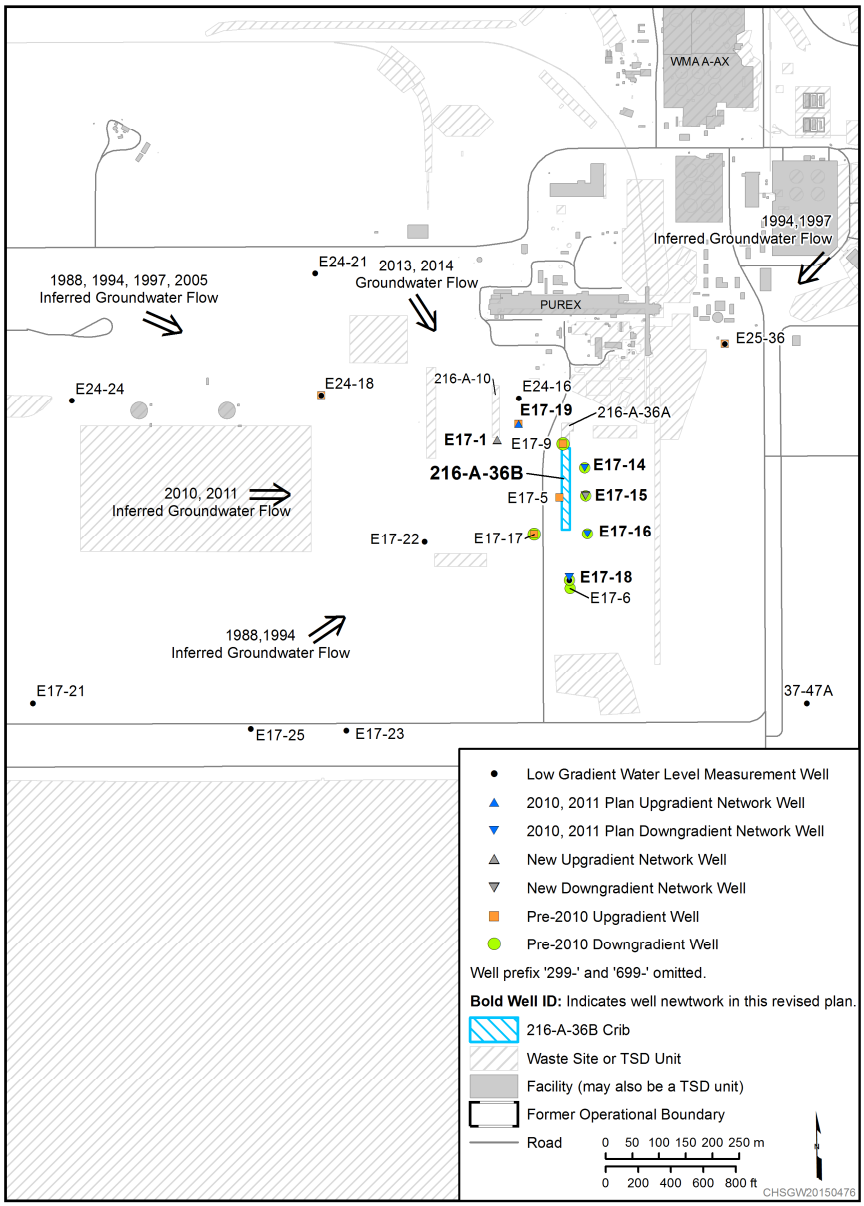



**Figure 2-3. Monitoring Networks Utilized near the 216-A-36B Crib and Estimated Local Flow Directions Over Time**

The TSD unit returned to an indicator evaluation program because nitrate was determined to be the cause of elevated specific conductance and nitrate is not a dangerous waste constituent listed in Ecology Publication 97-407, *Chemical Test Methods for Designating Dangerous Waste, WAC 173-303-090 & -100*. However, nitrate may indicate the presence of dangerous constituents in groundwater. The DOE/RL-2010-93 Rev. 0 plan was updated in 2011 with DOE/RL-2010-93, Rev. 1 to include a section outlining the constituent list and sampling frequency for the first year of monitoring. An indicator evaluation program that monitors parameters required for groundwater contamination detection continues to this day.

## 2.3 Waste Characteristics

The 216-A-36B Crib received PUREX Plant ASD effluent. The PUREX process used a boiling solution of ammonium fluoride and ammonium nitrate to dissolve zirconium–alloy cladding from fuel elements. Large quantities of gaseous ammonia byproduct from this process was directed through a water scrubber to reduce atmospheric discharge, with the resulting ASD effluent waste stream discharged to the 216-A-36B Crib. ASD was designated as a state only toxic waste (waste code WT02) under the Washington State waste mixture rule because concentrations of ammonium hydroxide in the waste stream were in excess of one percent by weight according to the Hanford Facility RCRA Permit Part A Form for the 216-A-36B Crib. The Part A Form identified liquid ammonium hydroxide as the only dangerous waste compound potentially managed at 216-A-36B.

## 2.4 Geology and Hydrogeology

The geology and hydrogeology of the 200 East Area, including the region of the 216-A-36B Crib, are described in detail in the following documents:

- CP-57037, *Model Package Report: Plateau to River Groundwater Transport Model Version 7.1*
- DOE/RL-2009-85, *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit*
- DOE/RL-2011-01, *Hanford Site Groundwater Monitoring Report for 2010 (Chapter 2 "Overview of Hanford Hydrogeology and Geochemistry")*
- DOE/RL-2014-32, *Hanford Site Groundwater Monitoring Report for 2013*
- ECF-Hanford-13-0029, *Development of the Hanford South Geologic Framework Model, Hanford Site, Washington*
- PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*
- SGW-54165, *Evaluation of the Unconfined Aquifer Hydraulic Gradient Beneath the 200 East Area, Hanford Site*

### 2.4.1 Stratigraphy

The general stratigraphy at the Hanford Site is presented in Figure 2-4. Stratigraphic units underlying the 200 East Area within the vicinity of the 216-A-36-B Crib include the following (listed in order from uppermost to lowermost) (DOE/RL-2009-85):

- Discontinuous veneer of Holocene eolian silty sand or backfill mixtures of sand and gravel.
- Hanford formation – Cataclysmic flood deposits equivalent to hydrostratigraphic unit (HSU) 1. The Hanford formation consists of three facies subunits (silt-dominated, sand-dominated, and

gravel-dominated) which grade into one another both vertically and laterally (Figure 2-4). On the central plateau, the Hanford formation is sometimes further delineated into Hanford 1 (H1), Hanford 2 (H2), and Hanford 3 (H3) lithostratigraphic sequences. The H1 and H3 gravel sequences are not differentiated in those areas where the intervening sandy H2 sequence is absent. Units H1 and H3 consist of coarse-grained, basalt-rich, sandy gravels with varying amounts of silt/clay. These gravel units may also contain interbedded sand and or silt/clay lenses. The H2 sequence is dominated by sand to gravelly sand, with minor sandy gravel or silt/clay interbeds. Both the sand-dominated H2 and gravel-dominated H3 sequences are present near the 216-A-36B Crib.

- Ringold Formation Unit E – equivalent to HSU 5. Fluvial deposits with thick layers of silty sandy gravel (conglomerate), intercalated with thinner beds of overbank silts and fine-grained paleosols. In the 200 East Area, HSU 5 is present only in the southern portion because to the north it has been removed by erosion or was never deposited.

- Ringold Formation, lower mud unit – equivalent to HSU 8. This unit is composed of a sequence of fluvial overbank, paleosol, and lacustrine silt and clay, with minor sand and gravel. The Ringold Formation lower mud is a confining unit acting as a barrier to groundwater flow between the Ringold Formation Unit E and the underlying Ringold Formation Unit A when all units are present.

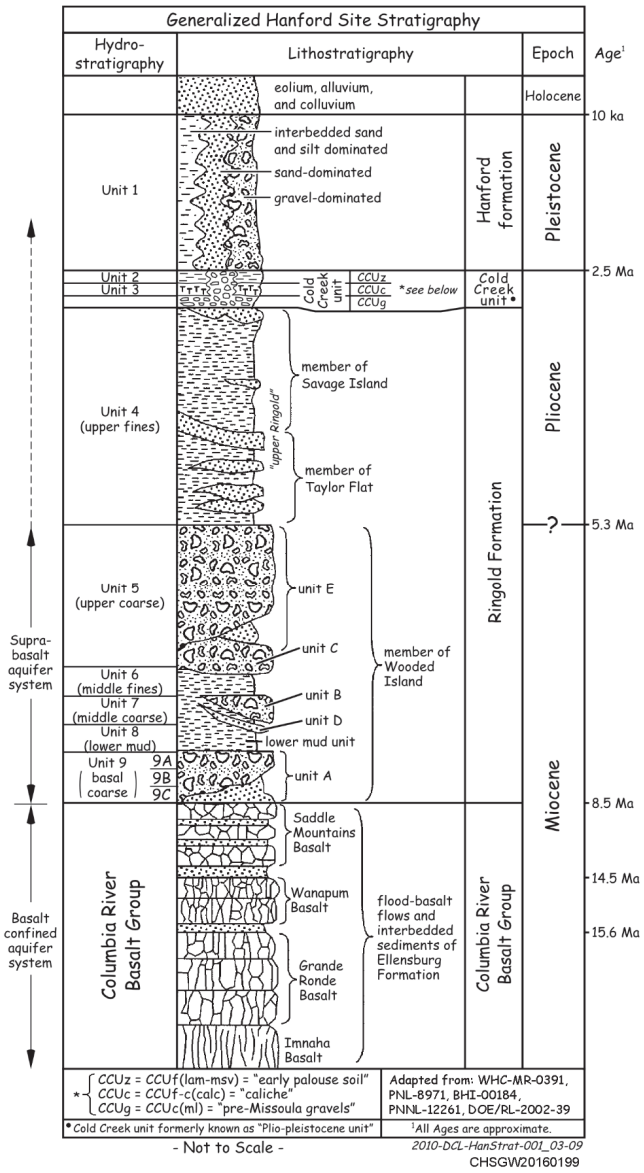
- Ringold Formation, Unit A – equivalent to HSU 9, which can be further subdivided into three hydrostratigraphic units based on markedly different lithologies and hydraulic properties. The primary subunit is characterized as a silt to clay-rich confining zone with lower permeability, classified as unit 9B. Subunits 9A and 9C have much higher permeabilities and lower clay content and consist of consolidated silty sandy gravel deposits.

- Bedrock, consisting of Columbia River Basalt flows, dips gently to the south toward the axis of the Cold Creek syncline. The two uppermost flows are within the Elephant Mountain Member of the Saddle Mountains Basalt. The top of basalt is approximately 150 m (490 ft) below ground surface (bgs) near the 216-A-36B Crib.

- The erosion related to paleochannel scouring near the 216-A-37-1 Crib is not present near the 216-A-36B Crib; therefore, the units incised and removed by channeling near the 216-A-37-1 Crib (Ringold unit E, lower mud, and unit A) are present beneath the 216-A-36B Crib. The Cold Creek unit (post-Ringold Formation and pre-Hanford formation) is not present beneath the 216-A-36B Crib but is present to the east, near the 216-A-37-1 Crib.

- Geologic cross sections, which include selected wells in the southern portion of the 200 East Area, present the stratigraphy underlying and adjacent to the 216-A-36-B Crib (Figures 2-5, 2-6, and 2-7). Stratigraphic contacts shown below wells presented in the cross sections are based on interpolated contacts using the Leapfrog Hydro®[10] geologic three-dimensional software (ECF-HANFORD-13-0029) and the cross section generation tool provided in the web-based version of DOE/RL-2015-07, *Hanford Site Groundwater Monitoring Report for 2014*. As indicated in each cross section figure legend, geologic information associated with a well is projected to the cross section within a buffer zone extending 75 m (246 ft) from either side of the cross section line, resulting in approximate depths for stratigraphic contacts. Definition of the stratigraphic units present is based on the most current, integrated understanding of the subsurface geologic framework beneath an area and in some cases utilizes projected geologic contacts and stratigraphy from adjacent areas where data is available, utilizing the Leapfrog geologic three-dimensional software.

[10] Leapfrog Hydro® is a registered trademark of ARANZ Geo Limited, Christchurch, New Zealand.




Note: Complete reference citations are provided in Chapter 6.

**Figure 2-4. General Stratigraphy at the Hanford Site**

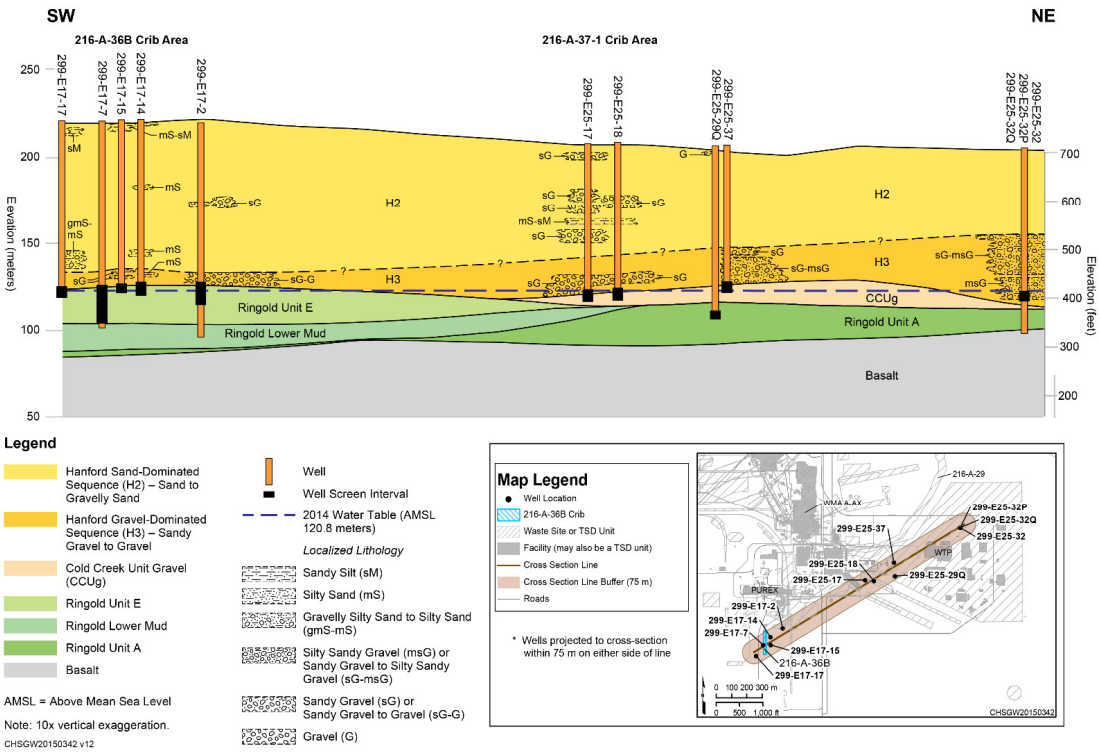



**Figure 2-5. Southwest-Northeast Geologic Cross Section Showing the Stratigraphy Below the 216-A-36B Crib**

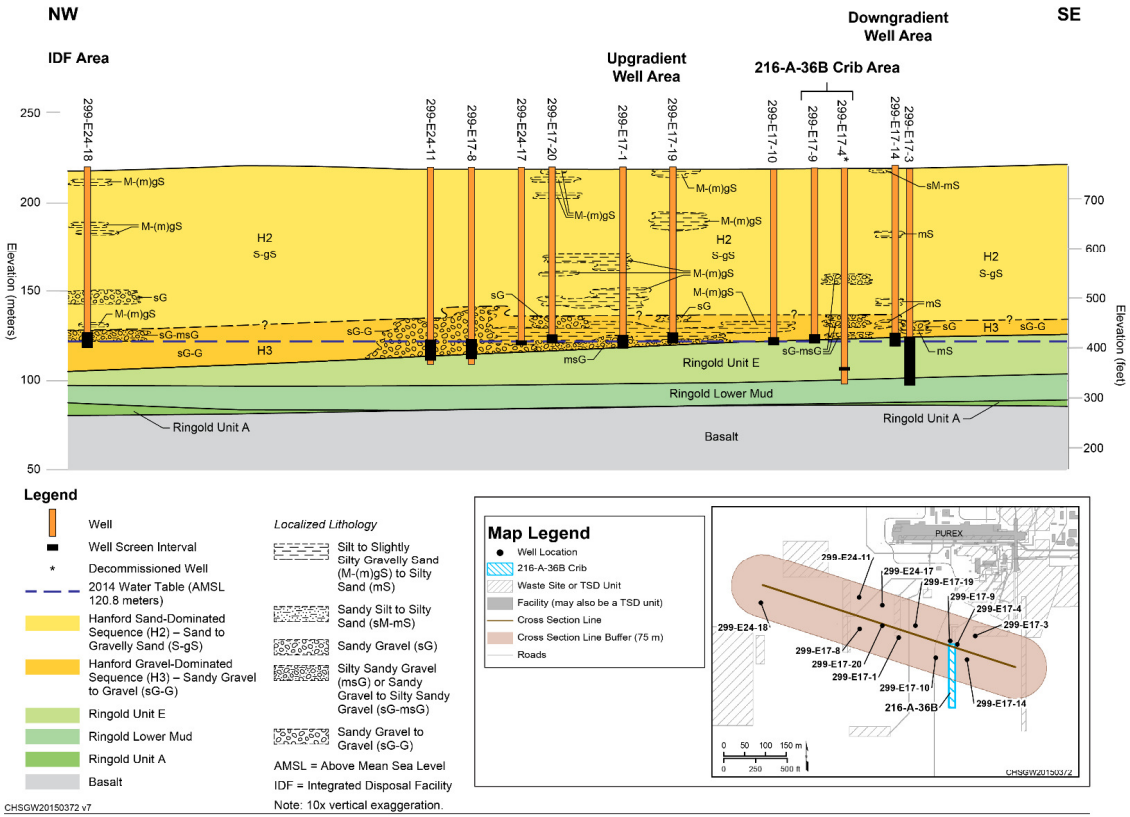



**Figure 2-6. Northwest-Southeast Geologic Cross Section Showing the Stratigraphy Below the 216-A-36B Crib**

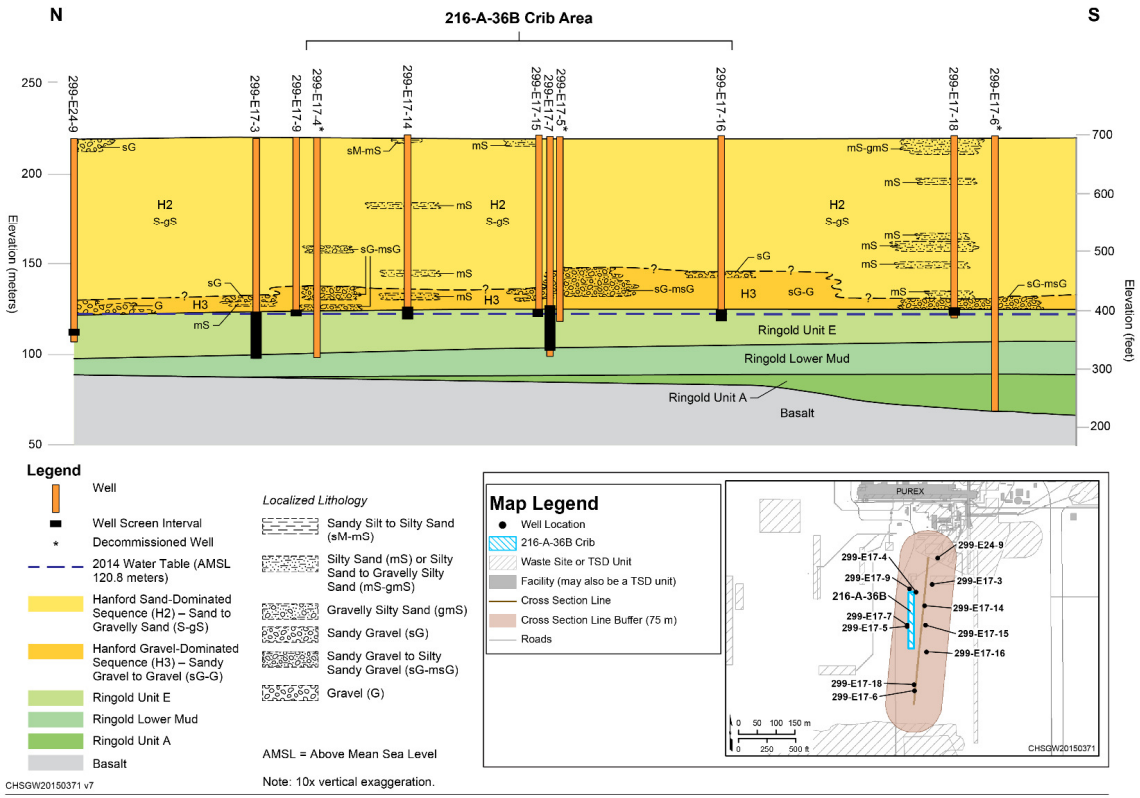



**Figure 2-7. North-South Geologic Cross Section Showing the Stratigraphy Below the 216-A-36B Crib**

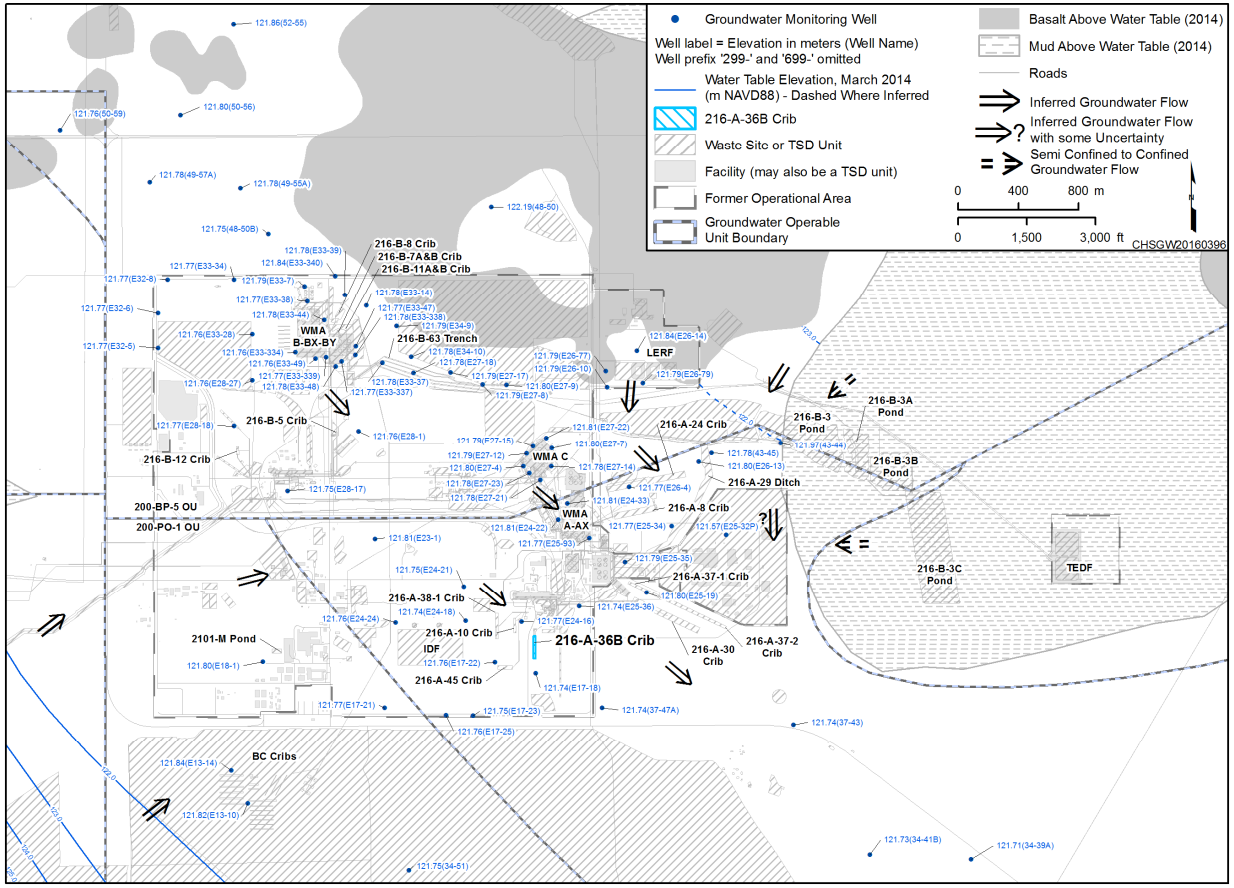
### 2.4.2 Hydrogeology

The uppermost aquifer underlying the 216-A-36B Crib occurs within the Ringold Unit E and extends from the water table to the top of the lower mud unit. The 216-A-36B Crib overlies a sequence that includes the Hanford formation (Unit 1), Ringold Unit E (Unit 5), and Ringold lower mud unit (Unit 8) (Figures 2-4 through 2-7). The sediments comprising the Hanford formation have a higher hydraulic conductivity than the underlying Ringold Formation. Based on recent groundwater flow and transport modeling iterations for the 200-PO-1 OU, the calibrated average hydraulic conductivity for the Hanford formation and Cold Creek unit, where channelized flow occurs, is estimated to be approximately 17,000 m/day (55,777 ft/day) and 2.27 m/day (7.45 ft/day) in those areas without channelized flow where older sediment occurs (DOE/RL-2009-85-ADD1, *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit Addendum 1*, Table 3-3 and CP-57037, Table 3-1). The average hydraulic conductivity of the Ringold Unit E is estimated to be 1 m/day (3.28 ft/day) (DOE/RL-2009-85-ADD1, Table 3-3). Flow velocities in the uppermost aquifer below the 216-A-36B Crib have been estimated to range from 0.0013 – 0.22 m/d (0.0004 – 0.73 ft/d) (Table B-1 in DOE/RL-2015-07). Due to high hydraulic conductivity, the water table in the area where the crib is located is very flat with an extremely low gradient (Section 2.2 in SGW-54165 and SGW-58828, *Water Table Maps for the Hanford Site 200 East Area, 2013 and 2014*). The current water table elevation is approximately 122 m (400 ft) above mean sea level and occurs within the Ringold Unit E in the vicinity of the 216-A-36B Crib (Figures 2-5, 2-6, and 2-7).

### 2.4.3 Groundwater Flow Interpretation

Historically, water levels in the unconfined aquifer increased as much as 5.5 m (18 ft) above the pre-Hanford natural water table level near the PUREX Cribs (i.e., 216-A-10, 216-A-36B, and 216-A-37-1) (BNWL-B-360, S*elected Water Table Contour Maps and Well Hydrographs For the Hanford Reservation 1944-1973*, Figure 4; HW-51277, *Changes in the Hanford Water Table 1944-1957*, Figure 1; HW-53599, *Fluctuations of Hanford Water Levels*, Figure 3; DOE/RL-92-23, *Hanford Site Groundwater Background*, Figures 3-5 and 3-6; and DOE/RL-2011-01, Rev. 0, Section 3.1, footnote 2). This increase was the result of artificial recharge from liquid waste disposal operations (e.g., PUREX Cribs and B Pond) between the mid-1940s and 1997. The pre-Hanford groundwater flow was to the east and southeast in the southeastern portion of the 200 East Area. While the 216-B-3 Pond (B Pond) was in operation, artificial recharge created a significant groundwater mound, resulting in a radial flow pattern around B Pond that impeded flow towards the east and redirecting it to the southwest. As discharges to B Pond ceased, the mound at B Pond subsided, and groundwater flow directions in the southeastern portion of the 200 East Area and vicinity of the 216-A-36B Crib began to change to a south or southeasterly direction.

Currently, the unconfined aquifer in the 200 East Area has a very low hydraulic gradient, making it difficult to determine groundwater flow direction. The hydraulic gradient of the water table in the area around the 216-A-36B Crib is calculated to be $2.3 \times 10^{-5}$ meters per meter (DOE/RL-2014-32). Estimated flow directions in different portions of the 200 East Area have been determined through statistical analysis of water levels obtained from wells comprising the low gradient monitoring well network in conjunction with tracking contaminant plume movements. In 2013, the local groundwater flow direction near the 216-A-36B Crib was interpreted to be southeast, based on measurements from low gradient monitoring network wells (Figure 2-8). Water table elevations and local flow directions occasionally show temporary changes due to discharges from the 200 East Area Treated Effluent Disposal Facility (Figure 2-8) and possibly from elevated Columbia River water levels (SGW-54165).




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

**Figure 2-8. Water Table Elevations and Local Groundwater Flow Directions for 200 East and the 216-A-36B Crib Area**

One characteristic of highly transmissive aquifers is that stressors to the aquifer can have effects at large distances from the source of the stress. For example, the discharge of effluent to the ground at the Treated Effluent Disposal Facility, located 3 km (1.9 mi) east of the 200 East Area, affects the water table elevation throughout the 200 East Area (PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*). Further, it had previously been hypothesized that large seasonal changes in Columbia River stage also affect the water table elevation in the 200 East Area (PNNL-16346). Although the river is approximately 10 km (6.2 mi) from the 200 East Area, the highly transmissive paleochannel between the river and the 200 East Area allows for river stage effects to be propagated large distances inland. This situation is described in more detail in Appendix D of SGW-54165. This hypothesis was confirmed by the results of the study, as described in Section 4.1.5.2 of SGW-54165**.**

## 2.5 Summary of Previous Groundwater Monitoring

Table 2-1 lists the previous groundwater monitoring plans implemented at the 216-A-36B Crib. Figure 2-3 shows the 216-A-36B Crib historical monitoring network wells and the wells included in this revised groundwater monitoring network. Estimated groundwater flow directions corresponding to the dates of each plan are shown on Figure 2-3. In response to Order No. DE 87-295 (Ecology, 1987), groundwater monitoring was initiated at the 216-A-36B Crib in 1988 through an informal groundwater monitoring plan submitted to Ecology (Izatt, R.D, 1988). The 1988 informal groundwater monitoring plan established a well monitoring network that contained five new wells (299-E17-17 [upgradient] and 299-E17-14, 299-E17-15, 299-E17-16, and 299-E17-18 [downgradient]), two existing wells (299-E17-5 and 299-E17-9, also downgradient), and one well (299-E17-6) that was included in the network for qualitative data only.

**Table 2-1. Previous Monitoring Plans**

| Document | Date Issued | Monitoring Program* |
|---|---|---|
| Letter provided to Ecology (Izatt, R.D., 1988) | July 12, 1988 | Indicator Evaluation Program |
| WHC-SD-EN-AP-170 | June 1994 | Indicator Evaluation Program |
| PNNL-11523, Rev. 0 | June 1997 | Groundwater Quality Assessment Program |
| PNNL-11523, Rev. 1 | July 2005 | Groundwater Quality Assessment Program |
| DOE/RL-2010-93, Rev. 0 | October 2010 | Indicator Evaluation Program |
| DOE/RL-2010-93, Rev. 1 | June 2011 | Indicator Evaluation Program |

Note: Complete reference citations are provided in Chapter 6.

* The Indicator Evaluation Program satisfies the requirements of 40 CFR 265.92(b)(2), (b)(3), (d)(1), (d)(2), and (e), "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis." The groundwater quality assessment program's first determination satisfies the requirements of 40 CFR 265.93(d)(4) and (d)(6), "Preparation, Evaluation, and Response."

In 1994, groundwater monitoring activities for the 216-A-36B and 216-A-10 Cribs were jointly addressed in a single indicator parameter evaluation monitoring plan (WHC-SD-EN-AP-170), which updated the 216-A-36B monitoring network and summarized the data from the crib monitoring networks established in 1988. The 216-A-36B well network was revised to add 299-E24-18 and 299-E25-36 as upgradient wells. Well 299-E17-17 was retained as an upgradient well. Due to the uncertainty of gradient direction in the vicinity of the cribs, these wells were selected because their location was far enough away from the crib to reduce the risk of false indication of contamination release, and to better account for heterogeneities in the background water quality. Downgradient wells (216-E17-14, 299-E17-15, 299-E17-16, 299-E17-18, and 299-E17-5; and 299-E17-9 [for water levels only]) were unchanged.

In 1997, the monitoring well network was revised to combine groundwater monitoring activities for three cribs (216-A-10, 216-A-36B, and 216-A-37-1), due to the proximity of the cribs to one another. A groundwater quality assessment program was implemented for the three cribs because well 299-E17-9 at the 216-A-36B Crib had specific conductance concentration indicating that the cribs contributed to groundwater contamination. Groundwater monitoring utilized an 11 well near-field monitoring network, located in the immediate vicinity of the combined cribs, and 57 far-field wells predominantly located in a region between the 200 East Area and the Columbia River. As part of the 11 near-field wells, three wells (299-E17-9, 299-E17-14, and 299-E17-17) were specifically identified as downgradient wells for the 216-A-36B Crib (Figure 2-3). Two of the downgradient wells were WAC 173-160 compliant (299-E17-14 and 299-E17-17); the third downgradient well (299-E17-9) was not WAC 173-160 compliant but was selected because of known contamination (i.e., high specific conductance due to nitrate in addition to elevated tritium levels). There were two upgradient wells included in PNNL-11523 (Section 5.3.2). Well 299-E24-18 was selected as the upgradient well for a groundwater flow direction inferred to be from the northwest toward 216-A-10 and 216-A-36B. Well 299-E25-31 was selected as the upgradient well for 216-A-37-1 based on an inferred groundwater flow direction from the northeast.

The 1997 monitoring network was updated in 2005 (PNNL-11523, Rev. 1, Section 3.2) and specifically identified wells 299-E17-14, 299-E17-16, and 299-E17-18 as downgradient from 216-A-36B. This plan also updated the constituents to be analyzed: chloride, iron, manganese, nitrate, sodium, and sulfate.

In 2010, PNNL-11523, Rev. 1 was replaced by DOE/RL-2010-93, Rev. 0 as a site-specific monitoring plan for the 216-A-36B Crib. A replacement for PNNL-11523 was required because one of the three cribs of the plan (216-A-10) had its Permit Application Part A Form removed from the Hanford Facility RCRA Permit. At this time, two separate monitoring well networks were considered appropriate for the remaining cribs: 216-A-36 and 216-A-37-1. In DOE/RL-2010-93 (Rev. 0), monitoring at the 216-A-36B Crib returned to an indicator evaluation program after a systematic check of all the groundwater constituents detected in the 216-A-36B Crib wells during the 5-year period of 2006 through 2010. The systematic check determined that no dangerous waste constituents listed in Ecology Publication 97-407 were among those detected. The site-specific well network in DOE/RL-2010-93 (Rev. 0, Section 3.2) consisted of upgradient well 299-E17-19, which was positioned to detect potential groundwater contamination from the 216-A-10 Crib as a known upgradient source (Figure 2-3). Downgradient wells continued as 299-E17-14, 299-E17-16, and 299-E17-18.

In 2011, DOE/RL-2010-93 (Rev. 0, Section 3.1) was revised to include quarterly sampling of well 299-E17-19 for pH, specific conductance, total organic halogen (TOX), and total organic carbon (TOC) for 1 year of monitoring. Well 299-E17-19 was an existing well in the well network included in WHC-SD-EN-AP-170 (Section 3.3.3) and PNNL-11523 (Rev. 0, Section 5.3.2 and Rev. 1, Section 3.1). The well network in DOE/RL-2010-93 (Rev. 1) remained unchanged from that in DOE/RL-2010-93 (Rev. 0).

In 1990, a nitrate concentration of 287 mg/L was measured in well 299-E17-15, which is located adjacent to the east side of the 216-A-36B Crib. Annual evaluation of nitrate data for wells throughout the 200-PO-1 OU indicate that the 216-A-10 Crib and 216-A-36B Crib are source areas of nitrate groundwater contamination. Upgradient network well 299-E17-19 (downgradient of 216-A-10) and downgradient network well 299-E17-14 show the highest nitrate levels (Figures 2-3 and 2-9) associated with the PUREX Cribs (DOE/RL-2014-32).

Since late 1999, well 299-E17-19 has had nitrate concentrations displaying an increasing trend. Sulfate levels have been increasing in the 216-A-36B monitoring network wells since 1995 (Figure 2-9). The increasing specific conductance values generally correlate closely with rising sulfate concentrations. Although, rising nitrate concentrations correlate better than sulfate levels to the increases in specific conductance measured in upgradient well 299-E17-19. Differences in pH values between upgradient and downgradient wells were greater during monitoring in the early 1990s. Since about 2009, pH levels in all network wells have been generally ranging between 7.8 and 8.1 (Figure 2-9).

TOX values have been relatively consistent in all wells since approximately 1995 (Figure 2-10). TOC concentrations were highly variable between 1990 and 1997. With the most recent monitoring of indicator parameter data that was initiated at 216-A-36B in 2010, TOC levels in both upgradient and downgradient wells started to show an increasing concentration trend beginning in mid-2012.

VOCs have been monitored intermittently at wells both upgradient and downgradient of the 216-A-36B Crib since 1990. Trichloroethene has been the most commonly detected VOC. When detected, its concentration is generally low, at or near the laboratory detection limit (Figure 2-11). Detections have been observed most commonly in both upgradient well 299-E17-19 (also downgradient of the 216-A-10 Crib) and downgradient well 299-E17-14. In January 2015, trichloroethene was detected in upgradient well 299-E17-19 at 1.47 µg/L and in downgradient wells at 1.53 µg/L (well 299-E17-16) and 0.88 µg/L (well 299-E17-14) (Figures 2-3 and 2-11). The presence of low concentrations of VOCs in both the upgradient and downgradient wells indicates the VOCs are sourced from an upgradient location. VOC analysis will be completed on a triannual frequency to provide supplemental data and to assist with continued evaluation of VOC concentrations and trending.

Groundwater monitoring activities at the 216-A-36B Crib under this groundwater monitoring plan (DOE/RL-2010-93, Rev. 2) currently sample from a network of six wells: upgradient wells 216-E17-1 and 299-E17-19 and downgradient wells 299-E17-14, 299-E17-15, 299-E17-16, and 299-E17-18 (Figure 2-3). Samples are analyzed semiannually for parameters used as indicators of groundwater contamination and annually for parameters establishing groundwater quality. During the first year of monitoring, the two existing wells (299-E17-1 and 299-E17-15) added to the network in this plan will be sampled quarterly for indicators of groundwater contamination, groundwater quality parameters, and the drinking water suitability parameters included in Appendix III to 40 CFR 265. Water-level measurements are collected each time a sample is obtained from a network well. The network wells are also included in the annual comprehensive March water-level measurement campaign (SGW-38815, *Water-Level Monitoring Plan for the Hanford Site Soil and Groundwater Remediation Project*). Groundwater monitoring results are summarized annually for the 216-A-36B Crib in the annual Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2016-12, *Hanford Site RCRA Groundwater Monitoring Report for 2015*).

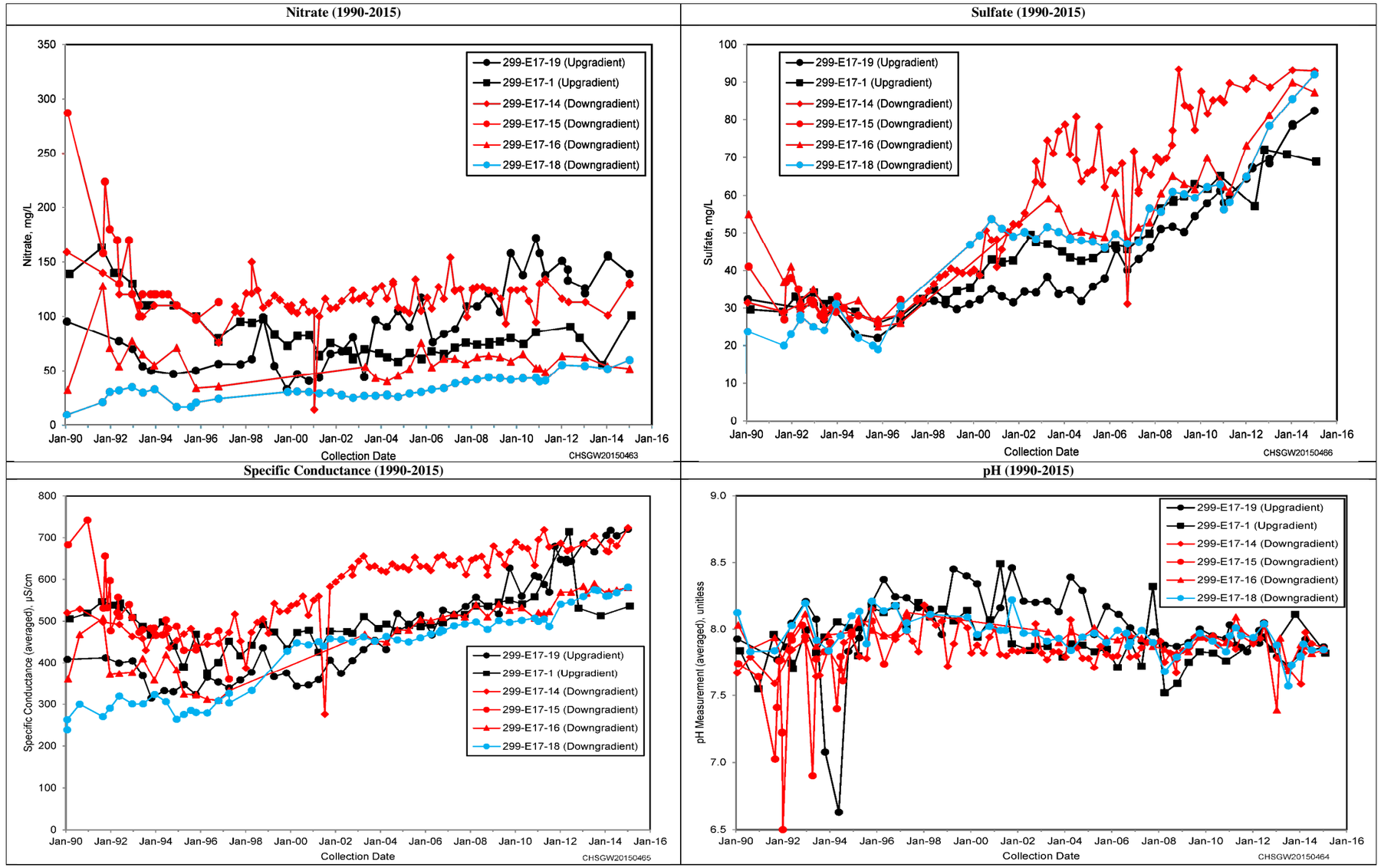



**Figure 2-9. Time Series Plots Showing Relationship between Nitrate, Sulfate, Specific Conductance, and pH for Wells Currently Upgradient and Downgradient of the 216-A-36B Crib**

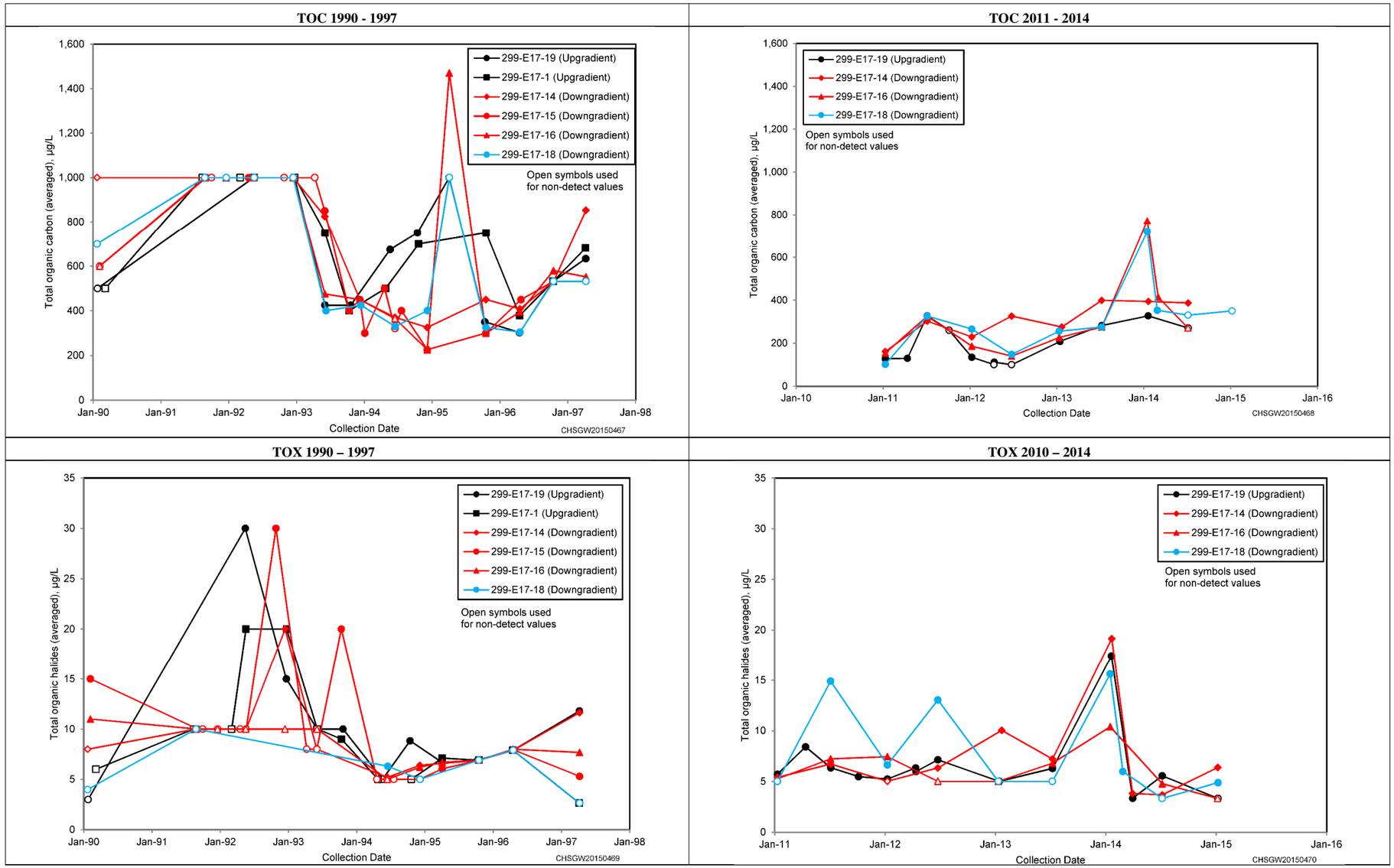



**Figure 2-10. Time Series Plots Showing Averaged Total Organic Halogen and Total Organic Carbon Concentrations for Wells Currently Upgradient and Downgradient of the 216-A-36B Crib**

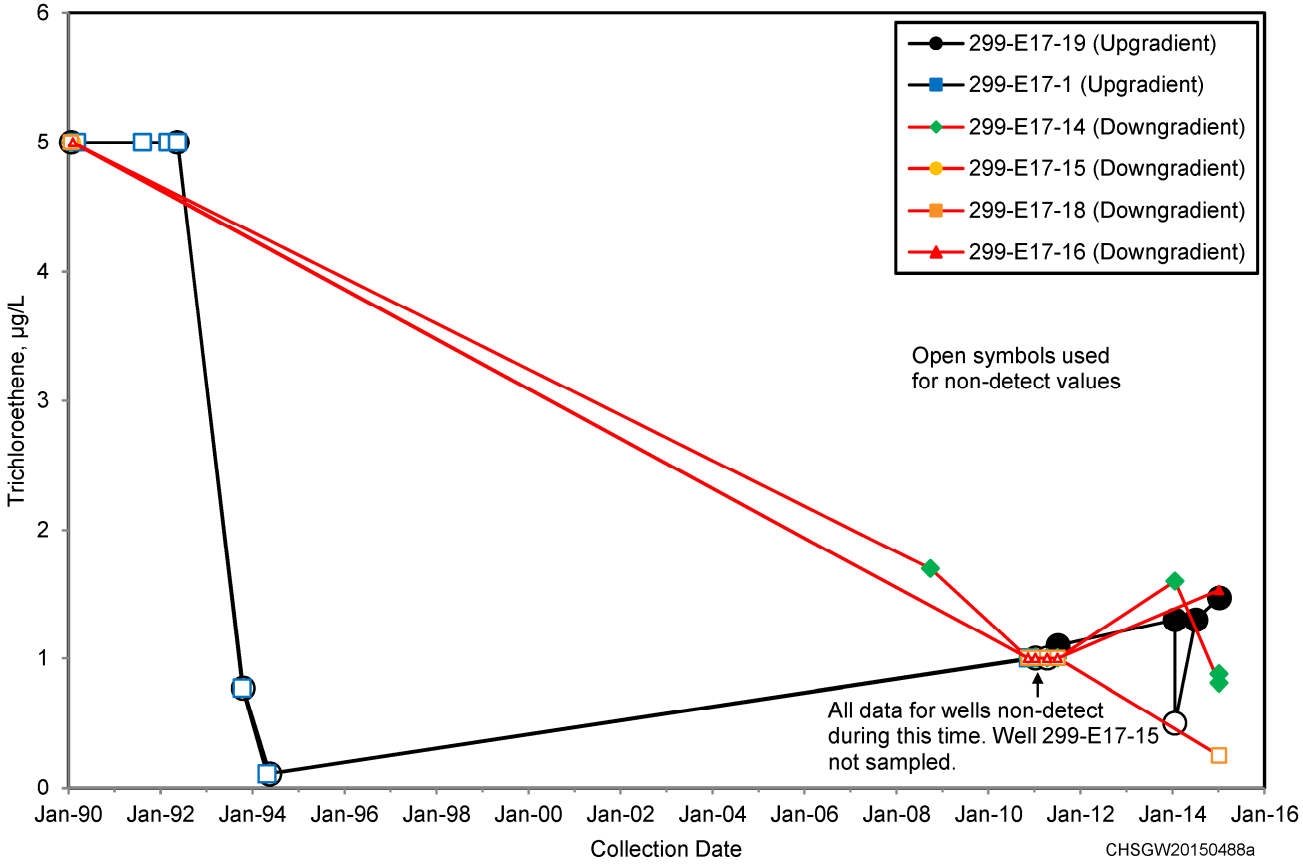



**Figure 2-11. Time Series Plots Showing Trichloroethene Concentrations for Wells Currently Upgradient and Downgradient of the 216-A-36B Crib**

## 2.6 Conceptual Site Model

Groundwater flow and potential contaminant transport strongly influence the groundwater monitoring strategy. Therefore, having a CSM of hydrogeologic and potential contaminant conditions is necessary for development of a practical groundwater monitoring plan. A groundwater CSM is an evolving hypothesis that identifies important features, actual and possible events, and processes that control groundwater and contaminant movement. This CSM is based on the results of previous geological and hydrogeological studies, and groundwater monitoring results (PNNL-11523 [Rev. 1], PNNL-12261, DOE/RL-2009-85, and annual Hanford Site groundwater monitoring reports [e.g., DOE/RL-2015-07]).

The generalized hydrogeologic characteristics below the 216-A-36B Crib are shown in Figure 2-12. The CSM includes the following site characteristics and assumptions:

- Liquid wastes are released in the crib, migrate through the vadose zone and into the groundwater.
- As the mobile constituents in the vadose zone (e.g., nitrate) intercept and mix with groundwater in the unconfined aquifer, the constituents move laterally with groundwater flow.
- A water table mound was created by discharges to the PUREX Cribs and B Pond, resulting in changes to groundwater flow direction in the 200 East Area over time (Figure 2-3). More recently, groundwater flow has begun to revert toward the flow patterns that existed before large discharges to B Pond occurred. Historically, because of extremely low hydraulic gradient, flow direction near the 216-A-36B Crib was inferred primarily from observing contaminant plume migration. In 2013, the flow direction near the 216-A-36B Crib was interpreted to be southeast (Chapter 10 of DOE/RL-2015-07), based on measurements obtained from adjacent wells comprising low gradient water table measurement network (Figure 2-8). The water table in the 200 East Area has declined significantly since discharges to B Pond ceased in 1997. The rate of decline has decreased during the last 5 years. Wells in the area have shown a decrease in the water table elevation of only 0.07 to 0.15 m (0.2 to 0.5 ft) between 2010 and 2015.
- Groundwater contamination tends to be higher in concentration near the water table, thus wells are most often screened (or casings perforated) near the water table (Conclusions and Recommendations in PNL-2724, *Vertical Contamination in the Unconfined Groundwater at the Hanford Site, Washington*).
- Near the 216-A-36B Crib, groundwater in the uppermost unconfined aquifer within the Ringold Unit E is isolated from groundwater in the confined Ringold aquifer (Ringold Unit A) by the Ringold lower mud unit. However, toward the northeast (near the 216-A-37-1 Crib), a large flood channel filled with Hanford formation sediment extends across the 200 East Area from the northwest to the southeast. This flood channel has removed the Ringold Unit E and the Ringold lower mud unit, so the sand and gravel of the Hanford formation (or the Cold Creek unit) lay directly upon the sand and gravel of the lower portions of Ringold Unit A (Figure 2-5).
- Hydraulic conductivity of Hanford and Cold Creek sediments are generally higher than that of Ringold unit E. Although in some areas within 200 East, the hydraulic conductivity of the upper portion of the Ringold unit E appears similar to that of the Hanford and Cold Creek.
- Nondangerous waste plume contribution from the 216-A-36B Crib (e.g., tritium) transported by groundwater is directed to the southeast until intercepting the preferential flow path within the major northwest-southeast trending high hydraulic conductivity Hanford formation and Cold Creek unit paleochannel deposits (Figure 2-13). At this point, groundwater flow and nondangerous waste contaminant plumes (i.e., tritium and iodine-129) coalesce and continue southeastward away from the 200 East Area (DOE/RL-2015-07).

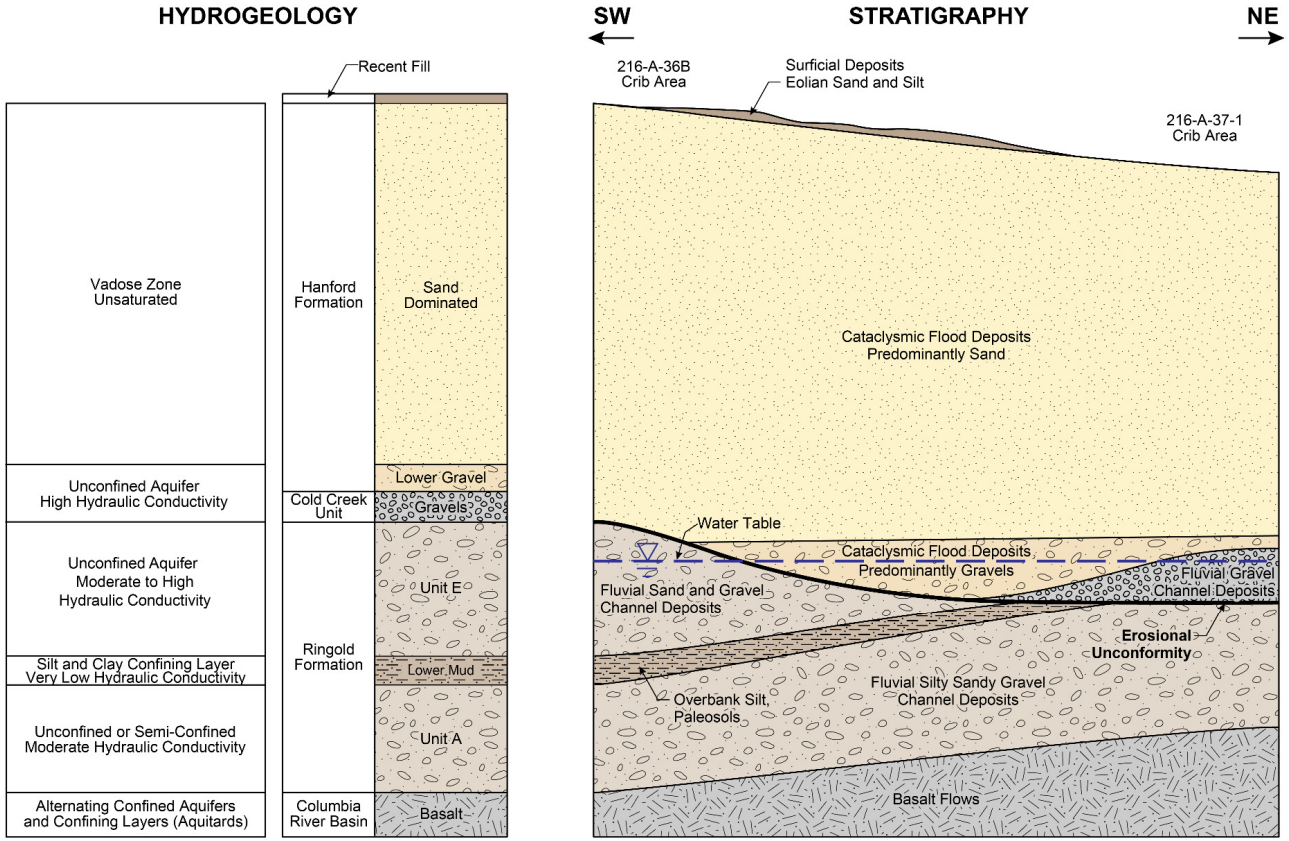



**Figure 2-12. General Representation of Hydrogeologic Characteristics Underlying the 216-A-36B Crib and Southeastern Portion of the 200 East Area**

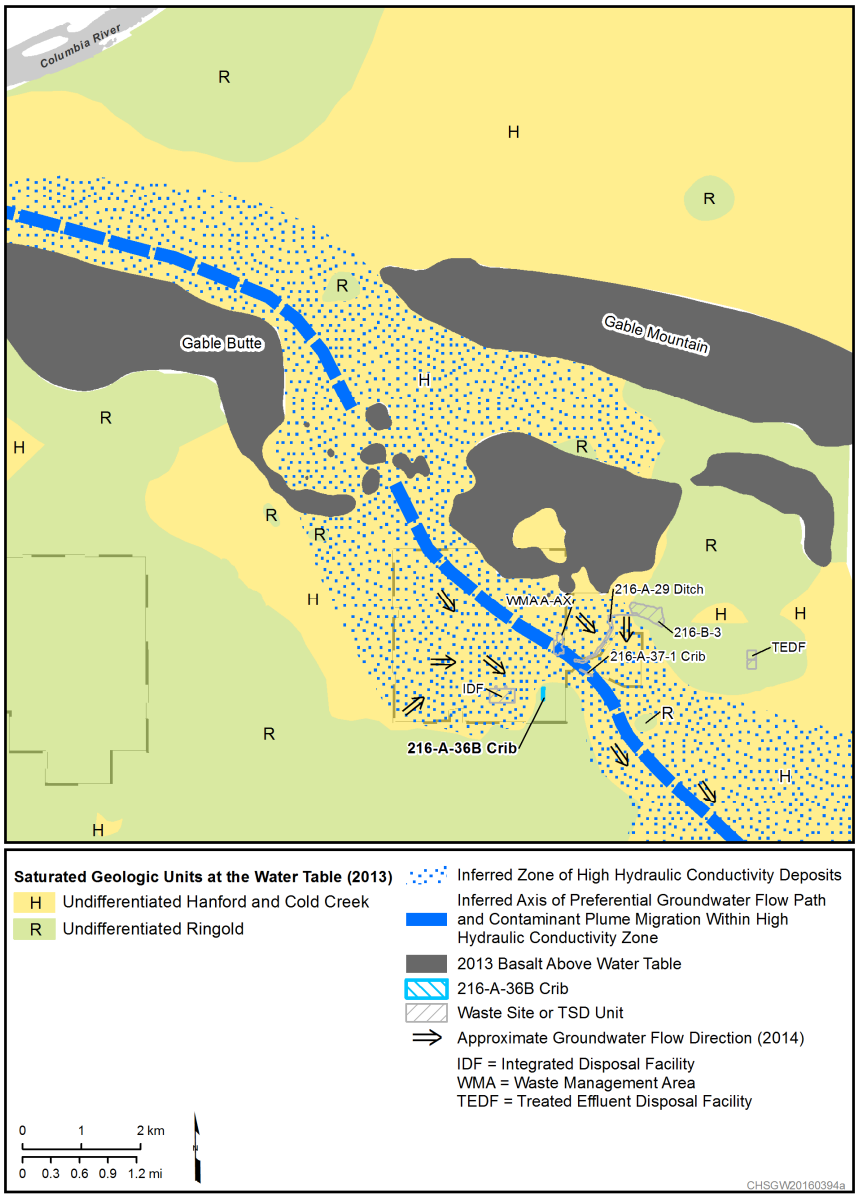



**Figure 2-13. Generalized Representation of High Hydraulic Conductivity Zone Associated With Hanford and Cold Creek Paleochannel Deposits**

## 2.7 Monitoring Objectives

The groundwater monitoring program at the 216-A-36B Crib is conducted with the objective of determining the facility's impact, if any, on the quality of the underlying groundwater. This groundwater monitoring plan addresses specifically those applicable dangerous waste requirements for interim status TSD units where no impact to groundwater has been identified. The regulatory requirements applicable to this groundwater monitoring plan are found in WAC 173-303-400(3) and 40 CFR 265.90 through 265.94, "Recordkeeping and Reporting." Table 2-2 identifies where each groundwater monitoring element of the pertinent regulations is addressed within this plan. Additional site-specific constituents are listed in Table 2-3.

**Table 2-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements**

| Groundwater Monitoring Element | Pertinent Requirement[a] | Section Where Requirement is Addressed in Monitoring Plan |
|---|---|---|
| Applicability | 40 CFR 265.90, "Applicability"<br>(a) Within one year after the effective date of these regulations, the owner or operator of a surface impoundment, landfill, or land treatment facility which is used to manage hazardous waste must implement a ground-water monitoring program capable of determining the facility's impact on the quality of ground water in the uppermost aquifer underlying the facility, except as §265.1 and paragraph (c) of this section provide otherwise.<br>(b) Except as paragraphs (c) and (d) of this section provide otherwise, the owner or operator must install, operate, and maintain a ground-water monitoring system which meets the requirements of §265.91, and must comply with §§265.92 through 265.94. This ground-water monitoring program must be carried out during the active life of the facility, and for disposal facilities, during the post-closure care period as well. | Chapter 1 |
| Number and Location of Wells | 40 CFR 265.91, "Ground-Water Monitoring System":<br>(a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of:<br>(1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield ground-water samples that are:<br>(i) Representative of background ground-water quality in the uppermost aquifer near the facility; and<br>(ii) Not affected by the facility; and<br>(2) Monitoring wells (at least three) installed hydraulically downgradient (i.e., in the direction of decreasing static head) at the limit of the waste management area. Their numbers, locations, and depths must ensure that they immediately detect any statistically significant amounts of dangerous waste or dangerous waste constituents that migrate from the waste management area to the uppermost aquifer. | Section 3.2 |

**Table 2-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements**

| Groundwater Monitoring Element | Pertinent Requirement[a] | Section Where Requirement is Addressed in Monitoring Plan |
|---|---|---|
| Well Configuration | 40 CFR 265.91:<br>(c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well bore hole. 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 bore hole 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), "Dangerous Waste Regulations," "Interim Status Facility Standards":<br>Ground water monitoring wells must be designed, constructed, and operated so as to prevent ground water contamination. Chapter 173-160 WAC may be used as guidance in the installation of wells. | Section 3.2 and Appendix C |
| Sample Protocols<br>Analytical Methods | 40 CFR 265.92:<br>(a) The owner or operator must obtain and analyze samples from the installed ground-water monitoring system. The owner or operator must develop and follow a ground-water sampling and analysis plan. He must keep this plan at the facility. The plan must include procedures and techniques for:<br>(1) Sample collection;<br>(2) Sample preservation and shipment;<br>(3) Analytical procedures; and<br>(4) Chain of custody control. | Appendix A, Section A3 and Appendix B, Sections B2 through B5 |

**Table 2-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements**

| Groundwater Monitoring Element | Pertinent Requirement[a] | Section Where Requirement is Addressed in Monitoring Plan |
|---|---|---|
| Parameters to be Sampled<br>Frequency of Sampling<br>Water-Level Measurements | 40 CFR 265.92, "Sampling and Analysis":<br>(b) The owner or operator must determine the concentration or value of the following parameters in ground-water samples in accordance with paragraphs (c) and (d) of this section:<br>(1) Parameters characterizing the suitability of the ground water as a drinking water supply, as specified in Appendix III[b].<br>(2) Parameters establishing ground-water quality:<br>(i) Chloride<br>(ii) Iron<br>(iii) Manganese<br>(iv) Phenols<br>(v) Sodium<br>(vi) Sulfate<br>[Comment: These parameters are to be used as a basis for comparison in the event a ground-water quality assessment is required under §265.93(d).]<br>(3) Parameters used as indicators of ground-water contamination:<br>(i) pH<br>(ii) Specific conductance<br>(iii) Total organic carbon<br>(iv) Total organic halogen<br>(c)(1) For all monitoring wells, the owner or operator must establish initial background concentrations or values of all parameters specified in paragraph (b) of this section. He must do this quarterly for one year.<br>(2) For each of the indicator parameters specified in paragraph (b)(3) of this section, at least four replicate measurements must be obtained for each sample and the initial background arithmetic mean and variance must be determined by pooling the replicate measurements for the respective parameter concentrations or values in samples obtained from upgradient wells during the first year.<br>(d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies:<br>(1) Samples collected to establish ground-water quality must be obtained and analyzed for the parameters specified in paragraph (b)(2) of this section at least annually.<br>(2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) of this section at least semi-annually.<br>(e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained. | Section 3.1 and<br>Appendix B, Section B2.2 |

**Table 2-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements**

| Groundwater Monitoring Element | Pertinent Requirement[a] | Section Where Requirement is Addressed in Monitoring Plan |
|---|---|---|
| Groundwater Quality Assessment Program Plan Outline | 40 CFR 265.93, "Preparation, Evaluation, and Response":<br>(a) Within one year after the effective date of these regulations, the owner or operator must prepare an outline of a ground-water quality assessment program. The outline must describe a more comprehensive ground-water monitoring program (than that described in §§265.91 and 265.92) capable of determining:<br>(1) Whether hazardous waste or hazardous waste constituents have entered the ground water;<br>(2) The rate and extent of migration of hazardous waste or hazardous waste constituents in the ground water; and<br>(3) The concentrations of hazardous waste or hazardous waste constituents in the ground water. | Chapter 5 |
| Methods Used to Evaluate the Collected Data and Responses | 40 CFR 265.93:<br>(b) For each indicator parameter specified in §265.92(b)(3), the owner or operator must calculate the arithmetic mean and variance, based on at least four replicate measurements on each sample, for each well monitored in accordance with §265.92(d)(2), and compare these results with its initial background arithmetic mean. The comparison must consider individually each of the wells in the monitoring system, and must use the Student's t-test at the 0.01 level of significance (see appendix IV) to determine statistically significant increases (and decreases, in the case of pH) over initial background.<br>(c)(2) If the comparison for downgradient wells made under paragraph (b) of this section show a significant increase (or pH decrease), the owner or operator must then immediately obtain additional ground-water samples from those downgradient wells where a significant difference was detected, split the samples in two, and obtain analyses of all additional samples to determine whether the significant difference was a result of laboratory error.<br>(d)(1) If the analyses performed under paragraph (c)(2) of this section confirm the significant increase (or pH decrease), the owner or operator must provide written notice to the department-within seven days of the date of such confirmation-that the facility may be affecting ground-water quality.<br>(d)(2) Within 15 days after the notification under paragraph (d)(1) of this section, the owner or operator must develop a specific plan, based on the outline required under paragraph (a) of this section and certified by a qualified geologist or geotechnical engineer, for a ground-water quality assessment at the facility. | Section 4.1, 4.2, 4.3 and Appendix A |

**Table 2-2. Pertinent Interim Status Facility Groundwater Monitoring Requirements**

| Groundwater Monitoring Element | Pertinent Requirement[a] | Section Where Requirement is Addressed in Monitoring Plan |
|---|---|---|
| Recordkeeping and Reporting | 40 CFR 265.93:<br>(c)(1) If the comparisons for the *upgradient* wells made under paragraph (b) of this section show a significant increase or (pH decrease), the owner or operator must submit this information in accordance with §265.94(a)(2)(ii).<br>40 CFR 265.94, "Recordkeeping and Reporting":<br>(a)(1) Keep records of the analyses required in §265.92(c) and (d), the associated ground-water surface elevations required in §265.92(e), and the evaluation required in §265.93(b) throughout the active life of the facility.<br>(a)(2) Report the following ground-water monitoring information to the department:<br>(ii) Annually: Concentrations or values of the parameters listed in §265.92(b)(3) for each ground-water monitoring well, along with the required evaluations for these parameters under §265.92(b). The owner or operator must separately identify any significant differences from the initial background found in the upgradient wells, in accordance with §265.93(c)(1).<br>(iii) No later than March 1 following each calendar year: Results of the evaluations of ground-water surface elevations under §265.93(f), and a description of the response to that evaluation, where applicable. | Section 4.5<br>Appendix A, Sections ~~A2.6~~ A2.5 and A3.9 |

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Notes: The references cited in this table are listed in the reference section (Chapter 6) of this plan.

In accordance with WAC 173-303-400(3)(b), "Dangerous Waste Regulations," "Interim Status Facility Standards", for the purposes of applying the interim status standards of 40 CFR 265, Subpart F, the federal terms "Regional Administrator" means the "Department" and "Hazardous" means "Dangerous".

In accordance with Section I.A of the WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit*, *Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste* (Hanford Facility RCRA Permit), this unit will continue to be considered an interim status unit until is it incorporated into Part III, V, and/or VI of the Hanford Facility RCRA Permit, or until interim status is terminated.. Therefore, groundwater monitoring continues under interim status requirements.

a. Regulatory requirements for interim status TSD units, where no impact to groundwater has been identified, are found in WAC 173-303-400(3) and 40 CFR 265.90, "Applicability," through 40 CFR 265.94, "Recordkeeping and Reporting," which are applicable to this groundwater monitoring plan.

b. The parameters characterizing the suitability of the groundwater as a drinking water supply, as specified in 40 CFR 265, Appendix III, "EPA Interim Primary Drinking Water Standards," are conducted during the first year of monitoring in accordance with 40 CFR 265.92(c)(1), "Sampling and Analysis." For this TSD unit, the Appendix III parameters are included for monitoring at well(s) specified in Section 3.1.

RCRA = *Resource Conservation and Recovery Act of 1976* TSD = treatment, storage, and disposal

**Table 2-3. Additional Monitoring Objectives**

| Monitoring Objective | TSD Unit-Specific Constituent/ Field Measurement* |
|---|---|
| Alkalinity constituents-used in ion balance and to support water chemistry analysis | Total alkalinity ~~Alkalinity, bicarbonate (from alkalinity), carbonate (from alkalinity), hydroxyl ion~~ |
| Metals-additional metals used in ion balance and to support water chemistry analysis | Calcium, magnesium, potassium |
| Metals-additional metals used to determine corrosion of stainless steel | Chromium, iron, manganese, molybdenum, and nickel |
| Anions-additional anions used in ion balance and to support water chemistry analysis | Fluoride, nitrate, nitrite |
| Field parameters provided information on water properties at the time of sampling | Dissolved oxygen, temperature, turbidity |
| Volatile organic compounds (chlorinated hydrocarbons), to monitor consistency/trend and concentrations of detections | 1,1,1-Trichloroethane, 1,1,2-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethene, carbon tetrachloride, chloroform, methylene chloride, tetrachloroethene, trichloroethene, vinyl chloride |

* Sampling for TSD unit-specific constituents/field measurements is not required by WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," nor 40 CFR 265, Subpart F, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground Water Monitoring."

TSD = treatment, storage, and disposal

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**Commented [CTJ4]:** RCRA-CN-01_DOE/RL-2010-93_R2

# 3 Groundwater Monitoring Program

This chapter describes the groundwater monitoring indicator evaluation program for the 216-A-36B Crib consisting of parameters used as indicators of groundwater contamination, parameters establishing groundwater quality, a monitoring well network, and sampling and analysis protocols. The monitoring program presented herein has been revised from that presented in the previous plan (DOE/RL-2010-93, Rev. 1) (updated groundwater flow direction and revised monitoring network), and supersedes the monitoring program of the previous plan.

## 3.1 Constituents List and Sampling Frequency

Table 3-1 presents the wells in the groundwater monitoring network, parameters analyzed and sampling frequency for monitoring of the 216-A-36B Crib. Parameters used as indicators of groundwater contamination (pH, specific conductance, TOC, and TOX) will be sampled and analyzed semiannually (40 CFR 265.92(b)(3) and (d)(2)). Parameters establishing groundwater quality (chloride, iron, manganese, phenols, sodium, and sulfate) will be sampled and analyzed annually (40 CFR 265.92(b)(2) and (d)(1)). Though not required by 40 CFR 265 Subpart F, site-specific constituents (alkalinity, anions, and metals) will also be analyzed semiannually (to provide information on groundwater chemistry and stainless steel corrosion at the same frequency as the contamination indicator parameters) ~~annually~~ and VOCs consisting of chlorinated hydrocarbons will be analyzed triennially.

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During the first year, the two existing wells (299-E17-1 and 299-E17-15) added to the monitoring network will be sampled quarterly for indicators of groundwater contamination and parameters establishing groundwater quality as shown in Table 3-2. In addition to monitoring for constituents and parameters in Table 3-1 and Table 3-2, wells 299-E17-1 and 299-E17-15 will be sampled quarterly for 1 year for the drinking water suitability parameters included in Appendix III to 40 CFR 265 (Table 3-3). Monitoring for the Appendix III parameters in Table 3-3 will be performed concurrently with the monitoring required in Table 3-1. At the end of the first year, monitoring will thereafter be conducted along the same frequency as other established wells and as provided in Table 3-1. Water-level measurements at each monitoring well will be performed each time that a sample is obtained (40 CFR 265.92(e)). Site-specific constituents (alkalinity, anions, and metals) will also be analyzed annually during the first year of monitoring.

### 3.1.1 Sample Schedule Impacts from Well Maintenance and Sampling Logistics

Well maintenance (e.g., pump repairs, periodic well cleaning and redevelopment) and sampling logistics resulting from multiple factors including environmental (i.e., inclement weather) and access restrictions (i.e., heightened fire danger, area access restriction due to work by other Hanford contractors such as in the tank farms) sometimes delay scheduled sampling events. Sampling events are scheduled by month. The Field Work Supervisor (FWS) determines the specific times within a given month that a well will be sampled. If a well cannot be sampled at the times determined by the FWS, then the FWS and Sampling Management and Reporting group, along with the project scientist, will consult on how best to recover or reschedule the sampling event as close to the original sampling date as possible. If it is observed during the pre-sampling walkdown that one or more network wells cannot be sampled, then sampling of the well network will not begin and management will be notified. Depending on the situation, the network sampling will be rescheduled within a short time frame (such as 3 to 4 weeks). In some cases, it may not be obvious that sampling cannot be performed until a well is accessed (e.g., an issue with a pump).

**Table 3-1. Monitoring Well Network for the 216-A-36B Crib**

| Well Name | Purpose | WAC Compliant | RCRA-Required Parameters[a] | | | | | | | | | | | Site-Specific Constituents | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Contamination Indicator Parameters | | | | Groundwater Quality Parameters | | | | | | | | | | |
| | | | Water Level | pH | Specific Conductance | Total Organic Carbon | Total Organic Halogen | Chloride | Iron (Filtered and Unfiltered)[b] | Manganese (Filtered and Unfiltered)[b] | Phenols[i] | Sodium | Sulfate | Volatile Organic Compounds[c] | Alkalinity[d] | Metals (Filtered and Unfiltered)[b,e] | Anions[f] | Field Parameters[g] |
| 299-E17-1[h] | Upgradient | N | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | T | ~~SA~~ | ~~SA~~ | ~~SA~~ | S |
| 299-E17-19 | Upgradient | Y | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | T | ~~SA~~ | ~~SA~~ | ~~SA~~ | S |
| 299-E17-14 | Downgradient | Y | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | T | ~~SA~~ | ~~SA~~ | ~~SA~~ | S |
| 299-E17-15[h] | Downgradient | Y | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | T | ~~SA~~ | ~~SA~~ | ~~SA~~ | S |
| 299-E17-16 | Downgradient | Y | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | T | ~~SA~~ | ~~SA~~ | ~~SA~~ | S |
| 299-E17-18 | Downgradient | Y | S | S4 | S4 | S4 | S4 | A | A | A | A | A | A | T | ~~SA~~ | ~~SA~~ | ~~SA~~ | S |

a. Parameters are required by 40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, "Sampling and Analysis."

b. Unfiltered samples will be collected in conjunction with filtered samples for select analysis to determine if metal constituents being monitored occur as both suspended and dissolved phases, or in only one state. The evaluation of suspended and dissolved metals provide supporting information for groundwater geochemical characteristics, as well as indication of well integrity such as the presence of dislodged well encrustation, well corrosion products, or failure of the well screen filter pack.

c. See Table 2-3 for volatile organic compound constituent list.

d. Alkalinity includes total alkalinity ~~analysis of bicarbonate alkalinity, carbonate alkalinity, and hydroxide alkalinity.~~

e. Includes analysis of calcium, magnesium, and potassium for water chemistry analysis and chromium, iron, manganese, molybdenum, and nickel to monitor for stainless steel corrosion.

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**Commented [HMS7]:** RCRA-CN-02_DOE/RL-2010-93_R2

**Commented [HMS8]:** RCRA-CN-02_DOE/RL-2010-93_R2

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**Commented [HMS10]:** RCRA-CN-02_DOE/RL-2010-93_R2

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**Commented [HMS12]:** RCRA-CN-02_DOE/RL-2010-93_R2

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**Table 3-1. Monitoring Well Network for the 216-A-36B Crib**

| Well Name | Purpose | WAC Compliant | RCRA-Required Parameters[a] | | | | | | | | | | | | | | | | | Site-Specific Constituents | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Contamination Indicator Parameters | | | | Groundwater Quality Parameters | | | | | | | | | | | | | | | | |
| | | | Water Level | pH | Specific Conductance | Total Organic Carbon | Total Organic Halogen | Chloride | Iron (Filtered and Unfiltered)[b] | Manganese (Filtered and Unfiltered)[b] | Phenols[i] | Sodium | Sulfate | Volatile Organic Compounds[c] | Alkalinity[d] | Metals (Filtered and Unfiltered)[b,e] | Anions[f] | Field Parameters[g] |

f. Includes analysis of fluoride, nitrate, and nitrite.

g. Includes temperature, turbidity, and dissolved oxygen.

h. See Tables 3-2 and 3-3 for frequency for 1 year of monitoring.

i. The specific phenols to be analyzed as groundwater quality parameters are identified in Table 3-1a.

A = to be sampled annually

CFR = *Code of Federal Regulations*

N = well is not constructed as a resource protection well (WAC 173-160, "Minimum Standard for Construction and Maintenance of Wells")

RCRA = *Resource Conservation and Recovery Act of 1976*

S = to be sampled semiannually

S4 = to be sampled semiannually, with quadruplicate samples collected during each event

T = to be sampled triennially

WAC = *Washington Administrative Code*

Y = well is constructed as a resource protection well (WAC 173-160, "Minimum Standard for Construction and Maintenance of Wells")

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**Commented [CTJ15]:** RCRA-CN-01_DOE/RL-2010-93_R2

**Table 3-1a. Phenols Analyzed as Groundwater Quality Constituents**

| Constituent | CAS Number |
|---|---|
| 2-Chlorophenol | 95-57-8 |
| 2-Methylphenol (o-Cresol) | 95-48-7 |
| 2-Nitrophenol (o-Nitrophenol) | 88-75-5 |
| 2,3,4,6-Tetrachlorophenol | 58-90-2 |
| 2,4-Dichlorophenol | 120-83-2 |
| 2,4-Dimethylphenol (2,4-Xylenol) | 105-67-9 |
| 2,4-Dinitrophenol | 51-28-5 |
| 2,4,5-Trichlorophenol | 95-95-4 |
| 2,4,6-Trichlorophenol | 88-06-2 |
| 2,6-Dichlorophenol | 87-65-0 |
| 3-Methylphenol (m-Cresol) | 108-39-4* |
| 4-Chloro-3-methylphenol (p-Chloro-m-cresol) | 59-50-7 |
| 4-Methylphenol (p-Cresol) | 106-44-5* |
| 4,6-Dinitro-O-cresol (4,6-Dinitro-2-methyl phenol) | 534-52-1 |
| Dinoseb (2-sec-Butyl-4,6-dinitrophenol) | 88-85-7 |
| p-Nitrophenol (4-Nitrophenol) | 100-02-7 |
| Pentachlorophenol | 87-86-5 |
| Phenol | 108-95-2 |

This table provides the specific phenols to be included for analysis as groundwater quality parameters under this monitoring plan.

*Analyzed and reported as 3 & 4 Methylphenol (CAS number 65794-96-9)

CAS = Chemical Abstracts Service

**Commented [CTJ1]:** RCRA-CN-01_DOE/RL-2010-93_R2

**Table 3-2. Frequency for 1 Year of Monitoring for Select Wells**

| Well Name | Purpose | WAC Compliant | RCRA-Required Parameters[a] | | | | | | | | | | | Site-Specific Constituents | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Contamination Indicator Parameters | | | | Groundwater Quality Parameters | | | | | | | | | |
| | | | Water Level | pH | Specific Conductance | Total Organic Carbon | Total Organic Halogen | Chloride | Iron (Filtered and Unfiltered)[b] | Manganese (Filtered and Unfiltered)[b] | Phenols[h] | Sodium | Sulfate | Alkalinity[c] | Metals (Filtered and Unfiltered)[b,d] | Anions[e] | Field Parameters[f] |
| 299-E17-1[g] | Upgradient | N | Q | Q4 | Q4 | Q4 | Q4 | Q | Q | Q | Q | Q | Q | A | A | A | Q |
| 299-E17-15[g] | Downgradient | Y | Q | Q4 | Q4 | Q4 | Q4 | Q | Q | Q | Q | Q | Q | A | A | A | Q |

a. Parameters are required by 40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, "Sampling and Analysis."

b. Unfiltered samples will be collected in conjunction with filtered samples for select analysis to determine if metal constituents being monitored occur as both suspended and dissolved phases, or in only one state. The evaluation of suspended and dissolved metals provide supporting information for groundwater geochemical characteristics, as well as indication of well integrity such as the presence of dislodged well encrustation, well corrosion products, or failure of the well screen filter pack.

c. Alkalinity includes total alkalinity ~~analysis of bicarbonate alkalinity, carbonate alkalinity, and hydroxide alkalinity.~~

d. Includes analysis of calcium, magnesium, and potassium for water chemistry analysis and chromium, iron, manganese, molybdenum, and nickel to monitor for stainless steel corrosion.

e. Includes analysis of fluoride, nitrate, and nitrite.

f. Includes temperature, turbidity, and dissolved oxygen.

g. See Table 3-1 for monitoring frequency after 1 year of monitoring is complete.

h. The specific phenols to be analyzed as groundwater quality parameters are identified in Table 3-1a.

A = to be sampled annually

**Commented [CTJ16]:** RCRA-CN-01_DOE/RL-2010-93_R2

**Commented [CTJ17]:** RCRA-CN-01_DOE/RL-2010-93_R2

**Commented [CTJ18]:** RCRA-CN-01_DOE/RL-2010-93_R2

**Table 3-2. Frequency for 1 Year of Monitoring for Select Wells**

| Well Name | Purpose | WAC Compliant | RCRA-Required Parameters[a] | | | | | | | | | | | Site-Specific Constituents | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Contamination Indicator Parameters | | | | Groundwater Quality Parameters | | | | | | | | | |
| | | | Water Level | pH | Specific Conductance | Total Organic Carbon | Total Organic Halogen | Chloride | Iron (Filtered and Unfiltered)[b] | Manganese (Filtered and Unfiltered)[b] | Phenols[h] | Sodium | Sulfate | Alkalinity[c] | Metals (Filtered and Unfiltered)[b,d] | Anions[e] | Field Parameters[f] |

N = well is not constructed as a resource protection well (WAC 173-160, "Minimum Standard for Construction and Maintenance of Wells")
Q = to be sampled quarterly
Q4 = to be sampled quarterly, with quadruplicate samples collected during each event
RCRA = *Resource Conservation and Recovery Act of 1976*
S = to be sampled semiannually
WAC = *Washington Administrative Code*
Y = well is constructed as a resource protection well (WAC 173-160)

**Table 3-3. Constituents and Sampling Frequency for 1 Year of Monitoring at Existing Wells Added to the 216-A-36B Network**

| Well Name | Water Level | 40 CFR 265 Appendix III Parameters[a] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Arsenic (Filtered and Unfiltered)[b] | Barium (Filtered and Unfiltered)[b] | Cadmium (Filtered and Unfiltered)[b] | Chromium (Filtered and Unfiltered)[b] | Fluoride | Lead (Filtered and Unfiltered)[b] | Mercury | Nitrate (as N) | Selenium (Filtered and Unfiltered)[b] | Silver (Filtered and Unfiltered)[b] | Endrin | Lindane | Methoxychlor | Toxaphene | 2,4,-D | 2,4,5-TP Silvex | Radium | Gross Alpha | Gross Beta | Coliform Bacteria | Turbidity |
| 299-E17-1 | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q |
| 299-E17-15 | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q |

Reference: 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Appendix III, "EPA Interim Primary Drinking Water Standards."

a. Monitoring for the Appendix III parameters will be performed for 1 year and will be performed concurrently with monitoring required in Table 3-1.

b. Unfiltered samples will be collected in conjunction with filtered samples for select analysis to determine if metal constituents being monitored occur as both suspended and dissolved phases, or in only one state. The evaluation of suspended and dissolved metals provide supporting information for groundwater geochemical characteristics, as well as indication of well integrity such as the presence of dislodged well encrustation, well corrosion products, or failure of the well screen filter pack.

CFR = *Code of Federal Regulations*

Q = to be sampled quarterly

Missed sampling events that are not rescheduled within the same month are given top priority when rescheduling sampling for the following month. In the event that a sampling delay has occurred and the representativeness of the samples is in question, DOE-RL and Ecology may agree to resampling wells. DOE-RL will provide informal notification to Ecology if sampling of the network is expected to be delayed for longer than 4 weeks. Ecology may provide input in a timely fashion to DOE-RL on how to proceed. Missed or cancelled sampling events are reported to DOE-RL, and are documented in the annual Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2016-12).

### 3.1.2 Well Biofouling and TOC Results

Biofouling of wells can result in collection of non-representative groundwater samples and produce non-representative analytical results for TOC. In Hanford Site wells, biofouling is often associated with iron and manganese-oxidizing bacteria. The bacterial growths are physically manifested as slime or as filamentous or flocculent accumulations. The accumulations frequently occur in the screened interval and exhibit discrete coloration (e.g., rusty orange in the case of iron-oxidizing bacteria or black in the case of manganese-oxidizing bacteria).

TOC is a non-specific analysis that is used as an indicator of the presence of organic compounds in groundwater. TOC represents organic compounds in the sample; this includes dissolved organic compounds as well as suspended organic particles that may be present in an unfiltered sample. Suspended organic materials in groundwater samples can include microbial biomass associated with well biofouling. TOC is used in RCRA detection monitoring as an indicator of the possible presence of regulated organic compounds, but the TOC measurement is non-specific. Furthermore, the TOC measurement is subject to positive interference if suspended organic material (e.g., microbial biomass) or dissolved naturally-occurring organic compounds (e.g., humic and fulvic acids) are present in the sample.

If elevated concentrations of TOC are measured within a well (particularly, if a TOC concentration above the critical mean is encountered), then well maintenance activities to address accumulated microbiological growth in the well will be performed. Well maintenance activities are designed to reduce the impact of biomass transfer from the well and generation of a resultant high TOC value. Well maintenance will include cleaning/rehabilitation of the well to ensure that the groundwater samples collected are representative of ambient groundwater conditions and not the result of sampling of biomass material present within the well. Well cleaning will be completed per the contractor's standard operating procedures. A down-hole camera survey and well cleaning will be scheduled immediately following receipt of elevated TOC result where biofouling of the well is suspected. Subsequent to completing the cleaning activities, a well having an exceedance of the critical mean for TOC will be sampled for confirmational laboratory split samples as required under 40 CFR 265.93(c)(2).

## 3.2 Monitoring Well Network

Numerous groundwater wells exist in the vicinity of the 216-A-36B Crib. Not all wells meet WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells" (Table 3-4). Wells considered for use are shown on Figure 2-3. Wells selected for use were identified as providing representative groundwater constituent concentrations upgradient and downgradient of the crib, based on the current groundwater flow direction. The following criteria were used to select wells for monitoring of the 216-A-36B Crib:

- Location of the downgradient wells with respect to the TSD unit boundary and groundwater flow path (wells closest to the TSD unit boundary were prioritized for use because they would provide the most immediate indication of a release)

- Well screen position with respect to the water table (wells constructed with screens positioned closest to the vadose zone/water table interface were preferred for detecting contaminant presence in groundwater resulting from a nearby waste site/TSD unit release)
- Suitable well construction such that the sampling data provided is comparable with other network wells
- Compliance with WAC 173-160

The 216-A-36B Crib monitoring well network implemented by this groundwater monitoring plan consists of two upgradient and four downgradient wells. Previous use of only one upgradient well (299-E17-19), located northwest of the 216-A-36B Crib and directly downgradient of the 216-A-10 Crib constituent contributions (Figure 3-1), is no longer considered suitable on its own for monitoring upgradient conditions. An additional upgradient monitoring well is added as two upgradient wells are needed to monitor current spatial variability in upgradient constituent concentrations impacting the site (Figure 2-9). Two upgradient wells are needed because of the southeast groundwater flow and known variability in upgradient constituent concentrations that affect indicator parameters monitored for the 216-A-36B Crib. This plan includes one new upgradient well (299-E17-1) to the monitoring well network (Figure 3-1). Previously used downgradient wells (299-E17-14, 299-E17-16, and 299-E17-18) will continue to be utilized as part of the network. This plan includes one new downgradient well (299-E17-15) which is positioned to monitor constituent releases from the 216-A-36B Crib. Justification for changes to the current plan from the previous monitoring plan are provided in Section 3.3.

Wells 299-E17-1 and 299-E17-15 are existing wells that are added to this monitoring plan. These wells were last used for indicator parameter monitoring in 1997. Well 299-E17-1 was previously used for monitoring downgradient of the 216-A-10 Crib. Well 299-E17-15 had previously been used for monitoring downgradient of the 216-A-36B Crib.

Upgradient monitoring well 299-E17-1 supports monitoring objectives but is not compliant with WAC 173-160 as a resource protection well. Per agreement between DOE and Ecology, a noncompliant well is identified and placed on the prioritized drilling schedule for replacement consistent with site-wide cleanup priorities as described in Milestone M-024-58 which is contained in the Tri-Party Agreement Action Plan (Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*), as revised. This well has been included in this milestone for future replacement.

Figure 3-1 shows the updated groundwater monitoring network to be utilized in this plan. Current attributes for wells comprising the updated network are summarized in Table 3-4. Wells 299-E17-14, 299-E17-16, 299-E17-18, and 299-E17-19 have had indicator parameter and water quality constituent data collected from 1990 to 1997, and from 2011 to 2015. Wells 299-E17-1 and 299-E17-15 have historical indicator parameter and water quality data available from 1990 to 1997. Well 299-E17-1 has also been used as part of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* monitoring program since 1976.

If a well is within approximately 2 years of going dry, a replacement well will be proposed; such wells are negotiated annually by Ecology, DOE, and EPA under Tri-Party Agreement (Ecology et. al., 1989a) Milestone M-24-00.

Construction details and pertinent information for the wells are provided in Appendix C.

**Table 3-4. Attributes for Wells in the 216-A-36B Crib Groundwater Monitoring Network**

| Well Name | Completion Date | Easting[a] (m) | Northing[a] (m) | Screen Top (m [ft] bgs) | Screen Bottom (m [ft] bgs) | Water Depth (m [ft] bgs) | Remaining Water Column (m[ft]) | Water Table Measurement Date |
|---|---|---|---|---|---|---|---|---|
| 299-E17-1[b] | 1955 | 574977.079 | 135386.153 | 92.4 (303) | 101.6 (333)[c] | 98.0 (321.3) | 2.7 (8.9) | 4/26/2016 |
| 299-E17-19[b] | 1988 | 575017.183 | 135414.871 | 92.7 (304) | 99.6 (326.6) | 98.0 (321.2) | 1.6 (5.4) | 7/8/2016 |
| 299-E17-14 | 1988 | 575140.608 | 135333.739 | 94.4 (309.5) | 101.1 (331.5) | 98.6 (323.3) | 2.5 (8.2) | 7/8/2016 |
| 299-E17-15 | 1988 | 575142.781 | 135252.047 | 94.4 (309.5) | 100.7 (330) | 98.4 (322.5) | 2.3 (7.7) | 10/11/2006 |
| 299-E17-16 | 1988 | 575145.774 | 135210.78 | 94.2 (309) | 100.7 (330) | 98.3 (322.2) | 2.4 (8.0) | 7/8/2016 |
| 299-E17-18 | 1988 | 575112.433 | 135123.586 | 94.2 (308.7) | 101.0 (331.1) | 98.2 (322.0) | 2.9 (9.5) | 7/24/2016 |

a. Coordinates are in NAD83, *North American Datum of 1983*.

b. Upgradient well.

c. Additional perforation is at 334.8 to 336 ft bgs.

bgs = below grade surface

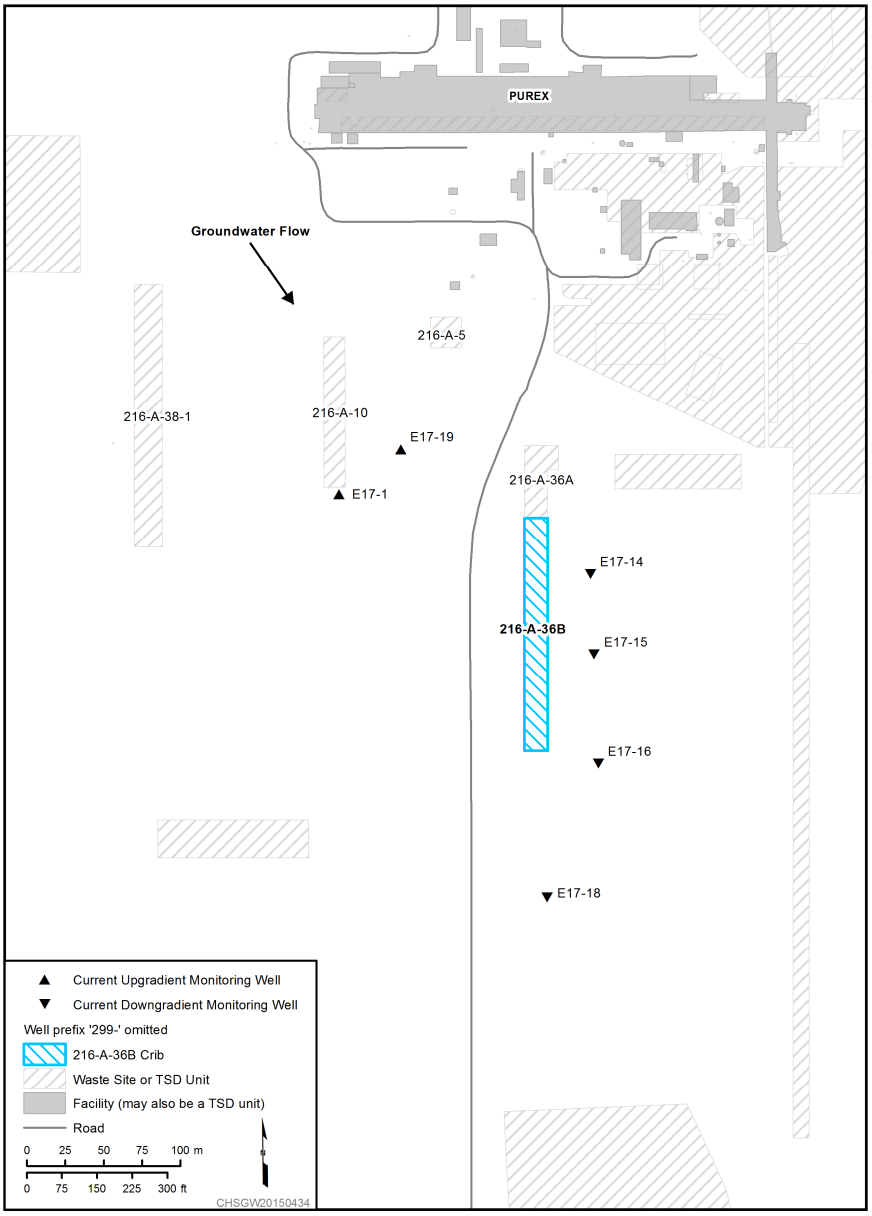


**Figure 3-1. 216-A-36B Monitoring Well Network**

## 3.3 Differences between This Plan and Previous Plan

Table 3-5 identifies the main differences between this plan and the previous groundwater monitoring plan.

**Table 3-5. Main Differences Between this Plan and Previous Plan**

| Type of Change | Previous Plan* | Current Plan | Justification Summary |
|---|---|---|---|
| Constituents | Indicator parameters, groundwater quality parameters | Indicator parameters, groundwater quality parameters | Indicator parameters, groundwater quality parameters – no change |
| | Supporting constituents – VOCs | Supporting constituents – VOCs (chlorinated hydrocarbons)<br>Stainless steel corrosion constituents (chromium, iron, manganese, molybdenum, and nickel) added | VOC analysis for only chlorinated hydrocarbons to evaluate persistence of detections<br>Stainless steel constituents are sampled to monitor for well corrosion |
| Sampling Frequency | Indicator parameters – Semiannual; Groundwater quality parameters – annual; Water level measurements – every sampling event; Additional constituents – annual; Field parameters – Semiannual | Indicator parameters, groundwater quality parameters – same<br>Water chemistry analysis and stainless steel corrosion constituents - semiannual | Indicator parameters, groundwater quality parameters – no change<br>Water chemistry analysis and stainless steel corrosion constituents – changed to semiannual to align with sampling frequency for indicator parameters. |
| | Supporting constituents – VOCs quarterly for 1 year, drop if not detected | Supporting constituents – VOCs triennial | Continue VOC analysis on a triennial frequency to monitor consistency/ trend and concentrations of detections. VOCs have historically been intermittently detected at concentrations near the method detection limits in wells both upgradient and downgradient of the 216-A-36B Crib (Figure 2-11). Considering the current pattern of occurrence and detected concentrations, analysis for VOCs will continue on a triennial frequency to monitor the consistency of detections and trending of analytical results. |

**Commented [CTJ19]:** RCRA-CN-01_DOE/RL-2010-93_R2

**Commented [HMS20]:** RCRA-CN-02_DOE/RL-2010-93_R2

**Table 3-5. Main Differences Between this Plan and Previous Plan**

| Type of Change | Previous Plan* | Current Plan | Justification Summary |
|---|---|---|---|
| Well Network | One upgradient well, three downgradient wells<br>Upgradient:<br>299-E17-19<br><br>Downgradient:<br>299-E17-14<br>299-E17-16<br>299-E17-18 | Two upgradient wells, four downgradient wells (add one additional existing upgradient well and add one additional existing downgradient well)<br>Upgradient:<br>299-E17-1<br>299-E17-19<br><br>Downgradient:<br>299-E17-14<br>299-E17-15<br>299-E17-16<br>299-E17-18 | Additional upgradient monitoring well added as two upgradient wells are needed to monitor current spatial variability in upgradient constituent concentrations impacting the site. Additional downgradient well added for early indication of potential releases from the site. |
| Groundwater Flow Direction | East to southeast | Southeast | Low gradient water table network and plume behavior indicate a southeast groundwater flow direction |
| Type of Groundwater Monitoring Program | Indicator evaluation program | Same | No change |
| Background Arithmetic Mean Recalculated | Calculated annually using one upgradient well | Calculated annually using two upgradient wells | Two wells are needed to capture spatial variability in upgradient conditions. Calculated annually using EPA 530/R-09-007, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*. |
| Groundwater Quality Assessment Plan Outline | None | Added in Chapter 5 | Update outline to current norms |

* DOE/RL-2010-93, Rev. 1, *Interim Status Groundwater Monitoring Plan for the 216-A-36B PUREX Plant Crib*.

## 3.4 Sampling and Analysis Protocol

The groundwater protection regulations of WAC 173-303-400 dictate the groundwater sampling and analysis requirements applicable to interim status TSD units. The QAPjP outlining the project management structure, data generation and acquisition, analytical procedures, and quality control is provided in Appendix A. Appendix B provides the sampling protocols (e.g., sampling methods, sample handling and custody, management of waste, and health and safety considerations).

# 4 Data Evaluation and Reporting

This chapter discusses the evaluation and interpretation of data.

## 4.1 Data Review

The data review and verification tasks are discussed in the QAPjP (Appendix A).

## 4.2 Statistical Evaluation

The goal of the groundwater monitoring indicator evaluation program is to determine if 216-A-36B Crib operations have affected groundwater quality beneath the TSD unit, which is determined based on the results of specified statistical tests. Under this plan, sampling activities and statistical evaluation methods are based on 40 CFR 265, Subpart F (incorporated by reference into WAC 173-303-400). These interim status regulations require the use of a statistical method that compares mean concentrations of the four general groundwater contamination indicator parameters (pH, specific conductance, TOC, and TOX) to background levels to test for potential impact to groundwater. Each time that a monitoring well is sampled, four replicate samples for TOC and TOX are collected, and four replicate field measurements are made for pH and specific conductance.

The basic procedure for statistical comparisons is as follows. Twice each year, monitoring data from downgradient wells are compared to the upgradient (background) results for each of the four indicator parameters. The arithmetic mean and variance must be calculated based on at least four replicate measurements on each sample, for each well monitored, and then compared with the background arithmetic mean obtained (40 CFR 265.92[c][2]) and updated as discussed in Chapter 5 of EPA 530/R-09-007, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance*. The comparison must consider each of the individual wells in the monitoring system and must use the Student's t-test at the 0.01 level of significance to determine statistically significant increases (and decreases, in the case of pH) over background (40 CFR 265.93(b) and Appendix IV to 40 CFR 265). Implementation of the statistical test method at the Hanford Site, including at the 216-A-36B Crib, is generally consistent with EPA 530/R-09-007. The background statistical analysis is updated annually to establish comparative values for indicator parameters. A rolling mean is used because of changing upgradient concentrations and groundwater flow conditions. The practice of annually updating the background values is consistent with statistical evaluation methods for TSD units in final status under WAC 173-303-645(8)(h), "Releases from Regulated Units," "General Groundwater Monitoring Requirements."

If a downgradient well comparison shows a significant increase (or pH decrease), then the well is resampled. For TOC and TOX, split samples are sent to different laboratories to determine if the exceedance of the comparison value was the result of laboratory error.

If the exceedance of the statistical comparison value is confirmed by resampling, then written notifications are made as detailed in Section 4.5 and in accordance with 40 CFR 265.93(d)(1).

## 4.3 Interpretation

Data are used to interpret groundwater conditions at the 216-A-36B Crib. Interpretive techniques include the following:

- **Hydrographs:** Graph water levels versus time to determine decreases and increases and seasonal or manmade fluctuations in groundwater levels.

- **Water table maps:** Use water table elevations from multiple wells to construct contour maps and estimate flow directions. Groundwater flow is assumed to be perpendicular to the equal potential lines on the maps.
- **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 groundwater flow directions.
- **Plume maps:** Map distributions of chemical constituent concentrations in the aquifer to determine the extent of contamination. Changes in plume distribution over time assist in determining plume movement and direction of groundwater flow.
- **Contaminant ratios:** Illustrate the relative abundances of contaminants from previously characterized Hanford Site-related processes and sources. Comparison of these ratios in groundwater can sometimes be used to distinguish among different sources of contamination (e.g., a specific process and its associated facility). Ratios may provide evidence of continuing source contamination, thereby linking contamination with a specific facility under monitoring. Evaluation of contaminant ratios in concentration trends may be used to demonstrate when facility-specific contamination no longer affects underlying groundwater.

## 4.4 Annual Determination of Monitoring Network

Groundwater monitoring requirements include an annual evaluation of the network to determine if it remains adequate to monitor the facility's impact on the quality of the groundwater in the uppermost aquifer underlying the facility (40 CFR 265.93(f)). The network must include at least one upgradient and at least three downgradient wells in the uppermost aquifer (40 CFR 265.91(a)(1) and (2)).

The current groundwater monitoring network will continue to be re-evaluated to ensure that it is adequate to monitor any changing hydrogeologic conditions beneath the unit. If flow changes are observed, the 216-A-36B Crib CSM and groundwater constituents will be re-evaluated to determine network efficiency and any necessary modifications required for the network.

Water-level measurements will continue to be collected during each sampling event. An additional and more comprehensive set of water-level measurements is made annually for selected wells on the Hanford Site, and the data are presented in the annual Hanford Site RCRA groundwater monitoring reports (e.g., DOE/RL-2016-12).

## 4.5 Reporting and Notification

Groundwater monitoring and evaluation of groundwater surface elevation results are reported annually in accordance with the requirements of 40 CFR 265.94(a)(2). Reporting will be made in the annual Hanford Site RCRA groundwater monitoring reports (e.g., DOE/RL-2016-12).

If an upgradient well comparison shows a significant increase (or pH decrease) relative to the statistical comparison value, that information is also reported (40 CFR 265.93(c)(1)) in the annual Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2016-12).

If the exceedance of the statistical comparison value is confirmed, written notice is then provided to Ecology within 7 days (40 CFR 265.93(d)(1)) stating that the facility may be affecting groundwater quality. Within 15 days after the notification, a groundwater quality assessment program plan must be developed and placed in the facility operating record (40 CFR 265.93(d)(2)). This plan must be submitted to Ecology (WAC 173-303-400(3)(c)(v)(D).

# 5 Outline for Groundwater Quality Assessment Plan

If a groundwater contamination indicator parameter at a downgradient well significantly exceeds the background value or if pH decreases and is confirmed by verification sampling, a groundwater quality assessment plan will be prepared and submitted to Ecology and the facility monitoring will be elevated to assessment monitoring status. The assessment program must be capable of determining whether dangerous waste or dangerous waste constituents from the facility have entered the groundwater, their rate and extent of migration, and their concentration. This chapter presents a revision of the groundwater quality assessment monitoring plan outline required by 40 CFR 265.93(a). A crosswalk to information that is still pertinent (e.g., the facility description, geology and hydrogeology, or sampling protocols) within the indicator parameter program groundwater monitoring plan that precedes the groundwater quality assessment plan may be included. An outline for the assessment plan is presented in Table 5-1. Changes may be made to this outline based on the information identified on the crosswalk, if used.
The groundwater quality assessment program may include the following elements:

- Description of the hydrogeologic conditions and identification of potential contaminant pathways
- Description of the investigative approach for making first determination to decide if dangerous waste or dangerous waste constituents from the facility have entered the groundwater or if the exceedance was caused by other sources (false positive rationale)
- Description of the approach to fully characterize rate and extent of contaminant migration
- Number, locations, and depths of wells in the monitoring network
- Sampling and analytical methods used
- Data evaluation methods
- An implementation schedule

The results of assessment determinations will be made as soon as technically feasible and a report of the findings will be sent to Ecology. The results of the groundwater quality assessment program will then be reported annually as required by 40 CFR 265.94(b).

**Table 5-1. Suggested Groundwater Quality Assessment Plan Outline**

| |
|---|
| Introduction |
| Background |
| Facility Description and Operational History |
| Regulatory Basis |
| Waste Characteristics |
| Geology and Hydrogeology |
| Summary of Previous Groundwater Monitoring and Results |
| Conceptual Site Model |
| Monitoring Objectives |
| Groundwater Monitoring |
| Constituent List and Sampling Frequency |
| Well Network Sampling and Analysis Protocol |
| Sampling and Sampling and Analysis Protocol |
| Data Evaluation and Reporting |
| Data Evaluation |
| Interpretation |
| Annual Determination of Monitoring Network |
| Reporting and Notification |
| Implementation Schedule |
| References |
| Appendix A – Quality Assurance Project Plan |
| Appendix B – As-Built Drawings of Wells in Well Network |

Note: A crosswalk to information that is still pertinent (e.g., the facility description, geology and hydrogeology, or sampling protocols) within the indicator parameter program groundwater monitoring plan that precedes the groundwater quality assessment plan may be included. Changes may be made to this outline based on the information identified on the crosswalk, if used.

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265.91, "Ground-Water Monitoring System."

265.92, "Sampling and Analysis."

265.93, "Preparation, Evaluation, and Response."

265.94, "Recordkeeping and Reporting."

Subpart F, "Ground-Water Monitoring."

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# Appendix A

# Quality Assurance Project Plan

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# Terms

| | |
|---|---|
| DOE | U.S. Department of Energy |
| DQI | data quality indicator |
| DUP | duplicate (laboratory) |
| DWMU | dangerous waste management unit |
| EB | equipment blank |
| ECO | Environmental Compliance Officer |
| EPA | U.S. Environmental Protection Agency |
| FSO | Field Sample Operations |
| FTB | full trip blank |
| FWS | Field Work Supervisor |
| FXR | field transfer blank |
| HEIS | Hanford Environmental Information System |
| LCS | laboratory control sample |
| MB | method blank |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| QA | quality assurance |
| QAPjP | quality assurance project plan |
| QC | quality control |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| SMR | Sample Management and Reporting |
| SPLIT | field split |
| SUR | surrogate |
| VOC | volatile organic compound |

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# A1 Introduction

A quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection. This QAPjP includes planning, implementation, and assessment of sampling tasks, field measurements, laboratory analysis, and data review. This chapter describes the applicable environmental data collection quality assurance (QA) elements for this groundwater monitoring plan. This QAPjP is intended to supplement the contractor's environmental QA program plan.

This QAPjP is divided into the following four chapters that describe the quality requirements and controls applicable to the dangerous waste management unit (DWMU) groundwater monitoring activities:

- Chapter A2, Project Management
- Chapter A3, Data Generation and Acquisition
- Chapter A4, Data Review and Usability
- Chapter A5, References

# A2 Project Management

This chapter addresses the management approaches planned, project goals, and planned documentation.

## A2.1 Project/Task Organization

Project organization (regarding groundwater monitoring) is described in the following sections and illustrated in Figure A-1. Titles used in the project organization are for the purposes of discussing the role of the individual in the performance of the work scope. Individuals with different titles but similar/equivalent positions may fulfill these roles.

### A2.1.1 U.S. Department of Energy Manager

Hanford Site operation is the responsibility of the U.S. Department of Energy (DOE). The DOE Manager is responsible for authorizing the contractor to perform activities at the Hanford Site under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*; *Resource Conservation and Recovery Act of 1976* (RCRA); *Atomic Energy Act of 1954*; and Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*.

### A2.1.2 U.S. Department of Energy Project Lead

The DOE Project Lead is responsible for providing day-to-day oversight of the contractor's performance of the work scope, working with the contractor to identify and work through issues, and providing technical input to DOE management.

### A2.1.3 U.S. Department of Energy Primary Contractor Management for Groundwater Science

The DOE Primary Contractor Management for Groundwater Science provides oversight and coordinates with DOE in support of sampling and reporting activities. The DOE Primary Contractor Management for Groundwater Science also provides support to the Project Delivery Manager for Groundwater Science to ensure that work is performed safely and cost effectively.

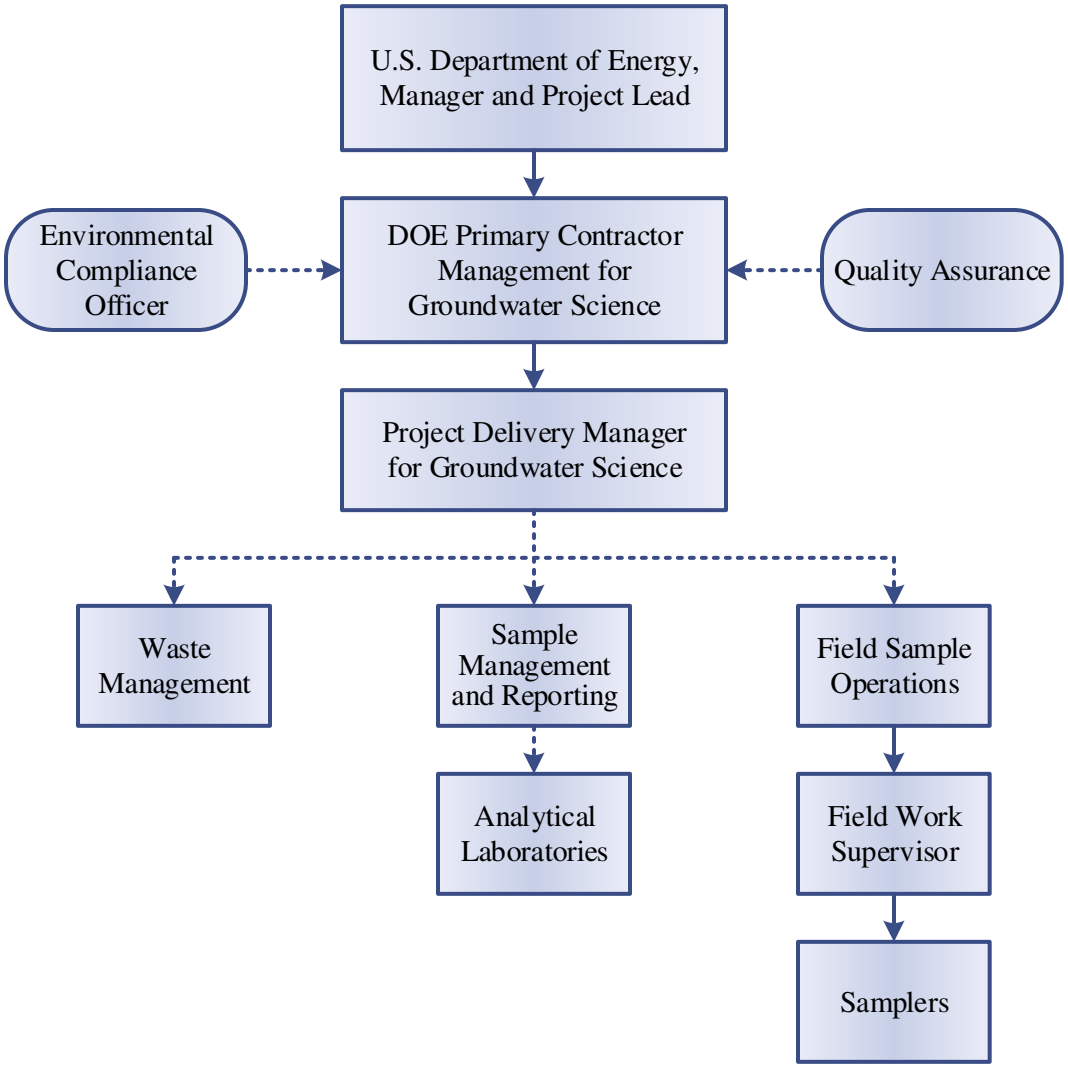


**Figure A-1. Project Organization**

### A2.1.4 Project Delivery Manager for Groundwater Science

The Project Delivery Manager for Groundwater Science is responsible for direct management of activities performed to meet DWMU groundwater monitoring requirements. The Project Delivery Manager for Groundwater Science coordinates with, and reports to, DOE and DOE Primary Contractor Management for Groundwater Science regarding DWMU groundwater monitoring requirements. The Project Delivery Manager for Groundwater Science (or designee) works closely with the Environmental Compliance Officer (ECO), QA, and Sample Management and Reporting (SMR) group to integrate these and other technical disciplines in planning and implementing the work scope. The Project Delivery Manager for Groundwater Science assigns staff to provide technical expertise.

### A2.1.5 Sample Management and Reporting Group

The SMR group oversees offsite analytical laboratories, coordinates laboratory analytical work with this plan, and verifies that laboratories are qualified for performing Hanford Site analytical work. They generate field sampling documents, labels, and instructions for field sampling personnel and develop sample authorization forms, which provide information and instruction to the analytical laboratories. The SMR group revises field sampling documents to reflect approved changes. This group's

responsibilities include receiving analytical data from the laboratories, performing data entry into the Hanford Environmental Information System (HEIS) database, arranging for data validation and recordkeeping. The SMR group is responsible for resolving sample documentation deficiencies or issues associated with Field Sample Operations (FSO), laboratories, or other entities. They are responsible for informing the Project Delivery Manager for Groundwater Science (or designee) of any issues reported by the analytical laboratories.

### A2.1.6 Field Sample Operations

FSO is responsible for planning and coordinating field sampling resources and provides the Field Work Supervisor (FWS) for routine groundwater sampling operations. The FWS directs the samplers who collect groundwater samples for this groundwater monitoring plan. Samplers collect samples, complete field logbooks, data forms, and chain-of-custody forms, including any shipping paperwork, and assist sample delivery to the analytical laboratory.

### A2.1.7 Quality Assurance

The QA point of contact provides independent oversight, is responsible for addressing QA issues on the project, and overseeing implementation of the project QA program.

### A2.1.8 Environmental Compliance Officer

ECOs provide technical oversight, direction, and acceptance of project and subcontracted environmental work, with the goal of minimizing adverse environmental impacts.

### A2.1.9 Waste Management

Waste Management identifies waste management sampling/characterization activities for regulatory compliance and is responsible for data interpretation to determine waste designations and profiles. Waste Management communicates policies and practices for project compliance for waste storage, transportation, disposal, and tracking in a safe and cost-effective manner.

### A2.1.10 Analytical Laboratories

The laboratories maintain custody and analyze samples in accordance with established quality systems and provide data packages containing sample and quality control (QC) results. Laboratories provide explanations of results to support data review and resolve analytical issues.

## A2.2 Problem Definition/Background

The purpose of this groundwater monitoring plan is to satisfy *Washington Administrative Code* and *Code of Federal Regulations* requirements (WAC 173-303-400, “Dangerous Waste Regulations,” “Interim Status Facility Standards,” and 40 CFR 265, “Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities,” Subpart F, “Ground-Water Monitoring”) for indicator parameter evaluation. Additional information on the activities to satisfy these requirements and background information on monitoring is provided in the main text of this monitoring plan.

## A2.3 Project/Task Description

The focus of this plan is to monitor the parameters used as indicators of groundwater contamination and for parameters establishing groundwater quality in accordance with 40 CFR 265.92, “Sampling and Analysis;” evaluate the well network; and interpret analytical results. The indicator parameters to be monitored, along with the monitoring wells and frequency of sampling, are provided in the main text (Chapter 3). Information on the collection and analyses of groundwater from the monitoring network is provided in this appendix and in Appendix B.

## A2.4 Quality Assurance Objectives and Criteria

The QA objective of this plan is the generation of analytical data of known and appropriate quality. In support of this objective, the process to assess data usability may include data verification, data validation, or a data quality indicator (DQI) evaluation. Principal DQIs are precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity. These DQIs are defined for the purposes of this document in Table A-1.

The applicable QC guidelines, DQI acceptance criteria, and levels of effort for assessing data quality are dictated by the intended use of the data and the requirements of the analytical method. The process to assess data usability is further discussed in Section A4.

**Table A-1. Data Quality Indicators**

| Data Quality Indicator (QC Element)[a] | Definition | Determination Methodologies | Possible Corrective Actions |
|---|---|---|---|
| Precision<br>(field duplicates, laboratory sample duplicates, and matrix spike duplicates) | Precision measures the agreement among a set of replicate measurements. Field precision is assessed through the collection and analysis of field duplicates. Analytical precision is estimated by duplicate/replicate analyses, usually on laboratory control samples, spiked samples, and/or field samples. The most commonly used estimates of precision are the relative standard deviation and, when only two samples are available, the relative percent difference. | Use the same analytical instrument to make repeated analyses on the same sample.<br>Use the same method to make repeated measurements of the same sample within a single laboratory.<br>Acquire replicate field samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements. | If duplicate data do not meet objective:<br>• Evaluate apparent cause (e.g., sample heterogeneity).<br>• Request reanalysis or remeasurement.<br>• Qualify the data before use. |
| Accuracy<br>(laboratory control samples, matrix spikes, and surrogates) | Accuracy is the closeness of a measured result to an accepted reference value. Accuracy is usually measured as a percent recovery. QC analyses used to measure accuracy include laboratory control samples, spiked samples, and surrogates. | Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (a spiked sample). | If recovery does not meet objective:<br>• Qualify the data before use.<br>• Request reanalysis or remeasurement.<br>• Determine if follow-up evaluation is needed.<br>• Evaluate instrumentation and re-calibrate, if necessary |
| Representativeness<br>(field duplicates) | Sample representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. It is dependent on the proper design of the sampling program and will be satisfied by ensuring that the approved plans were followed during sampling and analysis. | Evaluate whether measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the environment or condition being measured or studied. | If results are not representative of the system sampled:<br>• Identify the reason for results not being representative.<br>• Flag for further review.<br>• Review data for usability.<br>• If data are usable, qualify the data for limited use and define the portion of the system that the data represent.<br>• If data are not usable, flag as appropriate.<br>• Redefine sampling and measurement requirements and protocols.<br>• Resample and reanalyze, as appropriate. |

**Table A-1. Data Quality Indicators**

| Data Quality Indicator (QC Element)[a] | Definition | Determination Methodologies | Possible Corrective Actions |
|---|---|---|---|
| Comparability<br>(field duplicate, field splits, laboratory control samples, matrix spikes, and matrix spike duplicates) | Comparability expresses the degree of confidence with which one dataset can be compared to another. It is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the approved plans are followed and that proper sampling and analysis techniques are applied. | Use identical or similar sample collection and handling methods, sample preparation and analytical methods, holding times, and quality assurance protocols. | If data are not comparable to other datasets:<br>• Identify appropriate changes to data collection and/or analysis methods.<br>• Identify quantifiable bias, if applicable.<br>• Qualify the data as appropriate.<br>• Resample and/or reanalyze if needed.<br>• Revise sampling/analysis protocols to ensure future comparability. |
| Completeness<br>(no QC element; addressed in data usability assessment) | Completeness is a measure of the amount of valid data collected compared to the amount of data planned. Measurements are considered valid if they are unqualified or qualified as estimated data during validation. Field completeness is a measure of the number of samples collected versus the number of samples planned. Laboratory completeness is a measure of the number of valid measurements compared to the total number of measurements planned. | Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's quality criteria (data quality objectives or performance/acceptance criteria). | If dataset does not meet the completeness objective:<br>• Identify appropriate changes to data collection and/or analysis methods.<br>• Identify quantifiable bias, if applicable.<br>• Resample and/or reanalyze if needed.<br>• Revise sampling/analysis protocols to ensure future completeness. |
| Bias<br>(equipment blanks, field transfer blanks, full trip blanks, laboratory control samples, matrix spikes, and method blanks) | Bias is the systematic or persistent distortion of a measurement process that causes error in one direction (e.g., the sample measurement is consistently lower than the sample's true value). Bias can be introduced during sampling, analysis, and data evaluation.<br>Analytical bias refers to deviation in one direction (i.e., high, low, or unknown) of the measured value from a known spiked amount. | Sampling bias may be revealed by analysis of replicate samples. Analytical bias may be assessed by comparing a measured value in a sample of known concentration to an accepted reference value or by determining the recovery of a known amount of contaminant spiked into a sample (matrix spike). | For sampling bias:<br>• Properly select and use sampling tools.<br>• Institute correct sampling and subsampling processes to limit preferential selection or loss of sample media.<br>• Use sample handling processes, including proper sample preservation, that limit the loss or gain of constituents to the sample media.<br>• Analytical data that are known to be affected by either sampling or analytical bias are flagged to indicate possible bias.<br>• Laboratories that are known to generate biased data for a specific analyte are asked to correct |

**Table A-1. Data Quality Indicators**

| Data Quality Indicator (QC Element)[a] | Definition | Determination Methodologies | Possible Corrective Actions |
|---|---|---|---|
| | | | their methods to remove the bias as practicable. Otherwise, samples are sent to other laboratories for analysis. |
| Sensitivity (method detection limit, practical quantitation limit, and relative percent difference) | Sensitivity is an instrument's or method's minimum concentration that can be reliably measured (i.e., instrument detection limit or limit of quantitation). | Determine the minimum concentration or attribute to be measured by an instrument (instrument detection limit) or by a laboratory (limit of quantitation). The lower limit of quantitation[b] is the lowest level that can be routinely quantified and reported by a laboratory. | If detection limits do not meet objective:<br>• Request reanalysis or remeasurement using methods or analytical conditions that will meet required detection or limit of quantitation.<br>• Qualify/reject the data before use. |

Based on SW-846, *Compendium* (July 2014). Available at: https://www.epa.gov/hw-sw846/sw-846-compendium.

a. Acceptance criteria for QC elements are provided in Table A-5.

b. For purposes of this groundwater monitoring plan, the lower limit of quantitation is interchangeable with the practical quantitation limit.

QC = quality control

## A2.5 Documents and Records

The Project Delivery Manager for Groundwater Science (or designee) is responsible for ensuring that the current version of the groundwater monitoring plan is used and providing any updates to field personnel. Table A-2 defines the types of changes that may impact the groundwater monitoring plan and the associated approvals, notifications, and documentation requirements. Elements of the monitoring plan that are required by 40 CFR 265 Subpart F cannot be changed.

**Table A-2. Change Control for Monitoring Plans**

| Type of Change | Action | Documentation |
|---|---|---|
| Unintentional impact to groundwater monitoring plan that impacts the groundwater quality assessment program requirements of 40 CFR 265, Subpart F, including one-time missed well sampling due to operational constraints, delayed sample collection, broken pump, lost bottle set, missed sampling of groundwater constituents or parameters, or loss of samples in transit. | Project Delivery Manager for Groundwater Science provides informal notification to DOE-RL.<br><br>DOE-RL provides informal notification to Ecology as appropriate. | Copy of informal notification to Ecology is placed in the facility operating record.<br><br>Annual Hanford Site RCRA groundwater monitoring report. |
| Planned change to groundwater monitoring activities, including addition or deletion of constituents analyzed for, change of sampling frequency, or changes to well network. | Project Delivery Manager for Groundwater Science obtains DOE-RL approval; revise monitoring plan as appropriate. | Annual Hanford Site RCRA groundwater monitoring report and revised groundwater monitoring plan as appropriate. |

40 CFR 265, Subpart F, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring."

DOE-RL = U.S. Department of Energy, Richland Operations Office

Ecology = Washington State Department of Ecology

RCRA = *Resource Conservation and Recovery Act of 1976*

Logbooks and data forms are used to document field activities. The logbooks are identified with a unique project name and number. Individuals responsible for the logbooks are identified in the front of the logbook, and only authorized individuals may make entries into the logbooks. Logbooks will be controlled documents. Data forms are also identified with a unique project name and number, may be used to record the same field information as logbooks, and are referenced in the logbooks.

The FWS, SMR group, and field crew supervisors are responsible for alignment of field instructions with the groundwater monitoring plan.

Convenience copies of laboratory analytical results are maintained in the HEIS database. Records may be stored in either electronic (e.g., in the managed records area of the Integrated Document Management System) or hardcopy format (e.g., DOE Records Holding Area). Records of analyses required by 40 CFR 265.94, "Recordkeeping and Reporting," are to be maintained throughout the active life of a facility and post-closure care period (if any).

By March 1, groundwater monitoring results are reported in the Hanford Site RCRA groundwater monitoring report (e.g., DOE/RL-2018-65, *Hanford Site RCRA Groundwater Monitoring Report for 2018*).

# A3 Data Generation and Acquisition

This chapter addresses data generation and acquisition so that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented. Instrument calibration and maintenance, supply inspections, and data management are also discussed.

## A3.1 Analytical Method Requirements

Sample analytical methods are presented in Table A-3. Equivalent (e.g., U.S. Environmental Protection Agency [EPA] Method 300 and SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods,* Method 9056) or updated (e.g., updates to SW-846 methods) Washington State Department of Ecology-accredited methods may be substituted for the methods identified in Table A-3.

**Table A-3. Analytical Methods for the DWMU**

| CAS Number | Waste Constituent (Alternate Name) | Analytical Method[a] | Practical Quantitation Limit (µg/L) |
|---|---|---|---|
| **General Chemistry** | | | |
| ALKALINITY | Alkalinity, total as CaCO3 | 310.1, Standard Method 2320, Standard Method 4500 | 5250 |
| 18496-25-8 | Sulfide (total) | 376.1, Standard Method 4500S | 2100 |
| TOC | Total organic carbon | 415.1, 9060 | 1050 |
| 59473-04-0 | Total organic halogen | 9020 | 31.5 |
| **Anions[b]** | | | |
| 16887-00-6 | Chloride | 300, 9056 | 400 |
| 16984-48-8 | Fluoride | 300, 9056 | 525 |
| 14797-55-8 | Nitrate, as NO3 | 300, 9056 | 250 |
| 14797-65-0 | Nitrite, as NO2 | 300, 9056 | 250 |
| 14808-79-8 | Sulfate | 300, 9056 | 1050 |
| **Field Measurements** | | | |
| -- | pH | 150.1, 9040, Standard Method 4500 H+ | N/A |
| -- | Dissolved oxygen | 360.1, Standard Method 4500 O | N/A |
| -- | Specific conductance | 120.1, 9050, Standard Method 2520 B-97 | N/A |
| -- | Temperature | 170.1 | N/A |

**Table A-3. Analytical Methods for the DWMU**

| CAS Number | Waste Constituent (Alternate Name) | Analytical Method[a] | Practical Quantitation Limit (µg/L) |
|---|---|---|---|
| -- | Turbidity | 180.1, Standard Method 2130 B | N/A |
| **Metals** | | | |
| 7440-70-2 | Calcium | 6010 | 1050 |
| 7440-47-3 | Chromium | 6020 | 10.5 |
| 7439-89-6 | Iron | 6010 | 105 |
| 7439-95-4 | Magnesium | 6010 | 1050 |
| 7439-96-5 | Manganese | 6020 | 5.25 |
| 7439-98-7 | Molybdenum | 6020 | 5.25 |
| 7440-02-0 | Nickel | 6020 | 21 |
| 7440-09-7 | Potassium | 6010 | 5250 |
| 7440-23-5 | Sodium | 6010 | 1050 |
| **Volatile Organic Compounds** | | | |
| 75-34-3 | 1,1-Dichloroethane | 8260 | 10 |
| 75-35-4 | 1,1-Dichloroethene (1,1-Dichloroethylene) | 8260 | 10 |
| 71-55-6 | 1,1,1-Trichloroethane | 8260 | 5 |
| 79-00-5 | 1,1,2-Trichloroethane | 8260 | 5 |
| 56-23-5 | Carbon tetrachloride | 8260 | 3 |
| 67-66-3 | Chloroform | 8260 | 5 |
| 75-09-2 | Methylene chloride (Dichloromethane) | 8260 | 5.25 |
| 127-18-4 | Tetrachloroethene | 8260 | 5 |
| 79-01-6 | Trichloroethylene (Trichloroethene [TCE]) | 8260 | 2.1 |
| 75-01-4 | Vinyl chloride (Chloroethene, chloroethylene) | 8260 | 2.1 |
| **Semivolatile Organic Compounds** | | | |
| 95-57-8 | 2-Chlorophenol | 8270 | 10.5 |
| 95-48-7 | 2-Methylphenol (o-Cresol) | 8270 | 10.5 |
| 88-75-5 | 2-Nitrophenol (o-Nitrophenol) | 8270 | 10.5 |
| 58-90-2 | 2,3,4,6-Tetrachlorophenol | 8270 | 52.5 |

**Table A-3. Analytical Methods for the DWMU**

| CAS Number | Waste Constituent (Alternate Name) | Analytical Method[a] | Practical Quantitation Limit (µg/L) |
|---|---|---|---|
| 120-83-2 | 2,4-Dichlorophenol | 8270 | 10.5 |
| 105-67-9 | 2,4-Dimethylphenol (2,4-Xylenol) | 8270 | 10.5 |
| 51-28-5 | 2,4-Dinitrophenol | 8270 | 50 |
| 95-95-4 | 2,4,5-Trichlorophenol | 8270 | 10.5 |
| 88-06-2 | 2,4,6-Trichlorophenol | 8270 | 10.5 |
| 87-65-0 | 2,6-Dichlorophenol | 8270 | 10.5 |
| 108-39-4[c] | 3-Methylphenol (m-Cresol) | 8270 | -- |
| 59-50-7 | 4-Chloro-3-methylphenol (p-Chloro-m-cresol) | 8270 | 10.5 |
| 106-44-5[c] | 4-Methylphenol (p-Cresol) | 8270 | -- |
| 534-52-1 | 4,6-Dinitro-O-cresol (4,6-Dinitro-2-methyl phenol) | 8270 | 52.5 |
| 88-85-7 | Dinoseb (2-sec-Butyl-4,6-dinitrophenol) | 8270 | 21 |
| 100-02-7 | p-Nitrophenol (4-Nitrophenol) | 8270 | 21 |
| 87-86-5 | Pentachlorophenol | 8270 | 52.5 |
| 108-95-2 | Phenol | 8270 | 10.5 |
| **Drinking Water Suitability Parameters[d]** | | | |
| 7440-38-2 | Arsenic | 6020 | 10.5 |
| 7440-39-3 | Barium | 6020 | 5.25 |
| 7440-43-9 | Cadmium | 6020 | 2.1 |
| 7440-47-3 | Chromium | 6020 | 10.5 |
| 16984-48-8[b] | Fluoride | 300, 9056 | 525 |
| 7439-92-1 | Lead | 6020 | 3.15 |
| 7439-97-6 | Mercury | 7470 | 0.5 |
| 14797-55-8[b] | Nitrate, as NO3 | 300, 9056 | 250 |
| 7782-49-2 | Selenium | 6020 | 10.5 |
| 7440-22-4 | Silver | 6020 | 5.25 |
| 72-20-8 | Endrin | 8081 | 0.1 |
| 58-89-9 | gamma-BHC (Lindane; hexachlorocyclohexane) | 8081 | 0.0525 |

**Table A-3. Analytical Methods for the DWMU**

| CAS Number | Waste Constituent (Alternate Name) | Analytical Method[a] | Practical Quantitation Limit (µg/L) |
|---|---|---|---|
| 72-43-5 | Methoxychlor | 8081 | 0.5 |
| 8001-35-2 | Toxaphene | 8081 | 2.625 |
| 94-75-7 | 2,4-D (2,4-Dichlorophenoxy acetic acid) | 8151 | 20 |
| 93-72-1 | Silvex (2,4,5-TP) | 8151 | 1.05 |
| ALPHA-RA | Radium (total alpha) | Gas Flow Proportional Counting | 1 pCi/L |
| 12587-46-1 | Gross Alpha | Gas Proportional Counting | 3 pCi/L |
| 12587-47-2 | Gross Beta | | 4 pCi/L |
| -- | Coliform Bacteria | Standard Method 9223 | N/A |
| -- | Turbidity | 180.1, Standard Method 2130 B | N/A |

Note: Analytical methods and practical quantitation limits provided in this table do not represent EPA nor Washington State Department of Ecology requirements but are intended solely as guidance.

a. For EPA Methods 180.1 and 300, see EPA/600/R-93/100, *Methods for the Determination of Inorganic Substances in Environmental Samples.* For EPA Methods 120.1, 150.1, 170.1, 310.1, 360.1, 376.1 and 415.1, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For four-digit EPA methods, see the SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Compendium*. For Standard Methods, see APHA/AWWA/WEF, 2017, *Standard Methods for the Examination of Water and Wastewater*.
b. Dilutions for certain ion chromatography constituents may be necessary, potentially raising the practical quantitation limit above the limits provided.
c. Analyzed and reported as 3 & 4 Methylphenol (CAS number 65794-96-9). The PQL for 3 & 4 Methylphenol is 20 µg/L.
d. Parameters characterizing the suitability of groundwater as a drinking water supply as presented in 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Appendix III, "EPA Interim Primary Drinking Water Standards," were be monitored for 1 year at the wells identified in Table 3-3 of the main text.

CAS = Chemical Abstracts Service
DWMU = dangerous waste management unit
Ecology = Washington State Department of Ecology
EPA = U.S. Environmental Protection Agency
N/A = not applicable
PQL = practical quantitation limit

## A3.2 Field Analytical Methods

Field screening and survey data will be measured in accordance with applicable work practices. Field analytical methods may also be performed in accordance with manufacturer manuals. Appendix B provides further discussion on field measurements.

## A3.3 Quality Control

Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to sampling variability. Laboratory QC samples estimate the precision, bias, and matrix effects on the analytical data. Field and laboratory QC samples, and their typical frequencies, are summarized in Table A-4. Acceptance criteria for field and laboratory QC are shown in Table A-5. Data will be qualified and flagged in the HEIS database, as appropriate.

**Table A-4. QC Samples**

| Sample Type | Frequency | Characteristics Evaluated |
|---|---|---|
| **Field QC** | | |
| Equipment blanks | 1 in 20 samples when nondedicated equipment is used[a] | Contamination from nondedicated sampling equipment |
| Field duplicates | 1 in 20 well trips[b] | Reproducibility/sampling precision |
| Field splits | As needed | Interlaboratory comparability |
| Field transfer blanks | One each day VOCs are sampled; additional field transfer blanks are collected if VOC samples are acquired on the same day for multiple laboratories | Contamination from sampling site |
| Full trip blanks | 1 in 20 well trips[b] | Contamination from containers preservative reagents, storage, or transportation |
| **Analytical QC[c]** | | |
| Carrier | Added to each sample and quality control | Recovery/yield |
| Laboratory control samples | One per analytical batch[d] | Method accuracy |
| Laboratory sample duplicates | One per analytical batch[d] | Laboratory reproducibility and precision |
| Matrix spikes | One per analytical batch[d] | Matrix effect/laboratory accuracy |
| Matrix spike duplicates | One per analytical batch[d] | Laboratory reproducibility, and method accuracy and precision |
| Method blanks | One per analytical batch[d] | Laboratory contamination |

**Table A-4. QC Samples**

| Sample Type | Frequency | Characteristics Evaluated |
|---|---|---|
| Surrogates | Added to each sample and QC sample | Recovery/yield for organic compounds |

Note: The information in this table does not create U.S. Environmental Protection Agency or Washington State Department of Ecology requirements; it is intended solely as guidance.

a. For portable pumps, equipment blanks are collected (1 for every 20 well trips). Whenever a new type of nondedicated equipment is used, an equipment blank will be collected each time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination methods for the nondedicated equipment.

b. For groundwater, a sample is collected any time a well is accessed for sampling; this is also known as a well trip. Field duplicates and full trip blanks are run at a frequency of 1 in 20 well trips (i.e., 5% of the well trips) for all groundwater monitoring wells sampled within any given month and drilling campaign (for all groundwater monitoring programs).

c. A batch is a group of up to 20 samples that behave similarly with respect to the sampling or testing procedures being employed and which are processed as a unit. Batching across projects is allowed for similar matrices (e.g., Hanford Site groundwater).

d. Unless not required by, or different frequency is called out, in laboratory analysis method.

QC = quality control

VOC = volatile organic compound

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

| Analyte[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| **General Chemistry** | | | |
| Alkalinity | MB | <MDL<br><5% sample concentration | Flag with “C” |
| | LCS | 80% to 120% recovery | Flag with “o”[b] |
| | DUP[c] or MS/MSD[d] | ≤20% RPD | Review data[e] |
| | MS/MSD[d] | 75% to 125% recovery | Flag with “N” |
| | EB, FTB | <MDL<br><5% sample concentration | Flag with “Q” |
| | Field duplicate[c] | ≤20% RPD | Review data[e] |
| Sulfide | MB | <MDL<br><5% sample concentration | Flag with “C” |
| | LCS | 80% to 120% recovery | Flag with “o”[b] |
| | DUP[c] or MS/MSD[d] | ≤20% RPD | Review data[e] |
| | MS/MSD[d] | 75% to 125% recovery | Flag with “N” |
| | EB, FTB | <MDL<br><5% sample concentration | Flag with “Q” |
| | Field duplicate[c] | ≤20% RPD | Review data[e] |
| Total organic carbon | MB | <MDL<br><5% sample concentration | Flag with “C” |
| | LCS | 80% to 120% recovery | Flag with “o”[b] |

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

| Analyte[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| | DUP[c] or MS/MSD[d] | ≤20% RPD | Review data[e] |
| | MS/MSD[d] | 75% to 125% recovery | Flag with "N" |
| | EB, FTB | <MDL<br><5% sample concentration | Flag with "Q" |
| | Field duplicate[c] | ≤20% RPD | Review data[e] |
| Total organic halogen | MB | <MDL<br><5% sample concentration | Flag with "C" |
| | LCS | 80% to 120% recovery | Flag with "o"[b] |
| | DUP[c] or MS/MSD[d] | ≤20% RPD | Review data[e] |
| | MS/MSD[d] | 75% to 125% recovery | Flag with "N" |
| | EB, FTB | <MDL<br><5% sample concentration | Flag with "Q" |
| | Field duplicate[c] | ≤20% RPD | Review data[e] |
| **Anions** | | | |
| Anions by ion chromatography | MB | <MDL<br><5% sample concentration | Flag with "C" |
| | LCS | 80% to 120% recovery | Flag with "o"[b] |
| | DUP[c] or MS/MSD[d] | ≤20% RPD | Review data[e] |
| | MS/MSD[d] | 75% to 125% recovery | Flag with "N" |
| | EB, FTB | <MDL<br><5% sample concentration | Flag with "Q" |
| | Field duplicate[c] | ≤20% RPD | Review data[e] |
| **Metals** | | | |
| Metals by inductively coupled plasma/atomic emission spectrometry | MB | <MDL<br><5% sample concentration | Flag with "C" |
| | LCS | 80% to 120% recovery | Flag with "o"[b] |
| | DUP[c] or MS/MSD[d] | ≤20% RPD | Review data[e] |
| | MS/MSD[d] | 75% to 125% recovery | Flag with "N" |
| | EB, FTB | <MDL<br><5% sample concentration | Flag with "Q" |
| | Field duplicate[c] | ≤20% RPD | Review data[e] |
| Metals by inductively coupled plasma/mass spectrometry | MB | <MDL<br><5% sample concentration | Flag with "C" |
| | LCS | 80% to 120% recovery | Flag with "o"[b] |
| | DUP[c] or MS/MSD[d] | ≤20% RPD | Review data[e] |
| | MS/MSD[d] | 75% to 125% recovery | Flag with "N" |

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

| Analyte[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| | EB, FTB | <MDL<br><5% sample concentration | Flag with "Q" |
| | Field duplicate[c] | ≤20% RPD | Review data[e] |
| Mercury by cold-vapor atomic absorption | MB | <MDL<br><5% sample concentration | Flag with "C" |
| | LCS | 80% to 120% recovery | Flag with "o"[b] |
| | DUP[c] or MS/MSD[d] | ≤20% RPD | Review data[e] |
| | MS/MSD[d] | 75% to 125% recovery | Flag with "N" |
| | EB, FTB | <MDL<br><5% sample concentration | Flag with "Q" |
| | Field duplicate[c] | ≤20% RPD | Review data[e] |
| **Volatile Organic Compounds** | | | |
| Volatile organics by gas chromatography/mass spectrometry | MB | <MDL[f]<br><5% sample concentration | Flag with "B" |
| | LCS | 70% to 130% recovery or<br>% recovery statistically derived[g] | Flag with "o"[b] |
| | DUP[c] or MS/MSD[d] | ≤20% RPD | Review data[e] |
| | MS/MSD[d] | 70% to 130% recovery | Flag with "T" |
| | SUR | 70% to 130% recovery | Review data[e] |
| | EB, FTB, FXR | <MDL[f]<br><5% sample concentration | Flag with "Q" |
| | Field duplicate[c] | ≤20% RPD | Review data[e] |
| **Semivolatile Organic Compounds** | | | |
| Phenols gas chromatography/mass spectrometry | MB | <MDL<br><5% sample concentration | Flag with "B" |
| | LCS | 70% to 130% recovery or<br>% recovery statistically derived[g] | Flag with "o"[b] |
| | DUP[c] or MS/MSD[d] | ≤20% RPD | Review data[e] |
| | MS/MSD[d] | % recovery statistically derived[g] | Flag with "T" |
| | SUR | % recovery statistically derived[g] | Review data[e] |
| | EB, FTB | <MDL<br><5% sample concentration | Flag with "Q" |
| | Field duplicate[c] | ≤20% RPD | Review data[e] |
| **Herbicides** | | | |
| Herbicides by gas chromatography | MB | <MDL<br><5% sample concentration | Flag with "B" |

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

| Analyte[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| | LCS | 70% to 130% recovery or % recovery statistically derived[g] | Flag with "o"[b] |
| | DUP[c] or MS/MSD[d] | ≤20% RPD | Review data[e] |
| | MS/MSD[d] | % recovery statistically derived[g] | Flag with "N" |
| | SUR | % recovery statistically derived[g] | Review data[e] |
| | EB, FTB | <MDL<br><5% sample concentration | Flag with "Q" |
| | Field duplicate[c] | ≤20% RPD | Review data[e] |
| **Pesticides** | | | |
| Pesticides by gas chromatography | MB | <MDL<br><5% sample concentration | Flag with "B" |
| | LCS | 70% to 130% recovery or % recovery statistically derived[g] | Flag with "o"[b] |
| | DUP[c] or MS/MSD[d] | ≤20% RPD | Review data[e] |
| | MS/MSD[d] | % recovery statistically derived[g] | Flag with "N" |
| | SUR | % recovery statistically derived[g] | Review data[e] |
| | EB, FTB | <MDL<br><5% sample concentration | Flag with "Q" |
| | Field duplicate[c] | ≤20% RPD | Review data[e] |
| **Other Drinking Water Suitability Parameters** | | | |
| Coliform | MB | Pass/Fail[h] | Review Data[e] |
| | LCS | Pass/Fail[h] | Review Data[e] |
| | DUP | Pass/Fail[h] | Review Data[e] |
| | EB, FTB | Pass/Fail[h] | Flage with "Q" |
| | Field Duplicate[c] | Pass/Fail[h] | Review Data[e] |
| Gross alpha | MB | <MDA<br><5% sample activity concentration | Flag with "B" |
| | LCS | 80 to 120% recovery or statistically derived limits[g] | Flag with "o"[b] |
| | DUP[c] | ≤20% RPD | Review data[e] |
| | EB, FTB | < MDA<br>< 5% sample activity concentration | Flag with "Q" |
| | Field Duplicate[c] | ≤20% RPD | Review data[e] |

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

| Analyte[a] | QC Element | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| Gross beta | MB | <MDA<br><5% sample activity concentration | Flag with "B" |
| | LCS | 80 to 120% recovery or statistically derived limits[g] | Flag with "o"[b] |
| | DUP[c] | ≤20% RPD | Review data[e] |
| | EB, FTB | < MDA<br>< 5% sample activity concentration | Flag with "Q" |
| | Field Duplicate[c] | ≤20% RPD | Review data[e] |
| Total Alpha Radium by Gas Flow Proportional Counting | MB | <MDA<br><5% sample activity concentration | Flag with "B" |
| | LCS | 80 to 120% recovery or statistically derived limits[g] | Flag with "o"[b] |
| | DUP[c] | ≤20% RPD | Review data[e] |
| | Carrier | 40%-110% recovery | Review data[e] |
| | EB, FTB | < MDA<br>< 5% sample activity concentration | Flag with "Q" |
| | Field Duplicate[c] | ≤20% RPD | Review data[e] |

Notes: The information in this table does not create U.S. Environmental Protection Agency or Washington State Department of Ecology requirements; it is intended solely as guidance.

This table applies only to laboratory analyses. Field measurements (e.g., specific conductance, pH, temperature, and turbidity) are not listed because they are measured in the field.

a. See Table A-3 for constituent list and analytical methods.
b. The reporting laboratory will apply the "o" flag with SMR group concurrence.
c. Applies when at least one result is greater than the laboratory PQL.
d. Either a DUP or an MS/MSD is to be analyzed to determine measurement precision (if there is insufficient sample volume, a laboratory control sample duplicate is analyzed with the acceptance criteria defaulting to the ≤20% RPD criteria).
e. After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck or flagging the data.
f. For the common laboratory contaminants acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the acceptance criterion is less than five times the MDL.
g. Laboratory-determined, statistically derived control limits based on historical data are used here. Control limits are reported with the data.
h. Passing QC; MB = no colonies detected, LCS = appropriate colonies detected, DUP = colonies detected/undetected are consistent with sample.

DUP = laboratory sample duplicate
EB = equipment blank
FTB = full trip blank
FXR = field transfer blank
LCS = laboratory control sample
MB = method blank
MDA = minimum detectable activity
MS = matrix spike
MSD = matrix spike duplicate
PQL = practical quantitation limit
QC = quality control
RPD = relative percent difference
SMR = Sample Management and Reporting
SUR = surrogate

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

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

MDL = method detection limit

Data Flags

B, C = possible laboratory contamination: analyte was detected in the associated method blank – laboratory applied. The B flag is used for organic analytes. The C flag is used for general chemical and inorganic analytes.

N = result may be biased: associated matrix spike result was outside the acceptance limits (except gas chromatograph/mass spectrometry) – laboratory applied.

o = result may be biased: associated laboratory control sample result was outside the acceptance limits – laboratory applied.

Q = problem with associated field QC blank: results were out of limits – SMR review.

T = result may be biased: associated matrix spike result was outside the acceptance limits (gas chromatograph/mass spectrometry only) – laboratory applied.

### A3.3.1 Field Quality Control Samples

Field QC samples are used to monitor the integrity of field samples during sample collection, transportation, storage, and laboratory analysis. Field QC samples are submitted to the analyzing laboratories as field samples. Field QC samples are analyzed for the same set of analytes as their corresponding field samples. Field QC samples include field duplicates, field split (SPLIT) samples, and field blanks (equipment blanks [EBs], field transfer blanks [FXRs], and full trip blanks [FTBs]). Field blanks are typically prepared to match the sample matrix as closely as possible using high-purity water[1]. The following describe the QC samples in more detail:

- **Equipment blanks:** EBs are used to monitor the effectiveness of the decontamination process for reusable sampling equipment. They are samples of high-purity water contacted with the sampling surfaces of equipment used to collect samples prior to using that equipment for field sampling. EBs are collected from each type of reusable sampling equipment to ensure that the decontamination procedures are effective for the specific equipment types. EBs will be analyzed for the same analytes as samples collected using that equipment. EB samples are not required for disposable sampling equipment.

- **Field duplicates:** Field duplicates provide information regarding the homogeneity of the sample matrix and the precision of the sampling and analysis processes. Field duplicates are two samples that are intended to be identical and are collected as close as possible in time and location. Each sample in the sample-duplicate pair receives its own unique sample number.

- **Field splits:** SPLITs are two samples that are intended to be identical and are collected as close as possible in time and location. SPLITs will be stored in separate containers and analyzed by different laboratories for the same analytes. SPLITs are interlaboratory comparison samples used to evaluate comparability between laboratories.

- **Field transfer blanks:** FXRs are used to document possible contamination during field acquisition of volatile organic compound (VOC) samples. FXRs are sample bottles (already containing any required sample preservative) filled at the sample collection site with high-purity water. The blank is sealed at the sampling site and becomes part of the sample set sent to the laboratory. FXRs are prepared daily

[1] High-purity water is generally defined as water that has been distilled, deionized, or any combination of distillation, deionization, reverse osmosis, activated carbon filtration, ion exchange, particulate filtration, or other polishing techniques.

for sites sampling for VOC analysis. Typically, one set of FXRs is prepared each day that VOC field samples are collected. If VOC samples are collected on the same day and shipped to multiple laboratories, a set of FXRs is collected for each analyzing laboratory.

- **Full trip blanks:** FTBs are used to monitor for potential sample contamination from the sampling container, preservation reagents, or storage conditions. FTBs are prepared high-purity water and sealed prior to traveling to the sampling site, transported to the sampling site (not opened in the field), and then shipped as part of the sample set to the laboratory. The bottle set is either for volatile organic analysis only or identical to the set that will be collected in the field. Collected FTBs are typically analyzed for the same constituents as the samples from the associated sampling event.

### A3.3.2 Laboratory Quality Control Samples

Internal QA/QC programs are maintained by laboratories used by the project and include the use of laboratory control samples (LCSs), laboratory sample duplicates (DUPs), matrix spikes (MSs), matrix spike duplicates (MSDs), method blanks (MBs), and surrogates (SURs), and carriers (for radionuclide analyses). These QC analyses follow EPA methods (e.g., those in the SW-846 Compendium). QC checks outside of control limits are documented in analytical laboratory reports and during a DQI evaluation. Descriptions of the various types of laboratory QC samples are as follows:

- **Laboratory control sample:** A control matrix (e.g., reagent water) spiked with analytes representative of the target analytes or a certified reference material that is used to evaluate laboratory accuracy.

- **Laboratory sample duplicate:** A second aliquot of a sample that is taken through the entire sample preparation and analytical process. DUPs are used to evaluate the precision of a method in a given sample matrix.

- **Matrix spike:** An aliquot of a sample spiked with a known concentration of target analyte(s) that is then taken through the entire sample preparation and analytical process. An MS is used to assess the bias of a method in a given sample matrix. Thus, MS results are an indicator of the effect the sample matrix has on the accuracy of measurement of the target analytes.

- **Matrix spike duplicate:** A replicate spiked aliquot of a sample that is subjected to the entire sample preparation and analytical process. MSD results are used to determine the bias and precision of a method in a given sample matrix.

- **Method blank:** An analyte-free matrix to which the same reagents are added in the same volumes or proportions as used in the sample processing. The MB is carried through the complete sample preparations and analytical process. The MB is used to quantify contamination resulting from the sample preparation and analysis.

- **Surrogate:** Used only in organic analyses, a compound added to every sample in the analysis batch (field samples and QC samples) prior to preparation. SURs are typically similar in chemical composition to the analyte being determined, but they are not normally encountered. SURs are expected to respond to the preparation and analytical process in a manner similar to the analytes of interest. Because SURs are added to every sample and QC sample, they are used to evaluate overall method performance in a given matrix.

- **Carrier:** Used only in radioanalytical analyses. Carriers are a known quantity of non-radioactive isotope that is expected to behave similarly and is added to an aliquot of sample. Sample results are generally corrected based on carrier recovery.

Samples are analyzed within the holding time guidelines provided in Table A-6. In some instances, constituents in the samples not analyzed within the holding times may be compromised by volatilization, decomposition, or other chemical changes. Data from samples analyzed outside of the holding times are flagged in the HEIS database with an "H."

**Table A-6. Preservation and Holding Time Guidelines for Laboratory Analyses**

| Constituent[a] | Preservation[b] | Holding Time |
|---|---|---|
| **General Chemistry** | | |
| Alkalinity | Store ≤6°C | 14 days |
| Sulfide | Store ≤6°C, adjust pH to > 9 with zinc acetate and sodium hydroxide | 7 days |
| Total organic carbon | Store <6°C, adjust pH to <2 with sulfuric acid or hydrochloric acid | 28 days |
| Total organic halogen | Store <6°C, adjust pH to <2 with sulfuric acid | 28 days |
| **Anions** | | |
| Chloride, Fluoride, Sulfate | Store ≤6°C | 28 days |
| Nitrate, Nitrite | Store ≤6°C | 48 hours |
| **Metals** | | |
| Metals by inductively coupled plasma-atomic emission spectrometry | Adjust pH to <2 with nitric acid | 6 months |
| Metals by inductively coupled plasma/mass spectrometry | Adjust pH to <2 with nitric acid | 6 months |
| Mercury by cold-vapor atomic absorption | Adjust pH to <2 with nitric acid | 28 days |
| **Volatile Organic Compounds** | | |
| Volatile organics by gas chromatography/mass spectrometry | Store ≤6°C, Adjust pH to <2 with sulfuric acid or hydrochloric acid | 7 days unpreserved<br>14 days maximum preserved |
| **Semivolatile Organic Compounds** | | |
| Phenols by gas chromatography/mass spectrometry | Store ≤6°C | 7 days before extraction<br>40 days after extraction |
| **Herbicides** | | |
| Herbicides | Store <6°C | 7 days before extraction<br>40 days after extraction |
| **Pesticides** | | |
| Pesticides | Store <6°C | 7 days before extraction<br>40 days after extraction |
| **Other Drinking Water Suitability Parameters** | | |
| Coliform | Store ≤6°C | 6 hours |

**Table A-6. Preservation and Holding Time Guidelines for Laboratory Analyses**

| Constituent[a] | Preservation[b] | Holding Time |
|---|---|---|
| Gross alpha/Gross beta | Adjust pH to <2 with nitric acid | 6 months |
| Total alpha radium by gas flow proportional counting | Adjust pH to <2 with nitric acid | 6 months |

Notes: Holding times and preservation methods are dependent on the constituent and are consistent with EPA guidance and approved analytical methods. Information in this table does not create EPA or Washington State Department of Ecologyrequirements but is intended solely as guidance.

The container type for a sample is available on the chain-of-custody documentation.

This table applies only to laboratory analyses. Field measurements (e.g., specific conductance, pH, dissolved oxygen [if applicable], temperature, and turbidity) are not listed because they are measured in the field.

a. See Table A-3 for constituent list and analytical methods.

b. For preservation identified as stored at ≤6°C, the sample should be protected against freezing unless it is known that freezing will not impact the sample integrity.

EPA = U.S. Environmental Protection Agency

## A3.4 Measurement Equipment

Each measuring equipment user will ensure that equipment is functioning as expected, properly handled, and properly calibrated per methods governing control of the measuring equipment. Onsite environmental instrument testing, inspection, calibration, and maintenance will be recorded according to approved methods. Field screening instruments will be used, maintained, and calibrated as provided in manufacturer specifications and other approved methods.

## A3.5 Instrument and Equipment Testing, Inspection, and Maintenance

Collection, measurement, and testing equipment will meet applicable standards (e.g., ASTM International, formerly the American Society for Testing and Materials) or have been evaluated as acceptable and valid according to instrument-specific methods and specifications. Software applications will be acceptance tested prior to use in the field. Measurement and testing equipment used in the field will be subject to preventive maintenance measures to minimize downtime.

## A3.6 Instrument/Equipment Calibration and Frequency

Field equipment calibration is discussed in Appendix B.

## A3.7 Inspection/Acceptance of Supplies and Consumables

Consumables, supplies, and reagents will be reviewed per test methods in the SW-846 Compendium and EPA/600 Method series (e.g., EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*) and will be appropriate for their use. Supplies and consumables used in sampling and analysis activities are procured under internal work processes. Supplies and consumables are checked and accepted by users prior to use.

## A3.8 Nondirect Measurements

Data obtained from sources such as computer databases, programs, literature files, and historical records will be evaluated by the staff member assigned by the Project Delivery Manager for Groundwater Science. Data used in evaluations will be identified by source. Historical data obtained from the HEIS database are usable for comparison to data collected by this groundwater monitoring plan.

## A3.9 Data Management

Records of data analyses and groundwater surface elevations are maintained as required by 40 CFR 265.94.

Electronic data access will be through a Hanford Site database (e.g., HEIS). Where electronic data are not available, hard copies will be provided.

# A4 Data Review and Usability

This chapter addresses QA activities that occur after data collection. Implementation of these activities determines whether the data conform to the specified criteria, thus satisfying the project objectives.

## A4.1 Data Review and Verification

Data review and verification are performed to confirm that field and field QC sampling and chain-of-custody documentation are complete. This review includes linking sample numbers to specific sampling locations, and reviewing sample collection dates and sample preparation and analysis dates to determine if holding times were met.

The criteria for verification include, but are not limited to, review for contractual compliance (samples were analyzed as requested), use of the correct analytical method, transcription errors, correct application of dilution factors, and the correct application of conversion factors. Data verification is typically conducted on a portion of multi-media samples collected across projects.

The staff member, assigned by the Project Delivery Manager for Groundwater Science, will also perform a data review to determine if observed changes reflect improved/degraded groundwater quality or potential data errors, which may result in a request for data review on questionable data. The laboratory may be asked to check calculations, reanalyze samples, or the well may be resampled. Results of the request for data review process are used to flag data in the HEIS database and to add comments.

## A4.2 Data Validation

Data validation is performed at the discretion of the Project Delivery Manager for Groundwater Science, under the direction of the SMR group. The decision to perform validation is based on the results of QC samples for individual well networks and discussions with the staff member assigned by the Project Delivery Manager for Groundwater Science. If conducted, data validation (third-party) will be performed at a minimum frequency of 5% per method. Data validation evaluates the analytical quality of data from samples specifically collected for this plan.

## A4.3 Reconciliation with User Requirements

The purpose of reconciliation with user requirements is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project data needs. For routine groundwater monitoring undertaken by projects, DQIs such as precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity for the specific datasets (individual data packages) will typically be evaluated on an annual basis. A DQI evaluation specific to data quality requirements specified in this plan may be performed at the discretion of the Project Delivery Manager for Groundwater Science. Results of the DQI evaluation(s) will be used by the Project Delivery Manager for Groundwater Science to interpret the data and determine if the data quality objectives for this activity have been met.

## A5 References

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# Appendix B

# Sampling Protocol

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# Terms

| | |
|---|---|
| DOE | U.S. Department of Energy |
| DOT | U.S. Department of Transportation |
| FWS | Field Work Supervisor |
| gpm | gallons per minute |
| HASQARD | *Hanford Analytical Services Quality Assurance Requirements Document* (DOE/RL-96-68) |
| IATA | International Air Transport Association |
| NTU | nephelometric turbidity unit |
| QA | quality assurance |
| QC | quality control |
| SMR | Sample Management and Reporting |

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## B1 Introduction

Groundwater monitoring at the Hanford Site, as defined by the *Resource Conservation and Recovery Act of 1976* and implemented in WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," has been conducted since the mid-1980's. Hanford Site groundwater sampling methods contain extensive requirements for sampling precautions to be taken; equipment and its use; cleaning and decontamination; records and documentation; and sample collection, management, and control activities. Together, Appendices A and B provide the sampling and analysis essentials necessary for the groundwater monitoring plan: sample collection, sample preservation and holding times, chain-of-custody control, analytical procedures, and field and laboratory quality assurance (QA)/quality control (QC).

This appendix provides more specific elements of the sampling protocols and techniques used for the groundwater monitoring plan. Chapter 3 of the groundwater monitoring plan identifies the monitoring wells that will be sampled, constituents to be analyzed for, and sampling frequency for the groundwater monitoring at the 216-A-36B.

## B2 Sampling Methods

Sampling may include, but is not limited to, the following methods:

- Field screening measurements
- Groundwater sampling
- Water level measurements

Groundwater samples will be collected in accordance with the current revision of applicable operating methods. Groundwater samples are collected after field measurements of purged groundwater have stabilized:

- **pH** – two consecutive measurements agree within 0.2 pH units
- **Temperature** – two consecutive measurements agree within 0.2°C (32.3°F)
- **Conductivity** – two consecutive measurements agree within 10 percent of each other
- **Turbidity** – less than 5 nephelometric turbidity units (NTUs) prior to sampling (or project scientist's recommendation)

Unless any special requirements are requested from project scientists, wells are typically purged using the equivalent volume as that of three borehole diameters multiplied by the length of the saturated portion of the well screen. Stable field readings are also required (as specified above). The default pumping rate is 7.6 to 45.4 L/min (2 to 12 gallons per minute [gpm]) depending on the pump, although this is not practical at every well. On occasions when the purge volume is extraordinarily large, wells are purged for a minimum of 1 hour and are then sampled once stable field readings are obtained.

Field measurements (except for turbidity) are obtained using a flow-through cell. Groundwater is pumped directly from the well to the flow-through cell. At the beginning of the sample event, field crews attach a clean, stainless-steel sampling manifold to the riser discharge. The manifold has two valves and two ports: one port is used only for purgewater, and the other port is used to supply water to the flow-through cell. Probes are inserted into the flow-through cell to measure pH, temperature, and conductivity. Turbidity is measured by inserting a sample vial into a turbidimeter. The purgewater is then discharged to the purgewater truck.

Once field measurements have stabilized, the hose supplying water to the flow-through cell is disconnected and a clean, stainless-steel drop leg is attached for sampling. The flow rate is reduced during sampling to minimize loss of volatiles (if any) and prevent over filling the bottles. Sample bottles are filled in a sequence designed to minimize loss of volatiles (if any). Filtered samples are collected after collection of the unfiltered samples. For some constituents (e.g., metals), both filtered and unfiltered samples are collected. If additional samples require filtration (e.g., at turbidity greater than 5 NTUs), an inline, disposable 0.45 µm filter is used.

Typically, three traditional types (i.e., Grundfos[1], Hydrostar[2], and submersible electrical pumps) of environmental-grade sampling pumps are used for groundwater sampling at Hanford Site monitoring wells. In addition, low-purge-volume, adjustable-rate bladder pumps may be used. Individual pumps are selected based on the unique characteristics of the well and the sampling requirements.

A small number of wells will not support pumping of samples because of low yield or the physical characteristics of the well. In these cases, a grab sample may be obtained. In cases where there is not sufficient yield, purgewater activities are not performed.

Low-purge-volume sampling methodology for the collection of groundwater samples is also being implemented at the Hanford Site. Low-flow purging and sampling uses a low-purge-volume, adjustable-rate bladder pump with flow rates typically on the order of 0.1 to 0.5 L/min (0.26 to 0.13 gpm). This methodology is intended to minimize excessive movement of water from the soil formation into the well. The objective is to pump in a manner that minimizes stress (drawdown) to the system. Purge volumes for wells using low-purge bladder pumps are determined on a well-specific basis based on drawdown, pumping rate, pump and sample line volume, and volume required to obtain stable field conditions prior to collecting samples.

For certain types of samples, preservatives are required. Preservatives, based on the analytical methods used, are added to the collection bottles before their use in the field. Samples may require filtering in the field, as noted on the chain-of-custody form.

To ensure sample and data usability, sampling associated with this groundwater monitoring plan will be performed in accordance with the requirements of DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD), pertaining to sample collection, collection equipment, and sample handling.

Sample preservation and holding time requirements are specified for groundwater samples in Appendix A, Table A-6. These requirements are in accordance with the analytical method specified in Appendix A, Table A-3. The container type, preservatives, and volumes will be identified on the chain-of-custody form. This groundwater monitoring plan defines a sample as a filled sample bottle for purposes of starting the clock for holding time restrictions.

Holding time is the maximum allowable period between sample collection and analysis. Exceeding required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Required holding times depend on the constituent and are listed in analytical method compilations such as APHA AWWA/WEF, 2012, *Standard Methods for the Examination of Water and Wastewater*; and SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition; Final Update V*. Recommended holding times are also provided in HASQARD (DOE/RL-96-68) and in applicable laboratory contracts.

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[1] Grundfos® is a registered trademark of Grundfos Holding A/S Corporation, Bjerringbro, Denmark.
[2] Hydrostar® is a registered trademark of KYB Corporation, Tokyo, Japan.

### B2.1 Decontamination of Sampling Equipment

Sampling equipment will be decontaminated in accordance with sampling equipment decontamination methods. To prevent potential contamination of the samples, care should be taken to use decontaminated equipment for each specific sampling activity.

Special care should be taken to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting the equipment/sample bottle on or near potential contamination sources (e.g., uncovered ground)
- Handling bottles or equipment with dirty hands or gloves
- Improperly decontaminating equipment before sampling or between sampling events

Decontamination of sampling equipment and pumps is performed using high-purity water[3] in each step. In general, three rinse cycles are performed to decontaminate sampling equipment: a detergent rinse, an acid rinse, and a water rinse. During the detergent rinse, the equipment is washed in a phosphate-free detergent solution, followed by rinsing with water in three sequential containers. After the third water rinse, equipment that is stainless-steel or glass is rinsed in a 1M nitric acid solution (pH less than 2). Equipment is then rinsed with water in three sequential containers (the water rinses following the acid rinse are conducted in separate water containers that are not used for detergent rinse). Following the final water rinse, equipment is rinsed in hexane and then placed on a rack to dry. Dry equipment is loaded into a drying oven. The oven is set at 50°C (122°F) for items that are not metal or glass or at 100°C (212°F) for metal or glass. Once reaching temperature, equipment is baked for 20 minutes and then cooled. The equipment is then removed from the oven, and the equipment is enclosed in clean, unused aluminum foil using surgeon's gloves. The wrapped equipment is stored in a custody-locked, controlled-access area.

To decontaminate sampling pumps that are not permanently installed, the pump cowling is first removed, washed (if needed) in phosphate-free detergent solution, and then reinstalled on the pump. The pump is then submerged in phosphate-free detergent solution, and 11.4 L (3 gal) of solution is pumped through the unit and disposed. Detergent solution is then circulated through the submerged pump for 5 minutes. The pump is removed from solution and rinsed with water. The pump is submerged in water and 30.3 L (8 gal) of water is pumped through the unit and disposed. The pump is removed from the water and the intake and housing are covered with plastic sleeving. The cleaning is documented on a tag that is affixed to the pump, and the tag will include the following information:

- Date pump cleaned
- Pump identification
- Comments
- Signature of person performing decontamination

[3] High-purity water that is generally defined as water that has been distilled, deionized, or any combination of distillation, deionization, reverse osmosis, activated carbon filtration, ion exchange, particulate filtration, or other polishing techniques (DOE/RL-96-68).

### B2.2 Water Levels

Each time a sample is obtained, measurement of the ground water surface elevation at each monitoring well is required by 40 CFR 265.92(e), "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis." Using a calibrated depth measurement tape, the depth to water is recorded in each well prior to sampling. When two consecutive measurements are taken that agree within 6 mm (0.24 in.); the final determined measurement is recorded, along with the date and time for the specific event. The depth to groundwater is subtracted from the elevation of a reference point (usually the top of the casing) to obtain the water level elevation. The top of the casing is a known elevation reference point because it has been surveyed to local reference data.

## B3 Documentation of Field Activities

Logbooks or data forms are required for field activities and will be used in accordance with HASQARD (DOE/RL-96-68) requirements. A logbook must be identified with a unique project name and number. The individual(s) responsible for logbooks will be identified in the front of the logbook, and only authorized persons may make entries in logbooks. Logbook entries will be reviewed by the sampling Field Work Supervisor (FWS), cognizant scientist/engineer, or other responsible manager; the review will be documented with a signature and date. Logbooks will be permanently bound, waterproof, and ruled with sequentially numbered pages. Pages will not be removed from logbooks for any reason. Entries will be made in indelible ink. Corrections will be made by marking through the erroneous data with a single line, entering the correct data, and initialing and dating the changes.

Data forms may be used to collect field information; however, information recorded on data forms must follow the same requirements as those for logbooks. The data forms must be referenced in the logbooks.

A summary of information to be recorded in logbooks or on data forms is as follows:

- Day and date; time task started; weather conditions; and names, titles, and organizations of personnel performing the task.
- Purpose of visit to the task area.
- Site activities in specific detail (e.g., maps and drawings) or the forms used to record such information (e.g., soil boring log or well completion log). Also, details of any field tests that were conducted; reference to any forms that were used, other data records, and methods followed in conducting the activity.
- Details of any field calibrations and surveys that were conducted. Reference any forms that were used, other data records, and the methods followed in conducting the calibrations and surveys.
- Details of any samples collected and the preparation (if any) of splits, duplicates, matrix spikes, or blanks. Reference the methods followed in sample collection or preparation; list location of sample collected, sample type, each label or tag numbers, sample identification, sample containers and volume, preservation method, packaging, chain-of-custody form number, and analytical request form number pertinent to each sample or sample set; and note the time and the name of the individual to whom custody of samples was transferred.
- Time, equipment type, serial or identification number, and methods followed for decontaminations and equipment maintenance performed. Reference the page number(s) of any logbook where detailed information is recorded.

- Any equipment failures or breakdowns that occurred, with a brief description of repairs or replacements.

### B3.1 Corrective Actions and Deviations for Sampling Activities

The Project Delivery Manager for Groundwater Science, FWS, appropriate field crew supervisors, and Sample Management and Reporting (SMR) personnel must document deviations from protocols, issues pertaining to sample collection, chain-of-custody forms, target analytes, contaminants, sample transport, or noncompliant monitoring. Examples of deviations include samples not collected due to field conditions.

As appropriate, such deviations or issues will be documented (e.g., in the field logbook) in accordance with internal corrective action methods. The Project Delivery Manager for Groundwater Science, FWS, field crew supervisors, or SMR personnel will be responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities.

Changes in sample activities that require notification, approval, and documentation will be performed as specified in Appendix A, Table A-2.

## B4 Calibration of Field Equipment

Onsite environmental instruments are calibrated in accordance with the manufacturer's operating instructions, internal work requirements and processes, and/or field instructions that provide direction for equipment calibration or verification of accuracy by analytical methods. Calibration records shall include the raw calibration data, identification of the standards used, associated reports, date of analysis, and analyst's name or initials. The results from all instrument calibration activities are recorded in accordance with the HASQARD requirements (DOE/RL-96-68).

Field instrumentation, calibration, and QA checks will be performed as follows:

- Prior to initial use of a field analytical measurement system.
- At the frequency recommended by the manufacturer or methods, or as required by regulations.
- Upon failure to meet specified QC criteria.
- Daily calibration checks will be performed and documented for each instrument used. These checks will be made on standard materials sufficiently like the matrix under consideration for direct comparison of data. Analysis times will be sufficient to establish detection efficiency and resolution.
- Using standards for calibration that are traceable to a nationally recognized standard agency source or measurement system. Manufacturer's recommendations for storage and handling of standards (if any) will be followed.

## B5 Sample Handling

Sample handling and transfer will be in accordance with established methods to preclude loss of identity, damage, deterioration, and loss of sample. Custody seals or custody tape will be used to verify that sample integrity has been maintained during sample transport. The custody seal will be inscribed with the sampler's initials and date.

A sampling and analytical database is used to track samples from the point of collection through the laboratory analysis process.

### B5.1 Containers

Samples shall be collected, where and when appropriate, in break-resistant containers. The field sample collection record shall indicate the laboratory lot number of the bottles used in sample collection. When commercially pre-cleaned containers are used in the field, the name of the manufacturer, lot identification, and certification shall be retained for documentation.

Containers shall be capped and stored in an environment that minimizes the possibility of sample container contamination. If contamination of the stored sample containers occurs, corrective actions shall be implemented to prevent reoccurrences. Contaminated sample containers cannot be used for a sampling event. Container sizes may vary depending on laboratory-specific volumes/requirements for meeting analytical detection limits. Container types and sample amounts/volumes are identified on the chain-of-custody form.

### B5.2 Container Labeling

Each sample is identified by affixing a standardized label or tag to the container. This label or tag shall contain the sample identification number. The label shall identify or provide reference to associate the sample with the date and time of collection, preservative used (if applicable), analysis required, and collector's name or initials. Sample labels may be either preprinted or handwritten in indelible or waterproof ink.

### B5.3 Sample Custody

Sample custody will be maintained in accordance with existing protocols to ensure that sample integrity is maintained throughout the analytical process. Chain-of-custody protocols will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to any laboratory.

Shipping requirements will determine how sample shipping containers are prepared for shipment. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Each time the responsibility for custody of the sample changes, new and previous custodians will sign the record and note the date and time. ~~The field sampling team will make a copy of the signed record before sample shipment and transmit the copy to the SMR group.~~

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The following minimum information is required on a completed chain-of-custody form:

- Project name
- Collectors' names
- Unique sample number
- Date and time of collection
- Matrix
- Preservatives
- Chain of possession information (i.e., signatures and printed names of each individual involved in the transfer of sample custody and storage locations, and dates/times of receipt and relinquishment)
- Requested analyses (or reference thereto)

- Shipped-to information (i.e., analytical laboratory performing the analysis)

Samplers should note any anomalies with the samples. If anomalies are found, samplers should inform the SMR group; so special direction for analysis can be provided to the laboratory if deemed necessary.

### B5.4 Sample Transportation

Packaging and transportation instructions shall comply with applicable transportation regulations and U.S. Department of Energy (DOE) requirements. Regulations for classifying, describing, packaging, marking, labeling, and transporting hazardous materials, hazardous substances, and hazardous wastes are enforced by the U.S. Department of Transportation (DOT) as described in 49 CFR 171, "Transportation," "General Information, Regulations, and Definitions," through 49 CFR 177, "Carriage by Public Highway." [4] Carrier-specific requirements defined in the current edition of International Air Transport Association (IATA) *Dangerous Goods Regulations* shall also be used when preparing sample shipments conveyed by air freight providers.

Samples containing hazardous constituents shall be considered hazardous material in transportation and transported according to DOT/IATA requirements. If the sample material is known or can be identified, then it will be classified, described, packaged, marked, labeled, and shipped according to the specific instructions for that material. Appropriate laboratory notifications will be made, if necessary, through the SMR project coordinator.

## B6 Management of Waste

Waste materials are generated during sample collection, processing, and subsampling activities. Waste will be managed in accordance with DOE/RL-2004-18, *Waste Control Plan for the 200-PO-1 Operable Unit.* For waste designation purposes, wells listed in Table 3-1 in the main text of the monitoring plan may be surveyed in the Hanford Environmental Information System and the maximum concentration for each analyte within the most recent 5 years will be evaluated for use in creating a waste profile, if required.

Miscellaneous solid waste that has contacted suspect dangerous waste will be managed as dangerous waste. Purgewater and decontamination fluids will be collected and managed in accordance with DOE/RL-2011-41, *Hanford Site Strategy for Management of Investigation Derived Waste*; and DOE/RL-2009-80, *Investigation Derived Waste Purgewater Management Work Plan*. Waste materials requiring collection will be placed in containers appropriate for the material and the receiving facility in accordance with the applicable waste management or waste control plan and applicable substantive federal and/or state requirements.

Packaging and labeling during waste storage and transportation will meet WAC 173-303 and DOT requirements, as appropriate. Packaging exceptions to DOT requirements may be used for onsite waste shipments if documented as such and if the packaging provides an equivalent degree of safety during transportation.

Offsite analytical laboratories are responsible for the disposal of unused sample quantities.

[4] Transportation regulations 49 CFR 174, "Carriage by Rail," and 49 CFR 176, "Carriage by Vessel," are not applicable, as these two transportation methods are not used.

## B7 Health and Safety

DOE established the hazardous waste operations safety and health program pursuant to the *Price-Anderson Amendments Act of 1988* to ensure the safety and health of workers involved in mixed-waste site activities. The program was developed to comply with the requirements of 10 CFR 851, "Worker Safety and Health Program," which incorporates the standards of 29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response"; 10 CFR 830, "Nuclear Safety Management"; and 10 CFR 835, "Occupational Radiation Protection. The health and safety program defines the chemical, radiological, and physical hazards and specifies the controls and requirements for daily work activities on the overall Hanford Site. Personnel training; control of industrial safety and radiological hazards; personal protective equipment; site control; and general emergency response to spills, fire, accidents, injury, site visitors, and incident reporting are governed by the health and safety program.

## B8 References

10 CFR 830, "Nuclear Safety Management," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=47e3de0454360a17406cb89ade0c966d&mc=true&node=pt10.4.830&rgn=div5.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations.* Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=57ef404ac6f4734a67fd97302b2d7f7f&node=pt10.4.835&rgn=div5.

10 CFR 851, "Worker Safety and Health Program," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=47e3de0454360a17406cb89ade0c966d&mc=true&node=pt10.4.851&rgn=div5.

29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response," *Code of Federal Regulations*. Available at: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9765.

40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis," *Code of Federal Regulations*. Available at: http://www.ecfr.gov/cgi-bin/text-idx?SID=fc3e30d2a24de032666c2de7ddb46f1b&mc=true&node=se40.26.265_192&rgn=div8.

49 CFR, "Transportation," *Code of Federal Regulations*. Available at:http://www.ecfr.gov/cgi-bin/text-idx?gp=&SID=4eee73b085f2533d72722864dbca949a&mc=true&tpl=/ecfrbrowse/Title49/49CIsubchapC.tpl.

49 CFR 171, "General Information, Regulations, and Definitions."

49 CFR 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans."

49 CFR 173, "Shippers-General Requirements for Shipments and Packagings."

49 CFR 175, "Carriage by Aircraft."

49 CFR 177, "Carriage by Public Highway."

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http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL1-04.pdf.
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http://www.hanford.gov/files.cfm/DOE-RL-96-68-VOL3-04.pdf.
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*Price-Anderson Amendments Act of 1988*, Pub. L. 100-408, Aug. 20, 1988, 102 Stat. 1066, 42 USC 2010, et seq. Available at: http://www.gpo.gov/fdsys/pkg/STATUTE-102/pdf/STATUTE-102-Pg1066.pdf.

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

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173-303-400, "Interim Status Facility Standards."

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# Appendix C

# Well Construction

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# Tables

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# C1 Introduction

This appendix provides the following information for the 216-A-36B groundwater monitoring wells:

- Well name
- Hydrogeologic unit to be monitored (the portion of the aquifer that is located at the well screen or perforated casing) (Table C-1)
- The following sampling interval information, as shown in Table C-2:
  - Elevation at top of the screen or perforated interval
  - Elevation at the bottom of the screen or perforated interval
  - Open interval length (i.e., difference between elevations of top and bottom of the screen or perforated interval)

Figures C-1 through C-6 provide the well construction and completion summary for both upgradient and downgradient wells selected for the 216-A-36B well monitoring network.

**Table C-1. Hydrogeologic Monitoring Unit Classification Scheme**

| Unit | Description |
|---|---|
| TU | **Top of Unconfined.** Screened across the water table or the top of the open interval is within 1.5 m (5 ft) of the water table, and the bottom of the open interval is no more than 10.7 m (35 ft) below the water table. |

**Table C-2. Sampling Interval Information for Wells within the 216-A-36B Network**

| Well or Aquifer Tube Name | Hydrogeologic Unit Monitored | Elevation Top of Open Interval (m [ft] NAVD88) | Elevation Bottom of Open Interval (m [ft] NAVD88) | Open Interval Length (m [ft]) |
|---|---|---|---|---|
| 299-E17-1 | TU | 127.16 (416.93) | 118.01 (386.93) | 9.15 (30.0) |
| 299-E17-19 | TU | 126.74 (415.55) | 119.85 (392.96) | 6.89 (22.6) |
| 299-E17-14 | TU | 125.89 (412.74) | 119.18 (390.74) | 6.71 (22.0) |
| 299-E17-15 | TU | 125.77 (412.35) | 119.52 (391.86) | 6.25 (20.5) |
| 299-E17-16 | TU | 125.64 (411.92) | 119.24 (390.93) | 6.40 (21.0) |
| 200-E17-18 | TU | 125.70 (412.13) | 118.86 (389.70) | 6.84 (22.4) |

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

Note: See Table 3-4 for depth of remaining water column.

TU = Top of Unconfined, as described in Table C-1

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Row/Richards
Drilling Company: Not documented
Date Started: 15Nov55

Sample Drive barrel Method: Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 28Dec55

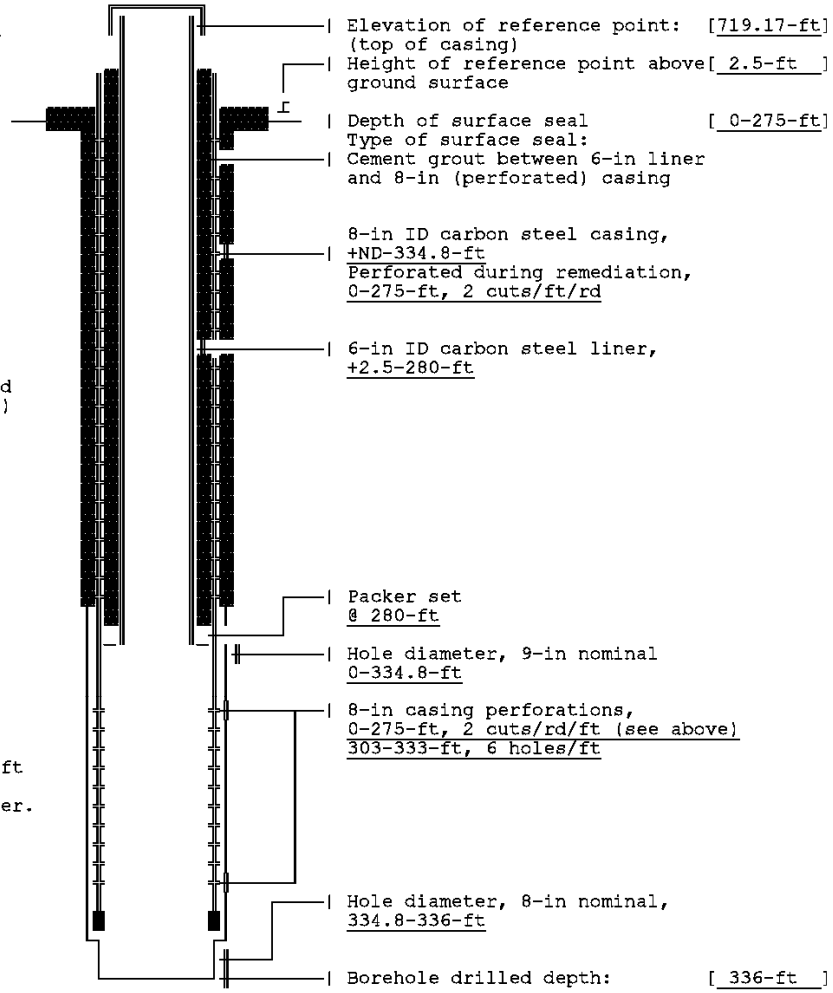
WELL NUMBER: 299-E17-1
TEMPORARY WELL NO: 216 A-10 #1
Hanford Coordinates: N/S N 39,053.2 E/W W 48,942.0
State Coordinates: N 444,229 E 2,246,283
Start Card #: Not documented T____ R____ S_____
Elevation Ground surface: 716.7-ft Estimated

Depth to water: 323-ft Dec55
(Ground surface) 315.8-ft 22Jun93

GENERALIZED STRATIGRAPHY — Driller's Log

0-160: SAND
160-180: SILT-SAND
180-220: SAND
220-255: SAND, some SILT
255-275: SAND
275-285: SAND and GRAVEL
285-290: SAND-SILT
290-295: SILT, heavy SAND
295-300: SILT, SAND and GRAVEL
300-305: GRAVEL
305-314: GRAVEL and SAND
314-315: Pure GRAVEL
315-327: GRAVEL-SAND
(Stuck tools, retrieved and sidetracked hole @ 320-ft)
327-335: Not documented
335-336: Clean GRAVEL

REMEDIATION:
Dec81-Feb82 by D. Garcia?
Perforated 0-275-ft, 2 cuts/rd/ft
Placed 6-in liner to to 280-ft top-of-casing. Assumed on packer.
Placed 10-gals sand, 518-gals cement grout.
DTB, 324-ft, DTW, 312-ft.




Drawing By: RKL/2E17-01.ASB
Date : 03Sep93
Reference : HANFORD WELLS

**Figure C-1. Well 299-E17-1 Construction and Completion Summary (page 1 of 2)**

```
                    SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
                            RESOURCE PROTECTION WELL - 299-E17-1

WELL DESIGNATION     :    299-E17-1
RCRA FACILITY        :    Not applicable
CERCLA UNIT          :    200 Aggregate Area Management Study
HANFORD COORDINATES  :    N   39,053.2  W    48,942.05 [03Mar88-200East]
LAMBERT COORDINATES  :    N  444,229    E 2,246,283    [HANCONV]
DATE DRILLED         :    Dec55
DEPTH DRILLED  (GS)  :    336-ft
MEASURED DEPTH (GS)  :    Not documented
DEPTH TO WATER (GS)  :    323-ft, Dec60;
                          315.4-ft, 22Jun93
CASING DIAMETER      :    8-in, carbon steel, +~2.0-334.8-ft
                          6-in, carbon steel, +2.5-280.0-ft
ELEV TOP CASING      :    719.17-ft, [03Mar88-200E]
ELEV GROUND SURFACE  :    716.7-ft, Estimated
PERFORATED INTERVAL  :    0-275 and 303-333-ft
SCREENED INTERVAL    :    Not applicable
COMMENTS             :    FIELD INSPECTION, 06Feb90,
                          6 and 8-in carbon steel casing.
                          2-ft concrete pad, no posts, capped and locked.
                          ID stamped on brass cap in pad.
                          Not in radiation zone.  Hole in casing.
AVAILABLE LOGS       :    Driller
TV SCAN COMMENTS     :    Not applicable
DATE EVALUATED       :    Not applicable
EVAL RECOMMENDATION  :    Not applicable
LISTED USE           :    A10/A-36 Crib quarterly water level measurement, 01May73-22Jun93;
CURRENT USER         :    WHC ES&M w/l monitoring, WHC ES&M RCRA sampling,
                          PNL sitewide sampling 93
PUMP TYPE            :    Electric submersible
MAINTENANCE          :
```

**Figure C-1. Well 299-E17-1 Construction and Completion Summary (page 2 of 2)**

WELL CONSTRUCTION AND COMPLETION SUMMARY

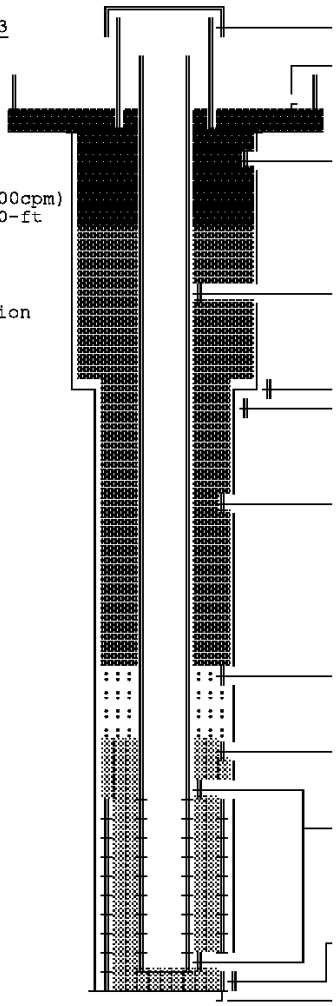
Drilling Method: Cable tool
Drilling Fluid Used: 200 W Water Supply
Driller's Name: F. Murphy/C. Walmsley
Drilling Company: Kaiser Engineers
Date Started: 02Aug88
Sample Method: Drive barrel Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 19Sep88

WELL NUMBER: 299-E17-19
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 39,147.1 E/W W 48,810.4
State Coordinates: N 444,324 E 2,246,415
Start Card #: Not documented T R S
Elevation Ground surface: 716.38-ft (Brass cap)

Depth to water: 311.1-ft Oct88
(Ground surface)315.2-ft 22Jun93

GENERALIZED STRATIGRAPHY Log
Geologist's
Sl=slightly

0-15: Silty SAND
15-20: Sl gravelly SAND
20-70: SAND
(Contamination @58-ft=1,000cpm)
(Nonflammable organics @70-ft also rad contamination)
70-76: Sl gravelly SAND
76-85: SAND
85-100: Sl silty SAND
(Organic & rad contamination @90-190-ft)
100-115: SAND
115-120: Sl gravelly SAND
120-135: SAND
135-140: Sl gravelly SAND
140-255: SAND
255-265: Sl gravelly SAND
265-270: Gravelly SAND
270-275: Sandy GRAVEL
275-290: SAND
290-295: SILT
295-305: Silty SAND
305-315: Silty sandy GRAVEL
315-326.7: Sandy GRAVEL



Elevation of reference point: [719.33-ft] (top of casing)
Height of reference point above ground surface [ 2.95-ft ]
Depth of surface seal [2.5-19.2-ft]
Type of surface seal: Cement grout to 19.2-ft, has 4-ftx4-ftx6-in concrete pad extending 2.5-ft into annulus
4-in ID stainless steel casing, ~+0.5-ft-304.0-ft
Hole diameter, 0-168.2-ft, 11-in nominal
168.2-333.5-ft, 9-in nominal
Bentonite crumbles 19.2-288.7-ft
¼-in bentonite pellets, 288.7-297.0-ft
Silica sand pack, 297.0-326.7-ft, 16-30-mesh
4-in ID stainless steel screen, 304.0-324.4-ft, #10-slot
8-in stainless steel telescoping screen, 306.3-326.6-ft, #20-slot
Borehole drilled depth: [ 326.7-ft]

Drawing By: RKL/2E17-19.ASB
Date : 03Sep93
Reference :

**Figure C-2. Well 299-E17-19 Construction and Completion Summary (page 1 of 2)**

```
                    SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
                          RESOURCE PROTECTION WELL - 299-E17-19

WELL DESIGNATION     :    299-E17-19
CERCLA UNIT          :    200 Aggregate Area Management Study
RCRA FACILITY        :    216-A-10 Crib
HANFORD COORDINATES  :    N   39,147.1  W    48,810.4 [28Oct88-200E]
LAMBERT COORDINATES  :    N  444,324    E 2,246,415   [HANCONV]
DATE DRILLED         :    Sep88
DEPTH DRILLED  (GS)  :    326.7-ft
MEASURED DEPTH (GS)  :    Not documented
DEPTH TO WATER (GS)  :    311.1-ft, Oct88;
                          315.2-ft, 22Jun93
CASING DIAMETER      :    4-in stainless steel, ~+0.5-304.0-ft;
                          6-in stainless steel, +2.95-~0.5-ft
ELEV TOP CASING      :    719.33-ft,           [28Oct88-200E]
ELEV GROUND SURFACE  :    716.38-ft, Brass cap [28Oct88-200E]
PERFORATED INTERVAL  :    Not applicable
SCREENED INTERVAL    :    304.0-324.4-ft, 4-in #10-slot stainless steel;
                          306.3-326.6-ft, 8-in telescoping, #20-slot
COMMENTS             :    FIELD INSPECTION, 06Feb90;
                          Stainless steel casing.  4-ft by 4-ft concrete pad, 4 posts, 1 removable
                          capped and locked, brass cap in pad with well ID.
                          Not in radiation zone.
                          OTHER:
AVAILABLE LOGS       :    Geologist, driller
TV SCAN COMMENTS     :    Not applicable
DATE EVALUATED       :    Not applicable
EVAL RECOMMENDATION  :    Not applicable
LISTED USE           :    A10/A36 Cribs quarterly water level measurement, 11Oct88-22Jun93;
CURRENT USER         :    WHC ES&M w/l monitoring and RCRA sampling,
                          PNL sitewide sampling 93
PUMP TYPE            :    Hydrostar
MAINTENANCE          :
```

**Figure C-2. Well 299-E17-19 Construction and Completion Summary (page 2 of 2)**

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200 W Water Supply
Driller's Name: L. Watkins
Drilling Company: Kaiser Engineers
Date Started: 22Mar88

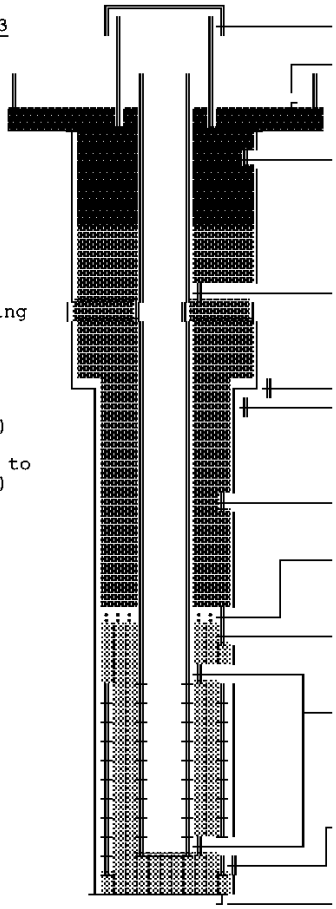
Sample Drive barrel Method: Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 19May88

WELL NUMBER: 299-E17-14
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,879.7 E/W W 48,406.2
State Coordinates: N 444,058 E 2,246,819
Start Card #: Not documented T R S
Elevation Ground surface: 719.10-ft (Brass cap)

Depth to water: 313.7-ft Jun88
(Ground surface) 317.3-ft 22Jun93

GENERALIZED STRATIGRAPHY Log
Geologist's
Sl=slightly

0-5: Sandy SILT
5-10: Cse-med SAND
10-15: Sl gravelly SAND
15-50: Cse-med SAND
50-55: Sl gravelly SAND
55-65: Cse-med SAND
65-70: Sl gravelly SAND
70-107: SAND
107-109: Silty SAND
109-190: SAND (Some $CaCO_3$ cementing 175-190-ft)
190-195: Sl gravelly SAND
195-240: SAND (Poorly developed CALICHE @ 230-ft)
240-245: Silty SAND (Ammonia vapors from well)
245-250: SAND
250-255: Silty gravelly SAND (Up to 1,000ppm ammonia vapors)
255-265: Gravelly SAND
265-285: SAND (No ammonia)
285-290: Sandy SILT
290-295: Gravelly SAND
295-300: Sl silty gravelly SAND (Positive ammonia)
300-310: Silty sandy GRAVEL
310-315: Sandy GRAVEL
315-320: Silty sandy GRAVEL
320-335: Sandy GRAVEL



Elevation of reference point: [722.18-ft] (top of casing)
Height of reference point above ground surface [3.08-ft]
Depth of surface seal [1.5-20-ft]
Type of surface seal: Cement grout to 20-ft, has 4-ftx4-ftx6-in concrete pad extending 1.5-ft into annulus
4-in ID stainless steel casing, ~+1.9-309.5-ft
Hole diameter, 0-141.7-ft, 11-in nominal; 141.7-335-ft, 9-in nominal
Granular bentonite, 20-298-ft
Bentonite pellets, 298-301-ft
Silica sand, 302-335-ft, 10-20-mesh
4-in ID stainless steel screen 309.5-330.1-ft, #20-slot
8-in stainless steel telescoping screen, 311.6-321.5-ft, #30-slot; 321.5-331.5-ft, #10-slot
Borehole drilled depth: [335.0-ft]

Drawing By: RKL/2E17-14.ASB
Date : 03Sep93
Reference :

**Figure C-3. Well 299-E17-14 Construction and Completion Summary (page 1 of 2)**

```
                    SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
                          RESOURCE PROTECTION WELL - 299-E17-14

WELL DESIGNATION     :    299-E17-14
CERCLA UNIT          :    200 Aggregate Area Management Study
RCRA FACILITY        :    216-A-36B Crib
HANFORD COORDINATES  :    N   38,879.7  W    48,406.2 [10Jun88-200E]
LAMBERT COORDINATES  :    N  444,058    E 2,246,819   [HANCONV]
DATE DRILLED         :    May88
DEPTH DRILLED  (GS)  :    335.0-ft
MEASURED DEPTH (GS)  :    Not documented
DEPTH TO WATER (GS)  :    313.7-ft, Jun88;
                          317.3-ft, 22Jun93
CASING DIAMETER      :    4-in stainless steel, ~+1.9-309.5-ft;
                          6-in stainless steel, +3.1-~0.5-ft
ELEV TOP CASING      :    722.18-ft,           [10Jun88-200E]
ELEV GROUND SURFACE  :    719.10-ft, Brass cap [10Jun88-200E]
PERFORATED INTERVAL  :    Not applicable
SCREENED INTERVAL    :    309.5-330.1-ft, 4-in #20-slot stainless steel;
                          311.6-331.5-ft, 8-in telescoping, #10 and 30-slot
COMMENTS             :    FIELD INSPECTION, 06Feb90;
                          Stainless steel casing.  4-ft by 4-ft concrete pad, 4 posts, 1 removable
                          capped and locked, brass cap in pad with well ID.
                          Not in radiation zone.
                          OTHER:
AVAILABLE LOGS       :    Geologist, driller
TV SCAN COMMENTS     :    Not applicable
DATE EVALUATED       :    Not applicable
EVAL RECOMMENDATION  :    Not applicable
LISTED USE           :    A10/A36 quarterly water level measurement, 31May88-22Jun93;
CURRENT USER         :    WHC ES&M w/l monitoring and RCRA sampling,
                          PNL sitewide sampling 93
PUMP TYPE            :    Hydrostar
MAINTENANCE          :
```

**Figure C-3. Well 299-E17-14 Construction and Completion Summary (page 2 of 2)**

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200 W Water Supply
Driller's Name: C. Wamsley
Drilling Company: Kaiser Engineers
Date Started: 17Mar88

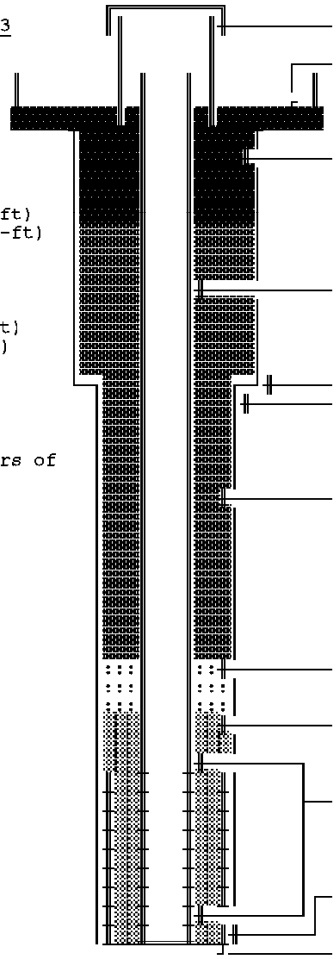
Sample Method: Drive barrel Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 16May88

WELL NUMBER: 299-E17-15
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,710.2 E/W W 48,399.6
State Coordinates: N 443,879 E 2,246,826
Start Card #: Not documented T R S
Elevation Ground surface: 718.70-ft (Brass cap)

Depth to water: 312.8-ft May88
(Ground surface)317.8-ft 22Jun93

GENERALIZED STRATIGRAPHY Log
Geologist's
Sl=slightly

0-10: Silty SAND
10-15: Sl gravelly SAND
15-25: Gravelly SAND
25-100: SAND
(Thin layers SILT, 62-63-ft)
(Faint ammonia smell @ 85-ft)
100-105: Sl gravelly SAND
(Ammonia smell-30ppm)
105-235: SAND
(SILT/vf SAND @ 109-ft)
(1,000ppm ammonia @ 110-ft)
(Ammonia smell to ~150-ft)
235-250: Sl gravelly SAND
250-270: Gravelly SAND
270-280: Sandy GRAVEL
280-285: Gravelly SAND
285-286: Sandy GRAVEL
286-295: Sl gravelly SAND w/layers of Sl gravelly SILT/CLAY
295-300: SAND
300-306: Gravelly SAND
306-325: Sandy GRAVEL
325-330: Gravelly SAND



Elevation of reference point: [721.78-ft] (top of casing)
Height of reference point above ground surface [3.08-ft]
Depth of surface seal [1.5-19.4-ft]
Type of surface seal: Cement grout to 19.4-ft, has 4-ftx4-ftx6-in concrete pad extending 1.5-ft into annulus
4-in ID stainless steel casing ~+0.5-309.5-ft
Hole diameter, 0-146.0-ft, 11-in nominal
146.0-329.8-ft, 9-in nominal
Granular bentonite, 19.4-298.0-ft, 8-20-mesh
Bentonite pellets, 298.0-305.3-ft
Silica sand, 305.3-330.0-ft, 20-30-mesh
4-in ID stainless steel screen 310.5-330.0-ft, #20-slot w/10-20-mesh sand filter pack
8-in stainless steel telescoping screen, 309.5-329.6-ft, #20-slot
Borehole drilled depth: [330.0-ft]

Drawing By: RKL/2E17-15.ASB
Date : 03Sep93
Reference :

**Figure C-4. Well 299-E17-15 Construction and Completion Summary (page 1 of 2)**

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                    SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
                          RESOURCE PROTECTION WELL - 299-E17-15

WELL DESIGNATION     :    299-E17-15
CERCLA UNIT          :    200 Aggregate Area Management Study
RCRA FACILITY        :    216-A-36B Crib
HANFORD COORDINATES  :    N   38,710.2  W    48,399.6 [10Jun88-200E]
LAMBERT COORDINATES  :    N  443,879    E 2,246,826   [HANCONV]
DATE DRILLED         :    May88
DEPTH DRILLED  (GS)  :    330.0-ft
MEASURED DEPTH (GS)  :    Not documented
DEPTH TO WATER (GS)  :    312.8-ft, May88;
                          317.8-ft, 22Jun93
CASING DIAMETER      :    4-in stainless steel, ~+0.5-310.5-ft;
                          6-in stainless steel, +3.1--0.5-ft
ELEV TOP CASING      :    721.78-ft,           [10Jun88-200E]
ELEV GROUND SURFACE  :    718.70-ft, Brass cap [10Jun88-200E]
PERFORATED INTERVAL  :    Not applicable
SCREENED INTERVAL    :    310.5-330.0-ft, 4-in #20-slot stainless steel;
                          309.5-329.6-ft, 8-in telescoping, #20-slot
COMMENTS             :    FIELD INSPECTION, 06Feb90;
                          Stainless steel casing.  4-ft by 4-ft concrete pad, 4 posts, 1 removable
                          capped and locked, brass cap in pad with well ID.
                          Not in radiation zone.
                          OTHER:
AVAILABLE LOGS       :    Geologist, driller
TV SCAN COMMENTS     :    Not applicable
DATE EVALUATED       :    Not applicable
EVAL RECOMMENDATION  :    Not applicable
LISTED USE           :    A10/A36 Cribs quarterly water level measurement, 31May88-22Jun93;
CURRENT USER         :    WHC ES&M w/l monitoring and RCRA sampling,
                          PNL sitewide sampling 93
PUMP TYPE            :    Hydrostar
MAINTENANCE          :
```

**Figure C-4. Well 299-E17-15 Construction and Completion Summary (page 2 of 2)**

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200 W Water Supply
Driller's Name: L. Cordon
Drilling Company: Kaiser Engineers
Date Started: 10Mar88

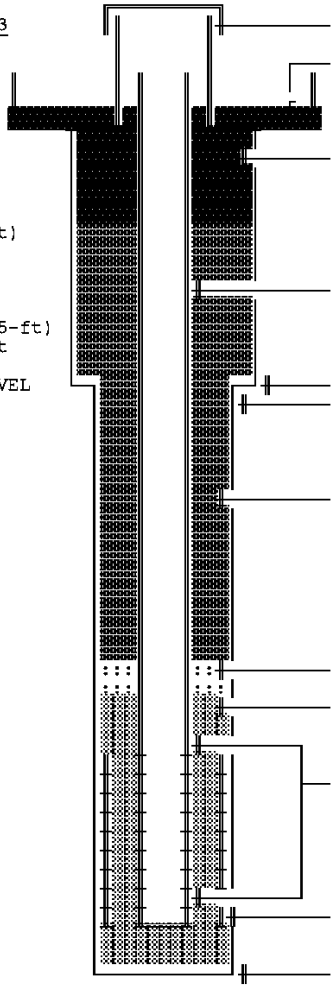
Sample Method: Drive barrel Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 16May88

WELL NUMBER: 299-E17-16
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 38,476.2 E/W W 48,390.5
State Coordinates: N 443,654 E 2,246,836
Start Card #: Not documented T R S
Elevation Ground surface: 717.78-ft (Brass cap)

Depth to water: 313.0-ft May88
(Ground surface) 316.3-ft 22Jun93

GENERALIZED STRATIGRAPHY Log
Geologist's
Sl=slightly

0-40: SAND w/SILT
(moist, 34-45-ft)
40-85: Cse-med SAND
85-105: SAND w/med-cse PEBBLES
@ 85-ft
(>1,000ppm ammonia @ 90-ft)
105-107: SAND w/SILT layers
107-110: SILT
110-235: SAND
(CaCO3 rich, 160-170-ft)
(CALICHE layering, 200-205-ft)
(SILT layering, 210-220-ft and 230-235-ft)
235-270: Gravelly SAND-sandy GRAVEL
270-285: SAND
285-286: Gravelly SAND
286-289: SILT
289-295: SAND
295-300: Sl gravelly SAND
300-305: SAND
305-320: Sandy GRAVEL
320-325: Sl gravelly SAND
325-330: SAND
330-335: Sandy GRAVEL
335-337: Gravelly SAND



Elevation of reference point: [720.58-ft] (top of casing)
Height of reference point above ground surface [2.8-ft]
Depth of surface seal [1.5-19.5-ft]
Type of surface seal: Cement grout to 19.5-ft, has 4-ftx4-ftx6-in concrete pad extending 1.5-ft into annulus
4-in ID stainless steel casing, ~+0.5-309.0-ft
Hole diameter, 0-133.0-ft, 11-in nominal
133.0-337.0-ft, 9-in nominal
Granular bentonite, 19.5-300.5-ft, 8-20-mesh
Bentonite pellets, 300.5-305.0-ft
Silica sand pack, 305.0-337.0-ft, 10-20-mesh
4-in ID stainless steel screen, 309.0-330.0-ft, #20-slot w/10-20-mesh, sand filter pack
8-in stainless steel telescoping screen, 310.0-330.0-ft, #30-slot
Borehole drilled depth: [337.0-ft]

Drawing By: RKL/2E17-16.ASB
Date : 03Sep93
Reference :

**Figure C-5. Well 299-E17-16 Construction and Completion Summary (page 1 of 2)**

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                    SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
                          RESOURCE PROTECTION WELL - 299-E17-16

WELL DESIGNATION     :    299-E17-16
CERCLA UNIT          :    200 Aggregate Area Management Study
RCRA FACILITY        :    216-A-36B Crib
HANFORD COORDINATES  :    N   38,476.2  W    48,390.5 [10Jun88-200E]
LAMBERT COORDINATES  :    N  443,654    E 2,246,836   [HANCONV]
DATE DRILLED         :    May88
DEPTH DRILLED  (GS)  :    337.0-ft
MEASURED DEPTH (GS)  :    Not documented
DEPTH TO WATER (GS)  :    313.0-ft, May88;
                          316.3-ft, 22Jun93
CASING DIAMETER      :    4-in stainless steel, ~+0.5-309.0-ft;
                          6-in stainless steel, +2.8-~0.5-ft
ELEV TOP CASING      :    720.58-ft,           [10Jun88-200E]
ELEV GROUND SURFACE  :    717.78-ft, Brass cap [10Jun88-200E]
PERFORATED INTERVAL  :    Not applicable
SCREENED INTERVAL    :    309.0-330.0-ft, 4-in #20-slot stainless steel;
                          310.0-330.0-ft, 8-in telescoping, #30-slot
COMMENTS             :    FIELD INSPECTION, 20Jan92;
                          Stainless steel casing.  4-ft by 4-ft concrete pad, 4 posts, 1 removable
                          capped and locked, brass cap in pad with well ID.
                          Not in radiation zone.
                          OTHER:
AVAILABLE LOGS       :    Geologist, driller
TV SCAN COMMENTS     :    Not applicable
DATE EVALUATED       :    Not applicable
EVAL RECOMMENDATION  :    Not applicable
LISTED USE           :    A10/A36 Cribs quarterly water level measurement, 22Jun88-22Jun93;
CURRENT USER         :    WHC ES&M w/l monitoring and RCRA sampling,
                          PNL sitewide sampling 93
PUMP TYPE            :    Hydrostar
MAINTENANCE          :
```

**Figure C-5. Well 299-E17-16 Construction and Completion Summary (page 2 of 2)**

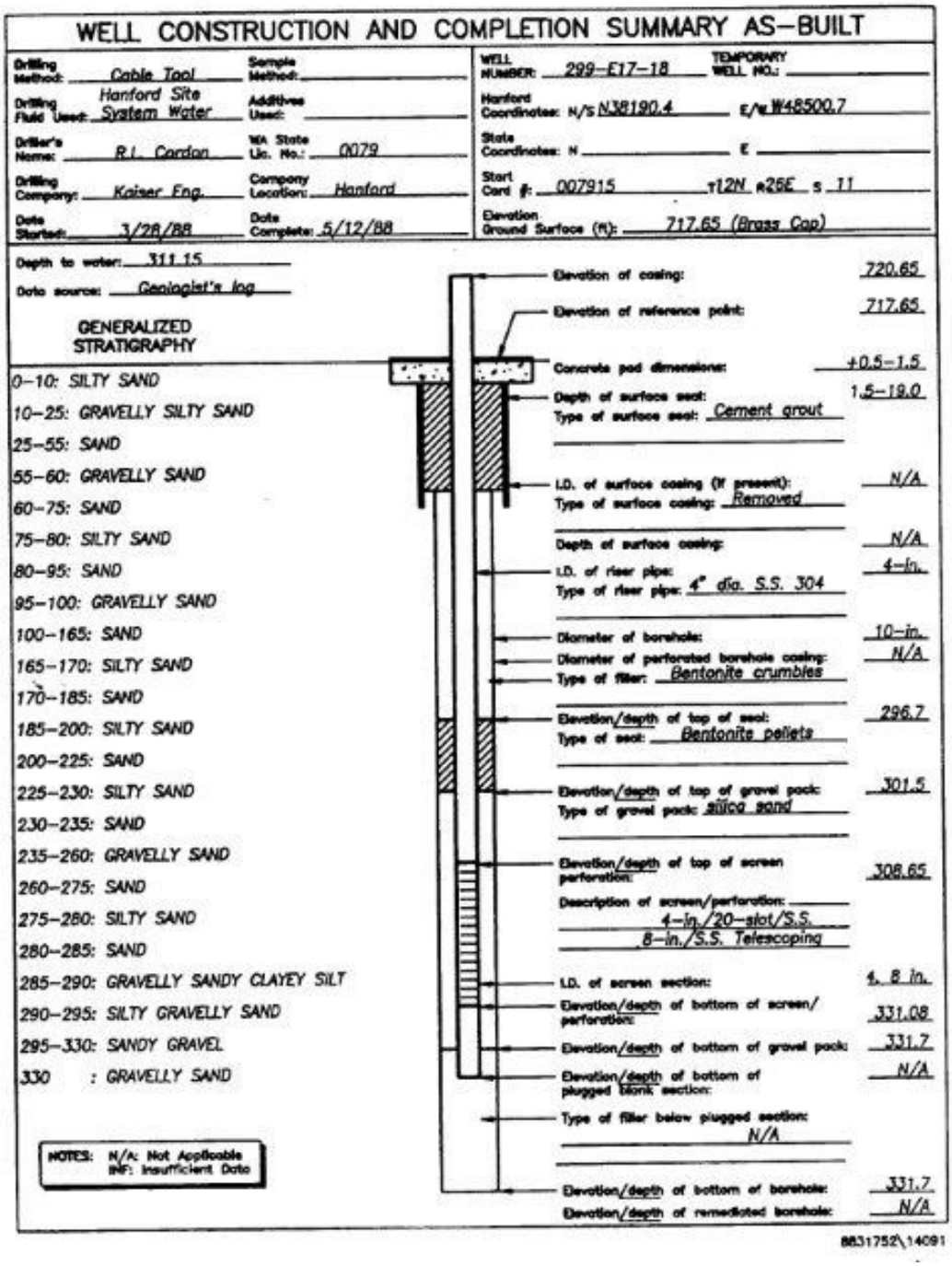


**Figure C-6. Well 299-E17-18 Construction and Completion Summary**

## C2 Reference

NAVD88, 1988, *North American Vertical Datum of 1988*, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland. Available at: http://www.ngs.noaa.gov/.

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